DOCUMENT RESUME

ED 447 804 IR 020 437

TITLE	Skill Standards for Information Technology. Millennium Edition. Building a Foundation for Tomorrow.
INSTITUTION	NorthWest Center for Emerging Technologies, Bellevue, WA.
SPONS AGENCY	National Science Foundation, Arlington, VA.
PUB DATE	1999-00-00
NOTE	487p.; Funded by the National Science Foundation's Advanced Technological Education (ATE) program. For related Building a Foundation for Tomorrow documents, see IR 020 420 and IR 020 438.
CONTRACT	DUE-9813446
AVAILABLE FROM	NorthWest Center for Emerging Technologies, 3000 Landerholm Circle SE, B127, Bellevue, WA 98007-6484; Tel: 425-564-4215; Fax: 425-564-2482; Web site: http://www.nwcet.org; e-mail: nwinfo@bcc.ctc.edu. American Association of Community Colleges; Tel: 202-728-0200; Web site: http://www.aacc.nche.edu/books/bookstore.
PUB TYPE	Guides - Non-Classroom (055) -- Reference Materials - General (130)
EDRS PRICE	MF02/PC20 Plus Postage.
DESCRIPTORS	Computer Literacy; Computer Science; *Information Technology; *Job Skills; Occupational Clusters; *Occupational Information; Postsecondary Education; Standards

ABSTRACT

This document presents skill standards for technology occupations. An overview describes national context, changes in the updated "Millennium Edition" of the skill standards, trends in information technology, and curriculum informed by skill standards. Skill standards are presented for eight career clusters in information technology (i.e., groupings of representative job titles related by a close association with a common set of technical skills, knowledge, and abilities). The career clusters include: (1) database development and administration; (2) digital media; (3) enterprise systems analysis and integration; (4) network design and administration; (5) programming/software engineering; (6) technical support; (7) technical writing; and (8) World Wide Web development and administration. The section for each career cluster contains: a brief description of the work and sample job titles; a summary template listing functions and tasks; an overview (called "The Scene") and scenarios describing typical job situations and the challenges faced by entry level, proficient, and expert workers; and a detailed template listing the performance criteria, technical skills, knowledge and abilities, and foundation/employability skills associated with each function and task. Appendices include: a chart of project management, task management, and problem-solving/troubleshooting functions and tasks; print and Internet resources; and a list of participants. (MES)

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Skill Standards for INFORMATION TECHNOLOGY

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Skill Standards for
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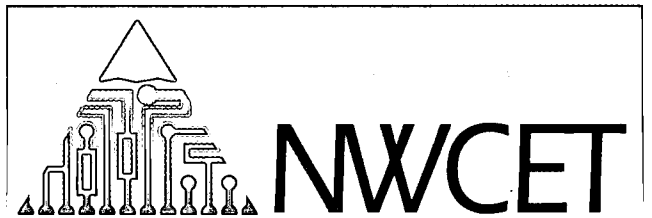

Bellevue Community College

Sponsored in part by the National Science Foundation

Partial support for this work was provided by the National Science Foundation's Advanced Technological Education (ATE) program through grant number DUE 9813446. Any opinions, findings, conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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Cover design by Joanne Lauterjung.

Layout by Illeny Maaza.

Produced by Bellevue Community College Printing Services.

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The format for this document differs somewhat from the Common Language published by the NSSB (National Skill Standards Board). The Steering Committee determined that the format selected for the document best reflects information technology skill standards, and that the differences were not significant. The methodology is in alignment with NSSB protocols.

Acknowledgments

The Millennium Edition of NWCET's landmark publication, *Building a Foundation for Tomorrow: Skill Standards for Information Technology*, updates the first edition and continues the cooperative effort among education, business and government that made it such a success.

CEOs, managers, human resource personnel and other information technology (IT) professionals from companies across the nation participated in generating the data that comprise the skill standards in the eight career clusters. Several hundred representatives from business and education, as well as organizations representing the breadth and scope of the information technology workforce both in IT companies and in firms that use and depend on IT, gave their time and expertise to the development of this document.

The NorthWest Center for Emerging Technologies especially acknowledges the major funding provided by the National Science Foundation, and the encouragement and vision of Dr. Gerhard Salinger, Dr. Elizabeth Teles and Dr. Thomas Howell, National Science Foundation Advanced Technological Education program directors. We are also indebted to our National Advisory Board for their perspective and feedback.

We are grateful to the American Electronics Association, which provided major funding and support for the national validation study review panels. Dr. Eileen Antonucci of Organizational Perspectives, Inc. conducted the national validation study, prepared the technical research report and gathered and summarized the field data that formed the basis for the update and revision.

We wish to acknowledge our IT Skill Standards Steering Committee, strategic partners, industry sponsors, subscribing members and printing sponsors for their material contributions to this work.

Special recognition goes also to Terryll Bailey of The Allison Group, who developed the research design and data gathering process for the Millennium Edition, facilitated the interviews and focus groups, and refined the raw data. Her devotion to the project and her dedication to the accurate development, categorizing and presentation of the tremendous amount of new data represented in this work deserve the highest praise.

We acknowledge the valuable contributions and support of the Washington State Board for Community and Technical Colleges and the faculty experts who collaborated on this project from Bellevue Community College and other community and technical colleges. Special thanks go to Suzanne Marks, Dean of Instruction for Workforce Development, and Carol Mandt, Special Assistant to Instruction for Curriculum, at Bellevue Community College for maintaining continuity between the first edition and the Millennium Edition, and to Jean Floten, President of Bellevue Community College, and Neil Evans, NWCET Executive Director, without whose vision the NWCET would not exist.

This project would not have been completed were it not for Dr. Sandra Mikolaski and Dr. Michèle Royer, Curriculum Project Managers at the NorthWest Center, who did the final data analysis and summary, organized the document and coordinated the work of our participants. Dr. Mikolaski managed the overall project from research through final production. D Koopman, Curriculum Associate, coordinated our skill standards project steering committee and kept track of hundreds of administrative details. Thanks to Renée Torobin and Teri Hull, NWCET staff, for their assistance in word processing and proofreading.

Peter Saflund

Peter Saflund
Associate Director, NWCET

Foreword

Building a Foundation for Tomorrow: Skill Standards for Information Technology represents a significant contribution to workforce development efforts in the critical information technology sector. The demand for information technology workers currently outstrips the supply, constraining the potential of the industry and curtailing economic growth. In response to this growing need, schools are rushing to establish programs. However, to be ethically responsible and economically viable, these emerging programs must be designed based on measurable, industry-approved skill standards. *Building a Foundation for Tomorrow: Skill Standards for Information Technology* establishes the definitive consensus on skill standards for technology occupations basic to the cultivation of a globally competitive, high-tech workforce.

- Students want assurance that the training they are receiving is relevant and marketable. Skill standards provide a template for educators when structuring the sequence of courses and experiences that define the employable graduate.
- Industry wants substantiation that potential workers have appropriate knowledge and capabilities. Skill standards provide an assessment tool for employers to determine the match between a candidate's skills and workplace expectations.
- Workers benefit when their skills are credentialed, based on industry accepted standards that are portable across business sectors and geographic regions. Such skills standardization ensures a more flexible, mobile workforce able to respond to fluctuating regional demand.

Reaching consensus on skill standards in the fluid world of high tech is no easy task. Institutions such as the NorthWest Center for Emerging Technologies (NWCET) make a major contribution to the industry due to their credibility within the high-tech community and capacity to consolidate thinking into this immensely practical document.

Now that the NWCET has codified and articulated the standards, the challenge is the dissemination of this work. The Millennium Edition of *Building a Foundation for Tomorrow: Skill Standards for Information Technology* "puts skill standards on the street" available to both employers and training providers. As employers publicize them through job announcements and candidate assessments, the standards will become recognized industry benchmarks. Wide use by the education/training community will result in consistently prepared candidates for IT positions. The publication brings our nation closer to the efficient, articulated workforce development system that will be the cornerstone of economic survival in the 21st century.

Louise Stevens, Ph.D.
U.S. Department of Education, Region X

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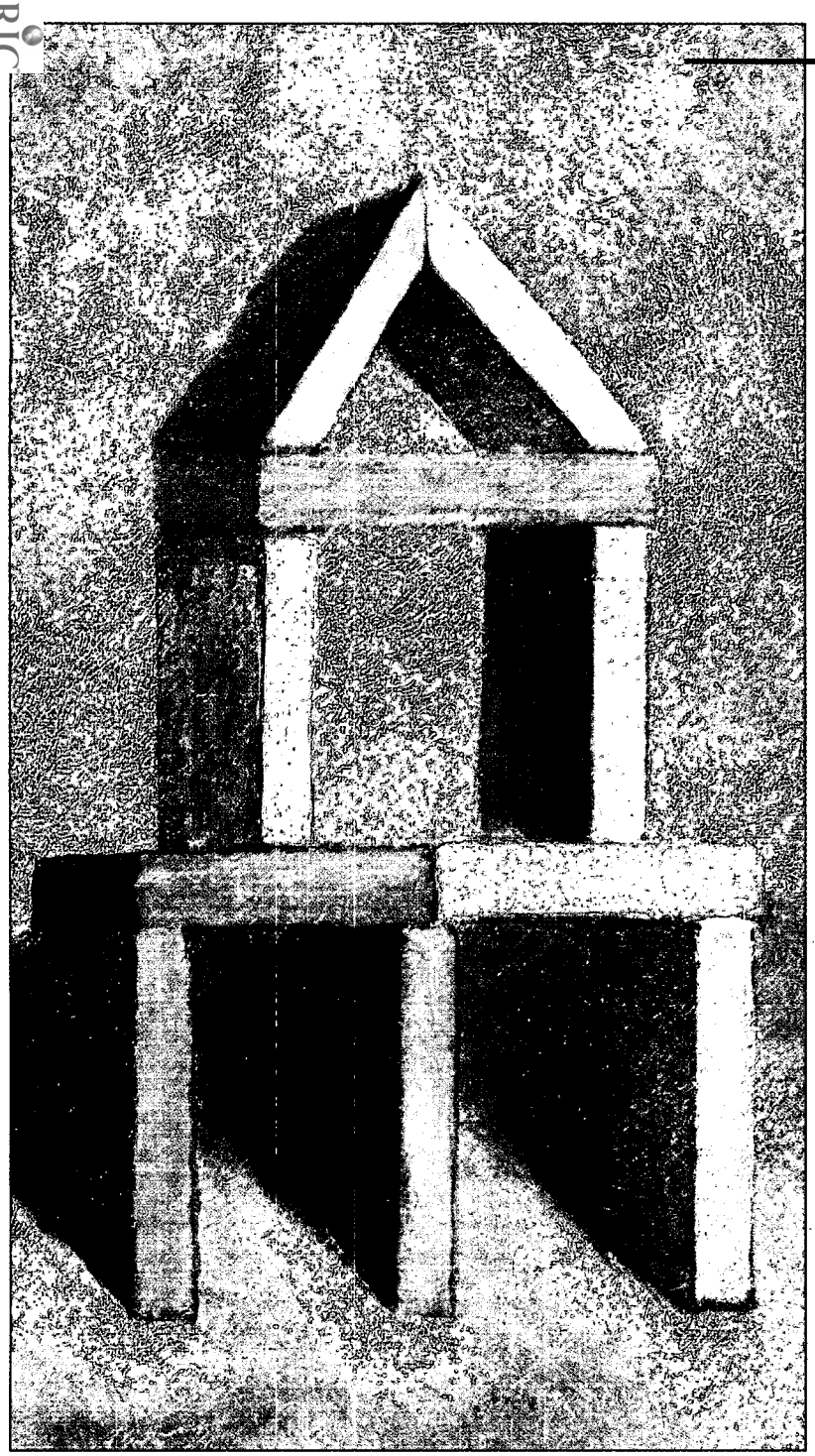


OVERVIEW

Skill standards can be the foundation tools for developing curriculum, profiling jobs, recruiting and evaluating employees, and designing academic and professional certification. They can be used alone, or in conjunction with other inputs such as those from subject-matter experts, industry advisory committees, professional organizations, existing academic or vendor-specific curriculum and accrediting organizations.

To compete internationally, U.S. companies must close the skills and knowledge gap between the requirements of today's technology—and information-based workplace and the current level of preparation of the workforce. Voluntary, industry-based skill standards provide a major step toward accomplishing this goal. They provide a common-language framework for educators, industry and other stakeholders to develop the educational and training tools necessary to prepare students and incumbent workers for today's workplace challenges as well as those that lie ahead.

Skill standards can:

- Improve the education and training of the information technology workforce.
- Increase cooperation between education and business.
- Improve academic mobility by facilitating the development of articulated curriculum that continues from high school through community or technical college and on to four-year institutions and graduate work.
- Establish criteria and standards for assessment, certification, compliance and degrees.

NWCET—Delivering Solutions for IT Education

In 1996, the NorthWest Center for Emerging Technologies (NWCET) and the Regional Advanced Technology Education Consortium (RATEC) identified skill standards for the original eight information technology (IT) career clusters in the first edition of *Building a Foundation for Tomorrow: Skill Standards for Information Technology*. Furthering this work, in the summer of 1998, the NWCET and the American Electronics Association (AEA) jointly undertook a nationwide project to validate the IT skill standards and to seek input from expert panels around the country for new and changing skills, work functions, technical knowledge and related employability skills to include in the Millennium Edition. Additional expert panel sessions were conducted regionally to augment and validate data on emerging career clusters. This document contains the results of those efforts.

The AEA contributed major funding for the national validation study and the nationwide expert panels. Organizational Perspectives, Inc. facilitated the national validation work groups, gathered and analyzed their data, and provided the technical research report summarizing the results of the national validation.

The major new industry research arising from recommendations of the national validation study, the research design, development of research instruments, conduct of industry expert panels, codification and interpretation of the resulting data and input to the skill clusters was performed by Terryll Bailey and the research associates of The Allison Group. Their research involved several methodologies including large and small groups, tele-

Introduction

phone interviews, and in-person interviews. National industry organizations such as the National Association of Networking Professionals and the World Organization of Webmasters provided interview subjects across the country to maintain the integrity of the national validation.

The document captures information from a large number of geographically diverse contributors and represents input from companies for whom IT is their core business, as well as many IT-intensive companies (companies whose products and services could not be delivered without IT). A detailed technical report explaining the research design, conduct of the expert panels, and the data gathering and summarizing process will be available from NWCET by late Fall of 1999.

Major funding for this project was provided by the National Science Foundation. The NWCET is an Advanced Technological Education (ATE) center devoted to increasing the quantity, quality and diversity of the IT workforce. The IT skill standards form the foundation for other IT curriculum products, assessment tools, certification exams, best practices and courseware developed by NWCET and its strategic partners.

Advanced Technological Education Program

The Advanced Technological Education (ATE) program at the National Science Foundation (NSF) promotes exemplary improvement in advanced technological education at the national and regional levels through support of curriculum development and program improvement at the undergraduate and secondary school levels. This program is especially beneficial for technicians being educated for the high-performance workplace of advanced technologies at two-year colleges. Projects and centers have a vision for technician education used to guide project development; they not only prepare students to enter the technical workforce, but also provide a solid foundation for continued higher education.

Currently, the ATE program is supporting 11 Centers of Excellence and about 160 projects. Centers focus on systemic approaches to technician education, usually within a specific discipline (manufacturing, environmental technology, biotechnology). However, they are also expected to have broad impact on two-year colleges, secondary schools, the region and the nation. Projects focus on specific aspects of technician education, such as curriculum or educational materials development and adaptation, faculty or teacher preparation or enhancement, technical experiences for students or laboratory development. All centers and most projects have extensive partnerships with business and industry, and also with other two-year colleges, four-year colleges and universities and secondary schools. Cooperative efforts among projects and centers assure the ATE program is having a national impact. NSF and the American Association of Community Colleges (AACC) act as partners by holding annual principal investigator meetings and supporting efforts that encourage networking and joint activities. In 5 years of program operation, centers account for 27% ($32.6 of $120.0 million) of fund allocation, and projects for 66% ($79.6 million).

Description of ATE Program provided courtesy of Michael Lesiecki, Director Maricopa Advanced Technological Education Center

National Context

"Our future depends on a community of well-educated responsible citizens—with the necessary skills to compete effectively in an increasingly global economy."

Phil Condit
Chairman and Chief Executive Officer,
The Boeing Company

To remain competitive, the U.S. must close the qualification gap between the knowledge and skills needed in the information- and technology-based workplace, and the current level of preparation of the workforce. The globalization of markets and industries together with the rapid development of technology have created a workplace where, increasingly, knowledge and technology are the key ingredients that must be combined to ensure the successful development and marketing of products and services.

Today even the most basic manufacturing operations are often performed in a technological context. Once the primary concern of software companies and computer manufacturers, the IT skill shortage now affects virtually every manufacturing and service industry, as these segments of the economy increasingly employ technology in their operations. Large multinational corporations report that their economic survival is keyed to the sharpness of their "technological edge" and this, in turn, places similar demands on the myriad of large and small local and regional suppliers, vendors and organizations providing services to these corporations.

E-business and e-commerce will generate additional need for skilled information technology workers and for increased technological literacy among all workers.

The move toward globalization of business and the need for increased organizational efficiency have driven organizations to be less hierarchical and more information- and knowledge-based. Old narrow divisions of labor have, in many cases, given way to more flexible, needs-based descriptions of work, resulting in increasing emphasis on teamwork, fluid transitions from leadership on one project to "followership" on the next, and a work environment where contextual application of knowledge and skills is the key ingredient for success. Today, people in virtually every occupation are increasingly required to think critically, solve problems creatively and efficiently, be flexible in the face of changing project demands, and demonstrate a commitment to continuous learning.

The shift to an economy and a workplace based more on information and knowledge implies a higher level of technical and foundation skills in the workforce. Education must restructure itself to help prepare this new workforce.

Why Skill Standards?

Successful industrialized nations that have maintained their competitiveness are characterized by a well-established skill standards system. The U.S. will be competitive only to the extent it is willing to reevaluate existing approaches to workforce development and adopt efficient strategies to ensure an adequate supply of workers with necessary skills. Since the inception of the School-to-Work Opportunities Act (1994), many states have embarked on programs to develop skill standards. The application of skill standards to the development of curriculum results in courses and programs whose outcomes can be assessed across a broad range of contextual technical and foundation performance criteria. This results in learners who are prepared to function effectively in the technology- and information-based workplace.

What Are Skill Standards?

Voluntary skill standards establish the agreed-upon, industry-identified knowledge, skills and abilities required to succeed in the workplace. They form a solid foundation for the development of outcomes-based instruction and assessment.

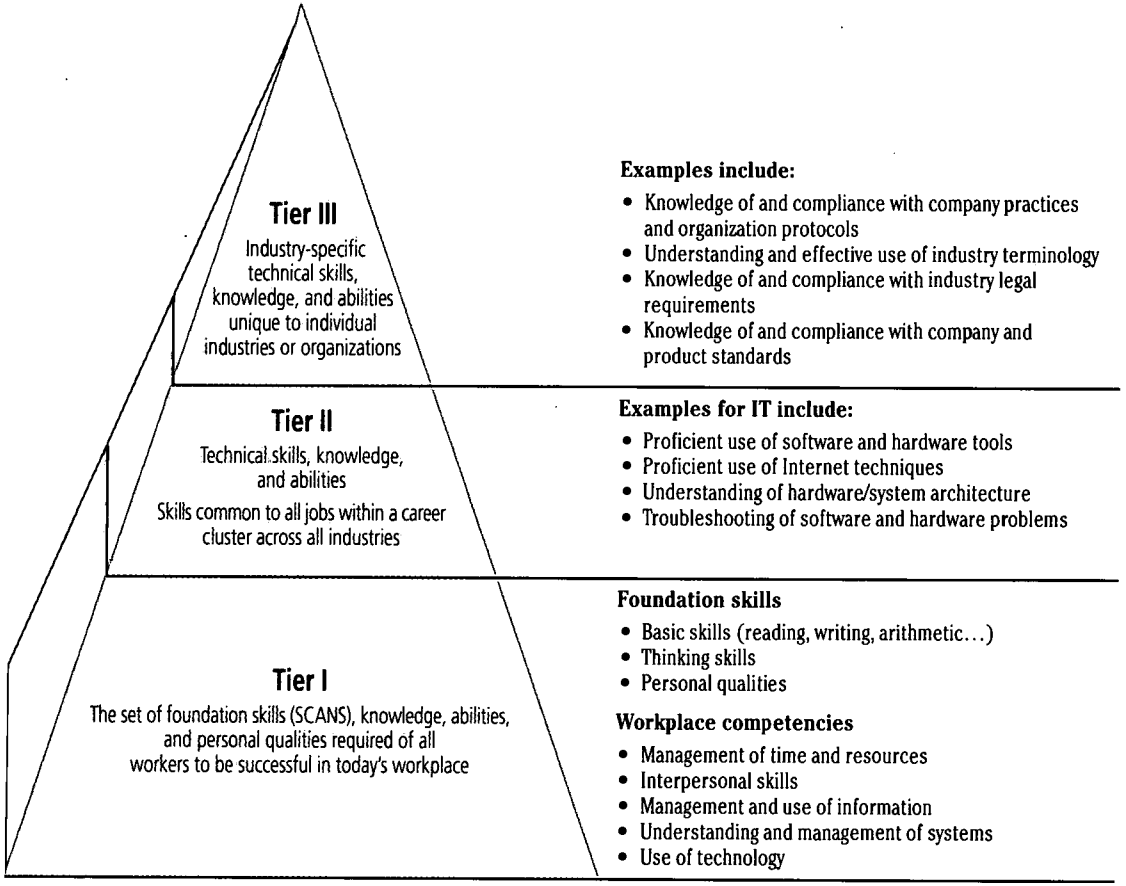
Skill standards differ from competencies in that they define high-level knowledge, skills, abilities and performance criteria.

The pyramid of competencies is a depiction of skill standards in three broad skill categories.

At the broadest level, Tier I, is the set of foundation skills, knowledge, abilities and personal qualities required of all employees to be successful in today's workplace. These are the universal skills—problem solving, team skills and flexibility—that are needed to apply technical knowledge and tools effectively.

Tier II—technical skills, knowledge and abilities—are the skills common to all jobs within a cluster across all industries. For a programmer, for example, knowledge of the principles of programming applies across all industries.

Tier III—industry-specific technical skills, knowledge and abilities—are unique to individual jobs or clusters and are the most prone to rapid change. For example, a programmer's required knowledge of data communications and network protocols may differ across companies and industries.



While traditional competencies may be developed from skill standards, the broad viewpoint taken by skill standards often provides clearer pathways for the development of more flexible and comprehensive curriculum. The practical value of this approach is to enable the development of more varied activities and assessments, provide for easier assessment of prior learning, and illuminate opportunities to use instructional resources such as internships or industry-expert guest teachers.

For skill standards to be effective, they must reflect the consensus of the industry professionals in that career field. The development of skill standards involves conducting extensive industry research, often using expert panels in intensive, tightly-focused work sessions aimed at extracting key job functions and tasks, identifying technical knowledge elements, determining performance criteria (how one knows when the task is performed well) and associating related knowledge, skills and abilities (including SCANS skills) to those functions and tasks.

The skill standards contained in this document have been developed utilizing this process with industry expert panels in different parts of the country. While the overall regional variation of industry-supplied data was very slight, our national data panels and world-class research methodology have produced a document of extraordinary reliability and utility.

To ensure the integrity, quality and continuity of the skill standards, several principles have guided their development:

- Experienced workers are the experts in their career field and are best able to identify the work performed and the skills, knowledge and abilities required to be successful.
- Business and education must work as partners to ensure the link between the work expectations and the curriculum.
- Skill standards should represent broad career clusters rather than narrowly defined jobs.
- Standards must be flexible and portable, and should be updated continuously.
- Skill standards must be voluntary and adaptable to regional and local needs.
- Skill standards describe the major functions and tasks, as well as the performance criteria, technical knowledge, tools and employability skills/attributes needed to perform those functions and tasks well.
- Integrated skill standards define work duties and the skills required to perform them in the context of work settings.

What Are the Benefits of Skill Standards?

Technology has not replaced workers as was once feared, but it has, for many, altered the way people do their jobs and relate to their coworkers and their organization. In order to ensure U.S. companies can be globally competitive and still have access to a skilled and technologically literate workforce, a new and closer partnership among business, education and government has emerged.

As former Secretary of Labor Robert Reich stated:

> *Our mission is far too vital, the stakes far too high, for anything but the most dispassionate analysis to guide decisions about how Americans learn and how Americans work.*
>
> *If we are to restore our heritage of shared prosperity, American workers need every bit of assistance we can give them in adapting to the new economy.*

"The challenge of delivering the highest quality products and services to our global customers requires that each of our businesses attract and utilize human resources...Voluntary skill standards will facilitate the skills dialogue with educators, employees, and our business associates."

James D. Burge
National Skills Standards Board,
Corporate Vice President, Motorola

Many of the old factory jobs that once formed the gateway to the middle class are gone. Such manufacturing jobs accounted for more than one third of all American employment in the 1950s; now no more than 16 percent. Many of the old service jobs have disappeared too. Telephone operators have been replaced by automatic switching equipment, bank tellers by automatic teller machines, gas station attendants by self service pumps that now even accept credit cards, and secretaries by computers and voice mail. Any job that can be done more cheaply by a machine is either gone, or pays far less than before.

The right education and skills don't guarantee a good job in the new economy, and certainly not job security. But it is getting harder to have either without education and skills.

In this new economy—a knowledge economy—skills matter more. Skills are what allow people to navigate change successfully.

And for workers to be highly productive, they must have the education and training necessary to keep them in tune with the onward march of technology. As America moves further into this age of information and global competition, it becomes increasingly important that we make critical investments in our "human capital"—that is, in the knowledge, education, and skills of our workers. Today, tomorrow, and far into the future, a highly-skilled workforce is and will be our competitive advantage.

Voluntary skill standards provide the framework within which U.S. companies can rebuild a competitive advantage in the global economy.

- Industry-identified skill standards will serve as a vehicle for companies to communicate their performance expectations for workers. Skill standards will provide a common framework for communication of workplace expectations among business, education, workers, students and government.
- Voluntary skill standards will facilitate the reform of education to match curriculum development to workplace requirements. Competency-based standards will assure the employability of students who have completed programs based on those standards. National recognition of skill standards in career fields will provide a common basis for certifying achievement against those standards, thereby allowing for portability of skills across companies and careers.
- Skill standards will close the qualification gap by linking industry expectations for knowledge, skills and abilities to the education provided to students. Skill standards will provide workplace expectations, so students will know what they need to be able to do to meet those expectations, workers understand what is expected in order to perform and advance in their field, and educators can identify the competencies on which curriculum can be developed or revised.

Who Benefits from Skill Standards?

Skill standards benefit industry, students, educators and government. Each group has a major stake in the education of our students and in the efficient development of a productive workforce. Particularly in fast-changing fields like information technology, relevant data that accurately reflects current and future knowledge and skills enables timely direction of resources, development and revision of industry-relevant curriculum, and efficient development of career information and job profiles. Skill standards occupy an indispensable position in any dialog concerning education or training in technical fields.

Industry can use skill standards to:	Students can use skill standards to:	Educators can use skill standards to:	Government can use skill standards to:
• Develop or modify training. • Communicate effectively with educators, students, parents and government. • Develop skill-centered work teams. • Assess and place new hires. • Develop performance appraisals. • Write job descriptions. • Develop recruiting methods, instruments and strategies. • Profile jobs and determine skill needs and gaps. • Forecast human resource needs. • Determine or modify supervisory roles or organizational structure. • Effectively benefit from vendor-neutral and professional certifications. • Compare and evaluate skills across divisions or departments.	• Research career pathways. • Understand skills requirements and employment characteristics of different jobs. • Plan educational programs. • Prepare resumes and other credentials to seek employment. • Evaluate and compare educational programs. • Prepare for industry and professional certifications. • Gain an understanding of the full range of technical knowledge and employability skills needed to succeed in a chosen field. • Help determine the application of prior learning or previous experience. • Obtain certification of their skills. • Improve the mobility and portability of their credentials. • Earn higher wages and experience greater security and opportunity. • Contribute to the success of their organizations.	• Develop or review curriculum, courses and courseware. • Communicate effectively with industry, parents, students and government. • Develop or enhance cross-curricular and interdisciplinary communication. • Determine current and future equipment requirements. • Develop professional development or inservice training plans. • Develop institutional response priorities. • Request or allocate human, physical and capital resources. • Research curriculum and instruction issues. • Advise students on career choices and educational options. • Develop internships, school-to-work, Tech Prep and other articulated programs. • Develop or highlight transfer pathways and inter-institutional programs. • Bridge technical and academic programs. • Assess prior learning. • Provide targeted instruction. • Start or improve the function of local advisory committees.	• Help develop a highly skilled, competitive workforce. • Forecast educational resource requirements and allocate resources using a gender-neutral, bias-free and vendor-neutral set of criteria. • Forecast workforce demands. • Develop training requirements. • Increase opportunities for underrepresented populations. • Develop educational, training and workforce policies. • Develop or enhance links among national efforts such as school-to-work, technical and vocational education, and other programs for targeted populations. • Research skills characteristics of fast-moving technology-based industries. • Effectively communicate with other institutions and stakeholders.

The Millennium Edition

Welcome to the Millennium Edition, version 2 of *Building a Foundation for Tomorrow: Skill Standards for Information Technology*. We have tried to retain the familiar look and feel of the first edition while incorporating the changes and updates suggested by our many educational and business users, and by the industry expert panels and national validation groups.

What's New in Version 2

Some of the major differences include:

- Standards content reviewed by national data panels for accuracy and consistency.
- New functions, tasks and supporting details in all skills clusters.
- Compliant with National Skill Standards Board (NSSB) terminology and taxonomy.
- Streamlined functions and tasks.
- Taxonomy of IT skills cluster by educational attainment.
- Updated cluster overviews and scenarios to reflect entry, proficient and expert level workers.
- More data on current workforce challenges and future trends.
- Critical employability skills emphasized.
- Core math and science skills identified.
- IT core curriculum identified.
- New cluster titles representing emerging technological and market trends.
- Expanded section on applications of skill standards.
- New section on e-business and e-commerce.
- New section on certification and assessment.

We have tried to ensure that the technical information is conveniently accessible and presented in a form that can be useful to both educators and business.

A CD-ROM version of this document is also available. Future plans include offering the skill cluster content in an electronic database, updated frequently and available by subscription.

Methodology

The Millennium Edition of *Building a Foundation for Tomorrow: Skill Standards for Information Technology* is the end result of a national review and update of the edition published in 1997. The goal of the national review and update project was to nationally validate and update the regionally developed NWCET information technology skill standards. This was accomplished with the following steps:

- Nationwide expert panels
- In-depth interviews/focus groups/surveys—regional and national
- Compilation and analysis of the data/development of the skill standards
- Validation

Nationwide Expert Panels

Quantitative and qualitative information was collected using expert panels of professional information technology workers, managers and other key stakeholders. These expert panels were conducted in geographically diverse locations of the country where there are high concentrations of IT workers: Fairfax County, Virginia; Springfield, Massachusetts; and Santa Clara, California.

Forty-five expert panel participants, representing 40 organizations attended the panels. There were

"Overall, the skill mix of the economy will be moving rapidly upscale, with most new jobs demanding more education with higher levels of language, math, and reasoning skills....the job prospects for professional and technical, managerial, sales, and service jobs will far outstrip the opportunities in other fields."

William B. Johnston and Arnold H. Packer
in *Workforce 2000, Work and Workers for the 21st Century*

five guidelines for recruitment of experts to the panels. Participants should:

- Represent a range of different types of companies (both high-tech and high-information use)
- Represent one of the principal job roles of the eight career clusters
- Be viewed as high performers in their jobs
- Work well in groups
- Be open to new ways of thinking

Five questions addressing emerging information technology workforce trends and career clusters were asked of each panel:

- What are the key business issues facing organizations?
- What are the most pressing workforce challenges?
- What workforce trends are emerging in information technology?
- What other IT career clusters would benefit from skill standards?
- What are some potential uses of skill standards in organizations?

Nine questions addressing the IT skill standards published in 1997 were also asked of each panel:

- Is the career cluster still relevant?
- Do the functions and tasks reflect what people do in carrying out these roles?
- Are the standards complete and logically organized? (Are there any functions or tasks missing? Can any of the functions be combined, deleted or reorganized?)
- Do the performance criteria reflect a fully competent level of performance?
- Which criteria are most critical to successful performance of the task?
- Is the language used appropriate and will it make sense to various users of the standards such as workers, supervisors, trainers and educators?
- Do the standards reflect a variety of settings and job titles?
- Will the standards be relevant one, three, five years from now?
- Can any of the career clusters or parts of them be merged with other clusters?

The information from the national expert panels was gathered, compiled and analyzed. It was compared to the 1997 skill standards and based on the new information regarding emerging workforce trends and feedback on the individual clusters, a preliminary draft of the skill standards was developed. This draft included: combining two of the career clusters from the 1997 skill standards (Programmer/Analyst and Software Engineer); distributing still relevant skills from one cluster (Information Systems Operator/Analyst) to other clusters (primarily Technical Support and Network Design and Administration); and adding one cluster (Enterprise Systems Analysis and Integration). A second new cluster was added, Web Development and Administration, based on extremely strong feedback during the interviews and input from industry members of the Information Technology Skill Standards Steering Committee, corroborated by information gathered from the nationwide expert panels. The initial draft was reviewed by a technical team with expertise in both information technology and skill standards to produce a working draft of the updated skill standards.

In-Depth Interviews/Focus Groups/ Surveys—Regional and National

The working draft of the standards formed the basis for additional data gathering from in-depth interviews, focus groups and follow-up surveys. Half-day interviews were conducted with groups of six to eight experts in each of the six original career clusters. Guidelines for recruitment included:

- High-tech and high-information use companies
- Diversity in size of company
- Geographical diversity
- High level of expertise in the cluster
- High performers
- At least one independent contractor per cluster

The purpose of the interviews was to clarify and critique the functions and tasks, performance criteria, technical knowledge and skills and employability/workplace skills for each cluster. Interviews provided the following information for each job cluster:

- Feedback regarding the working draft of the skill standards
- Information regarding performance criteria and skills, knowledge and abilities for new functions and tasks
- New scenarios and career information
- Data regarding math and science knowledge and skills required for information technology careers

A one-day focus group followed by a half-day conference call was conducted for each new career cluster: Enterprise Systems Analysis and Integration, and Web Development and Administration. Subject matter experts for each career cluster were recruited to:

- Define the critical work functions, key activities, performance indicators, technical knowledge, and employability (SCANS) skills and personal qualities required for the cluster
- Obtain appropriate scenarios and career information for each of these new clusters
- Provide industry views on foundation skills for information technology workers. The ADVANCE™ *Workplace Standards Skill Inventory* from Advance Educational Spectrums, Inc. was used to capture and rank the SCANS skill levels required for the career cluster.

Compilation and Analysis of the Data/ Development of the Skill Standards

Once the interviews were complete, the data was compiled, summarized and analyzed for consistency. The interviewees also provided feedback on clarification of language, logical organization of the critical work functions and key activities, and emerging trends and their relevance. This data was incorporated into the final draft, and reviewed and revised by a technical team with expertise in both skill standards and information technology. The draft was then examined and evaluated by an executive review team consisting of executives from industry and higher education to produce the final version of the skill standards for information technology.

Validation

Validation of the original research confirmed that the initial data gathered in the 1996 DACUMs was relevant to the industry at large. No significant variation was found to exist regionally. Surveys were conducted to determine if the functions and tasks identified by the IT professionals in each of

the eight career clusters would be validated by a broader sample of peers. Surveys were sent to a random sample of 2,400 companies drawn from six industry segments. A total of 940 completed surveys originating from 748 different companies was received. The results showed that there were no significant differences between the high-technology, high-information use, and low-information use companies in the survey sample.

The results from a new validation of the Millennium Edition of *Building a Foundation for Tomorrow: Skill Standards for Information Technology* will be available in a separate technical report which will be published late fall, 1999.

Contributed by Terryll Bailey,
The Allison Group

Trends in Information Technology

The following paragraphs describe some of the trends in information technology careers that may be of interest to users of skill standards. The information has been compiled and synthesized from a number of sources, including briefings from the industry expert panels that contributed to the skill standards, interviews with learned faculty and other resources.

E-Business

E-commerce and e-business are often used interchangeably. This section attempts to characterize the major impacts of this trend. Arguably, no application of information technology will be more pervasive in the foreseeable future than electronic commerce. Various aspects of electronic commerce will impact firms of every type and size, from home-based proprietors to global enterprises.

In general terms, electronic commerce is the intensive application of information technology to enable, enhance and facilitate business transactions. The most obvious examples are consumer-oriented businesses selling directly to end-users via the web. While these activities have garnered a large share of media attention, the total value of these transactions pales in comparison to business-to-business commercial activities.

There are diverse opinions regarding the dividing line between e-commerce and e-business. One clarification is contained in a report from *Extraprise* (Volume 1, No 4, June 1998). It defines e-business as:

> *...the intersection of Internet technology with critical enterprise applications. The thoughtful application of Internet, intranet, and external technologies, to either existing or re-engineered systems, can create an electronic continuum of business processes from marketing promotion to a sales transaction, through order processing, logistics, manufacturing, billing, shipping, customer support, and cross selling. The resulting environment extends significantly beyond a simple commerce phase to create a continuous Internet customer life cycle. The term e-commerce, then, is more limited to the use of Internet technology in the selling process only.*

There are other legitimate interpretations of what distinguishes e-business from e-commerce. One distinction that is often made is that e-commerce describes Internet sales to end users (retail purchases) while e-business defines enterprise-level transactions that may occur between manufacturers and vendors, manufacturers and distributors, suppliers and retailers, between distributors and among business divisions.

E-commerce will certainly revolutionize the way business is done. Entities that may be competitors may find they benefit from "co-opetition"—the coined word describing cooperative competition. For instance, two suppliers may compete in the retail market, but agree to give each other access to portions of their inventory databases for more rapid satisfaction of customer orders. The considerations surrounding conduct of business, data integrity and security, rights, access, restrictions and inter-operability are substantial.

Potentially, the considerations surrounding digital commerce, which includes e-business and e-commerce, impact several IT career cluster areas and differing organizational levels. At the technician level, implementation of digital commerce would probably impact network administrators, workstation support technicians, web page authoring and maintenance personnel and database administrators.

Above the technician level, critical decisions must be made concerning database design and security, possible programming changes, network security and configuration, web presence and inter-operability between and among disparate data repositories and systems. These decisions will involve application of high-level business rules, knowledge of accounting and business, network engineering considerations, and programming and database design, more appropriately the province of four-year or graduate-level personnel.

Electronic commerce considerations will become increasingly a part of work defined by the eight career clusters captured in the IT skill standards.

Contributed by Ted Smith, Gartner Institute

Iterative Processes

Throughout the running of the expert panels and focus groups that developed the skill standards, the iterative nature of work was repeatedly stressed. Work in the information technology field is almost never performed in discrete segments like a manufacturing assembly line. Significant interaction occurs frequently and at all levels during data gathering, design, testing, and integration or delivery. Teamwork, collaboration, cooperation, and group productivity skills are required in almost every occupation in information technology. These skills are applied not only within one's own organization, but extend to clients, customers and users as well.

The iterative nature of this work is both formal, as in the case of project and design reviews, and informal, as in the case of on-going exchanges between users and developers. Nevertheless, the requirement to communicate and document proposed and implemented suggestions will also be critical to the success of information technology workers.

Contracting and Consulting

The trend toward focusing on core businesses and core competencies that started with large firms is being adopted by smaller firms as well. For information technology, this trend has resulted in increasing numbers of long-term contract positions at the technician level, and large growth in consulting services at the professional level.

Firms for whom information technology is not a core competency may contract for computing infrastructure, hardware, maintenance, web site hosting, transaction processing, data warehousing and employee training in the use of technology. This trend has created opportunities for full-time employment with the contractors supplying these services, rather than with the end-user of the services. Contract workers often do not have permanent status. Although many assignments extend for the duration of the contract (and are therefore considered "long-term"), they are temporary because there is no assurance the contract will be renewed or extended. Because of the explosive growth of the information technology industry and the shortage of skilled workers, relatively few proficient individuals have experienced periods of unemployment, and this is expected to be the case for the foreseeable future.

Many firms also employ consultants in short- and long-term positions to help provide implementation and integration guidance, and to research and provide strategic input, especially in technology forecasting and deployment. Large and small firms also seek consultants with specific skills in current or emergent technologies as they apply to their business needs. Consultants may work independently but are often part of skilled groups whose services are arranged through large firms specializing in consulting services. Persons work-

ing for these firms often acquire valuable worldwide enterprise perspective as they work through their assignments, and bring their technical expertise and aggregated experience to each new assignment.

Specialists Versus Generalists

An interesting divergent trend seems to be emerging in the structure of the information technology workforce in large versus small companies. Larger firms seem to gravitate more toward specialization at both the technical and management level. Some technical workers support relatively small groups dedicated to one project that is narrow in scope. As a result, there is a tendency to develop extreme experts in a very tightly focused area.

Interestingly, smaller concerns and some larger companies for which IT is not a core business, express strong interest in finding individuals with a range of skills, knowledge and abilities. This implies that the employee is able to determine when the firm needs to seek external resources, and to make the case for justifying their use when necessary. It also means the employee is more effective when able to communicate not only laterally, but to all organizational levels. Since students and recareering adults often start with small concerns, this trend implies that educational and training efforts should include activities and assessments that build the student's ability to integrate a range of skills and abilities.

Nontraditional Degree Paths

The nature of information technology work and the explosive growth of the field has created opportunities for rapid career progression and salary advancement. The iterative and project-based nature of the work means experienced persons will have increasing responsibilities in project management, planning, and coordination. There is a trend toward "upside down" degrees. Technician-level persons are acquiring additional business education by which they become qualified for increasing management responsibility.

Four-year schools, especially those that cater to working adults, are often willing to evaluate technical education and professional development in partial fulfillment of academic degree requirements, and are increasingly willing to offer individualized study and flexible cohort-based learning groups to facilitate degree completion.

Information technology workers at all levels value their education, strive to stay current, and are often among the most willing employees to take advantage of professional development and career advancement opportunities. This trend implies that employers must continue to provide professional development and career advancement opportunities, and also suggests that there will be continued growth in nontraditional undergraduate and graduate education for information technology workers.

"More than ever, an education that emphasizes general problem-solving skills will be important. In a changing world, education is the best preparation for being able to adapt."

Bill Gates, Chairman and CEO
The Microsoft Corporation,
in *The Road Ahead*

Curriculum Informed by Skill Standards

The information in this section offers several starting points and examples for planning the development of curriculum informed by skill standards. Identification of skill standards is only the first step in a continuous process of curriculum and courseware development, articulation among various educational programs and levels, and ongoing feedback and revision to the standards. This iterative approach keeps the information vital, relevant and applicable to preparing and building a skilled information technology workforce.

Mapping Information Technology Careers

The table that follows describes in visual form our efforts to map the range of information technology jobs and the career progression within skill standards cluster areas. This data has been compiled from several sources, including separate interviews with selected industry expert panel participants, teachers, human resource professionals, counselors and advisors from high school through university, and equipment and software manufacturers.

The representative occupation titles are meant to be illustrative only and should not be interpreted as an inclusive, exhaustive or definitive summary of available job titles.

In general, this work illustrates the availability of career progression pathways in information technology fields. Mobility may be further enhanced by professional certification, and a variety of vendor-neutral and vendor-specific certification programs and examinations.

Not surprisingly, additional education provides additional options, higher starting pay and increased mobility. Consistent with other data, employers state that hiring decisions are made on the basis of many factors, one being technical skills. Others include judgment, maturity and the range of SCANS and employability skills.

The number of articulation pathways from high school to community and technical college programs is increasing. There are an encouraging number of career choices for individuals with two-year community or technical college degrees. Individuals with strong technical foundations are also accessing baccalaureate completion and Master's degree programs, especially those oriented to working professionals.

NWCET will continue to research and document information technology career options and track career progression pathways.

IT Core Curriculum

NWCET's Curriculum Research and Development Group has developed an IT core curriculum. The curriculum consists of learning components, learner program outcomes and key competencies. Learning components may be thought of as meaningful categories of related skills and knowledge that are best taught/learned together and represent logical pieces of curriculum. This competency-based curriculum was derived from the skill standards for the IT career clusters published in *Building a Foundation for Tomorrow: Skill Standards for Information Technology* by NWCET in 1997, and is available for order from NWCET.

The learning components included in the IT core curriculum are the following:

Analytical Skills and Problem Solving

Analytical and Logical Thinking

Conceptualization

Data Gathering, Analysis and Organization

Estimation and Cost/Benefit Analysis

INFORMATION TECHNOLOGY SKILL CLUSTER TITLES AND TAXONOMY OF EDUCATIONAL ATTAINMENT AND PROGRESSION

Cluster Title	Representative Occupation Titles	High School	1-Year Certificate	2-Year Certificate/ Degree	4-Year Degree	Graduate Level
Database Development and Administration	Data Analyst			✓		
	Database Administrator				✓	✓
	Database Analyst			✓	✓	
	Database Developer			✓	✓	✓
	Data Architect				✓	✓
	Data Modeler				✓	✓
	Knowledge Architect				✓	✓
Digital Media	Animator		✓	✓	✓	
	2D/3D Artist		✓	✓	✓	
	Virtual Reality Specialist			✓	✓	✓
	Multimedia Author		✓	✓	✓	✓
	Media Specialist		✓	✓	✓	
	Media/Instructional Design			✓	✓	✓
	Producer				✓	✓
Enterprise Systems Analysis and Integration	Systems Analyst				✓	✓
	Systems Integrator				✓	✓
	Electronic Commerce Specialist				✓	✓
	Electronic Transaction Specialist			✓	✓	✓
	Data Systems Manager				✓	✓
	Data System Designer				✓	✓
	Infrastructure Analyst				✓	✓
	Business Continuity Analyst				✓	✓
	Chief Information Officer				✓	✓

INFORMATION TECHNOLOGY SKILL CLUSTER TITLES AND TAXONOMY OF EDUCATIONAL ATTAINMENT AND PROGRESSION

Cluster Title	Representative Occupation Titles	High School	1-Year Certificate	2-Year Certificate/ Degree	4-Year Degree	Graduate Level
Network Design and Administration	Network Technician	✓	✓	✓		
	Network Engineer				✓	✓
	Network Operations Analyst			✓	✓	✓
	Data Communications Analyst		✓	✓	✓	✓
	Network Architect				✓	✓
Programming/ Software Engineering	Software Engineer				✓	✓
	Software Tester			✓	✓	
	Software Applications Specialist			✓	✓	
	SW Development Engineer				✓	✓
	Programmer/Analyst			✓	✓	✓
	Software QA Specialist			✓	✓	
Technical Support	Technical Support Representative		✓	✓		
	Customer Service Representative		✓	✓	✓	
	Help Desk Technician	✓	✓	✓		
	PC Support Specialist	✓	✓	✓		
	Sales Support Technician		✓	✓	✓	
	Maintenance Technician	✓	✓	✓		
Technical Writing	Technical Writer				✓	✓
	Document Specialist	✓	✓	✓		
	Electronic Publications Specialist		✓	✓		
	Technical Publications Manager				✓	✓
Web Development and Administration	Web Page Developer	✓	✓	✓	✓	
	Web Site Developer			✓	✓	✓
	Webmaster				✓	
	Web Architect				✓	✓
	Web Administrator			✓	✓	
	Web Designer				✓	✓

Analytical Skills and Problem Solving, continued

Hypothesis Development and Design of Experimentation
Pattern Recognition and Modeling
Problem Solving
Statistical Analysis
Business Environment Skills

Business Organization and Environment

Computer Trends in Business and Society
Principles of Accounting
Professional Development
Professionalism

Coordination and Communication Skills

Customer Relations
Oral Communication
Project Management
Task Management
Teamwork
Written Communication

Core Computer Software and Hardware Skills

Database Applications
Email
Hardware Installation and Configuration
Internet
Network Technologies
Presentation Software
Principles of Programming
Software Installation and Configuration
Spreadsheet Applications
Windows Environment
Word Processing

Project and Process Flow Skills

Analysis and Synthesis
Design and Development
Planning and Organization
Project Documentation
Proposal Writing
Quality Assurance
Research
Technical Documentation
User Testing and Validation

Employability Skills

Input from industry clearly shows that without a solid mastery of employability or foundation skills, employees cannot succeed in the highly competitive environment of today's technology companies. Employers often say that: "Technical skills may get you the job, but foundation skills will make you a valued employee and will significantly increase career advancement."

Even though many training and educational programs concentrate primarily on technical skills and knowledge, employers' concerns often focus on foundation skills rather than on technical skills. Employers are looking for people who display the right attitude, who display good customer service skills, and who exercise effective communication skills. When considering prospective employees for a new position employers often ask: "Do they have good work ethics? Are they good team players? Do they like to learn? Can they show initiative and make good decisions?"

What are employability skills? Employability skills, also referred to as foundation, "soft" or process skills, are skills that support a civil, respectful and efficient workplace.

"Look out, community colleges! Change is coming in the form of a new student body. Your technical curriculum will never be the same—and that's good!"

Dan Hull
founder of CORD,
in *Who Are You Calling Stupid?*

Employability skills include the following:

- **Communication Skills.** Effective information flow throughout the organization is a critical element to organizational success. Communication with team members, supervisors and subordinates, customers and clients, and between different groups needs to be timely and appropriate. Some jobs rely more heavily on written communication, while others depend primarily on verbal communication. Electronic communication (email) is rapidly becoming ubiquitous, bringing a new set of rules and practices to business communication. Communication in high technology organizations takes on many forms—from informal to formal presentations, from technical logs to complex reports and proposals. No matter the form, communication is key to individual and team effectiveness.
- **Organizational Skills.** As employees are asked to handle more parallel tasks with increased levels of complexity, good organizational and planning skills become very important. Depending on the job, the complexity of the organizational task may vary from scheduling and prioritizing multiple tasks or requests, to planning and tracking complex and capital-intensive projects involving many people and teams. Regardless of the size of the project, the ability to identify and define tasks, to track milestones, to recognize when a project timeline is running into problems, and to take appropriate action is crucial to ongoing success in technical jobs.
- **Team Contribution and Leadership.** Most organizations are relying increasingly on teams to accomplish projects. This is particularly true in high-tech environments where the success of projects depends on the contribution of many individuals with varied expertise. The ability to work with team members with different backgrounds and diverse communication styles is highly valued and rewarded in most environments. In many organizations, flexible or "flat" organizational structures require employees to take on different team roles, from listeners, to active contributors, to team leaders. The ability to read the team needs as a whole and the needs of individual team members, and to adjust one's role to increase team effectiveness is a critical factor to the success of the team process.
- **Professionalism.** Dealing with problematic employee issues, attitudes and behaviors consumes much time in any organization, and can be very detrimental to overall morale. Employees with good work ethics, who show up on time, who understand and follow company procedures, and who relate to coworkers and customers with respect are those more often selected for positions with increased levels of responsibilities and rewards. On the other hand, lack of professionalism can often lead to declining morale, dissatisfied customers or clients, and ultimately to an employee's dismissal.
- **Critical Thinking and Decision Making.** As organizations become leaner in management, employees are expected to assume increased responsibilities. Employees' ability to correctly analyze situations, understand tradeoffs, make good recommendations and make the right choices is often rewarded with increased freedom to self-manage, and with the opportunity to engage in more interesting and challenging projects. Deciding when to

take action, when to delegate, and when to elevate certain issues to a higher decision level are skills that promote trust and respect supervisors and coworkers.

- **Customer Relations.** Customers can take many faces. Internal customers can be the department down the hall or an offshore division. External customers can be suppliers, clients or end-users. The ability to solicit and listen to customer feedback and to effectively address customer issues and concerns is required to qualify for certain positions, such as technical support jobs. Customer interaction skills are necessary in all jobs whether or not the job description formally includes "customer relations."
- **Self-Directed and Continuous Learning.** In the high technology industry, and in particular in the information technology environment, technologies and practices change rapidly and sometimes radically. To keep up with the technology changes employees need to continuously engage in self-assessment against the technological landscape of skills and knowledge, and take proactive steps toward enrolling in continuous training for their trade. Employers expect employees to be current in their technical skills. Most organizations provide the necessary resources for continuous training. However, it is often seen as the employees' responsibility to identify personal gaps in knowledge and take actions to fill these gaps.

How can one learn foundation skills? Most professional/technical and academic programs include some requirement for the practice of foundation skills. However, many lack the emphasis that employers would like to see. Being aware of the importance of such skills can help students and employees enroll in programs that emphasize the use, practice and coaching of foundation skills in the learning process, class activities and projects. Educators must be aware of the importance of these skills to the long-term success of graduates, and provide ample opportunity for holistic and contextual practice as well as authentic assessment.

Work-based learning is one of the most available forms of training, yet often the most overlooked. Participating in special projects and cross-functional activities often enables employees to exercise organizational and communication skills that will benefit their overall performance and effectiveness. Community involvement can be another way to develop foundation skills in a low-pressure environment.

No matter how or where effective interpersonal, organizational, professional and learning skills are developed, the mastery of such skills will significantly impact the ability to successfully move within and between careers. These skills will provide a wider choice of projects and responsibilities, resulting in more job satisfaction and increased opportunity for advancement.

This does not imply that technical skills are not important; however, technical expertise alone does not guarantee success. Employees' technical skills are critical and are expected to match the required level for the job. However, someone with a solid foundation of learning abilities and technical skills can easily acquire further technical training to refine and enhance their expertise. Foundation skills, on the other hand, often take longer to acquire and master, and changes in attitude are often even more difficult. Many supervisors do not feel adequately prepared to coach employees in their interpersonal skills. As a result they rely heavily on schools to pro-

"Because of the nationally recognized work NWCET has done on eight IT career clusters, and their collaboration with industry and academic institutions throughout the country, we know they'll ensure thorough development of skill standards for emerging IT career clusters."

Kathleen Dietz
Information Technology
Skills Management,
The Boeing Company

vide solid training in the foundation skills area, and put a large emphasis in recruiting employees who already display proficiency in such skills. Schools are often the ideal place for students to learn to integrate foundation skills with technical knowledge, since they can provide low risk contextual learning opportunities.

Many new technical graduates are "produced" each year. However, the primary critical factor to job effectiveness and career mobility in today's environment is to develop, demonstrate and sustain proficiency in both technical and employability skills.

As Dan Hull, founder of CORD, emphasizes in *TechPrep, the Next Generation:*

> *...several discoveries have been made that contribute greatly to significant educational improvements ...*
>
> • *High expectations—Nearly all people can learn at advanced levels if we match teaching styles with the variety of learning styles in a diverse group of students and if students can be motivated to learn.*
>
> • *Contextual (situational) learning—We now understand that most people learn best when new information is presented in the context of what they already know and in a way it can be used.*
>
> • *SCANS—We've discovered that the skills employers want most in new workers go beyond technical information, techniques, and the use of specialized equipment. The frustration most employers have with school is that their graduates don't know how to use information, think critically, solve problems, or work cooperatively with other people on teams. And many are not capable of learning on their own.*
>
> • *Technology—Computers and the information highway have enormous potential to empower teachers and learners by providing access to information, high quality educational experiences, and interactivity with others in the learning community—if technology is understood and used properly.*

Science and Math Skills for Information Technology

During the research phase for the Millennium Edition, data was gathered from a wide range of information technology professionals on the math and science skills required or recommended for information technology students. Not surprisingly, the level of specific math and science skills varied directly with the level of educational attainment sought.

While experts have varying opinions on the exact scope and proportion of specific math and science content, there is a high level of agreement on what outcomes are desired. In other words, there is significant consensus that everyone desires the benefits of the thought, reasoning, observational and analytical processes that math and science courses can instill.

The tables below relate specific math and science concepts and tools to the skill cluster areas to which they most often apply, based on the survey data.

There is substantial agreement that industry values the ability to conceptualize, to gather and organize data, to recognize consistency and think analytically, to solve problems and troubleshoot, to make judgments based on quantitative relationships (such as cost-benefit) and to understand basic concepts of physics and electronics as

MATH CONCEPTS AND TOOLS MOST OFTEN CITED AS SUPPORTING IT SKILL CLUSTERS

	Database Development and Administration	Digital Media	Enterprise Systems Analysis and Integration	Network Design and Administration	Programming/ Software Engineering	Technical Support	Technical Writing	Web Development and Administration
Arithmetic Concepts and Tools	✓	✓	✓	✓	✓	✓	✓	✓
Measurement				✓		✓		
Algebraic Concepts and Tools	✓		✓	✓	✓	✓		
Computation	✓	✓	✓	✓	✓	✓	✓	✓
Estimation and Cost/ Benefit Analysis	✓	✓	✓	✓	✓		✓	✓
Geometric Concepts and Tools		✓						
Graphing		✓	✓	✓		✓	✓	✓
Relational Algebra	✓				✓			
Statistical Analysis	✓		✓	✓	✓	✓		✓
Trigonometric Concepts and Tools		✓						
Logic	✓	✓	✓	✓	✓	✓	✓	✓

Note: *The concepts of math and science set forth in these tables reflect a summary of topics that support IT skill cluster areas. This data provides a generalized link between IT skill clusters and math/science topics. It is not intended to be prescriptive with regard to content depth, or to imply particular instructional modes.*

SCIENCE CONCEPTS AND TOOLS MOST OFTEN CITED AS SUPPORTING IT SKILL CLUSTERS

	Database Development and Administration	Digital Media	Enterprise Systems Analysis and Integration	Network Design and Administration	Programming/ Software Engineering	Technical Support	Technical Writing	Web Development and Administration
Animation Realism		✓						
Basic Electricity and Magnetism				✓		✓		
Data Transmission		✓		✓		✓		✓
Integrated Circuits				✓		✓		
Optics and Vision		✓						
Sound		✓						✓
Terminology		✓		✓	✓	✓	✓	
Experimental Design	✓		✓					
Testing Procedure	✓	✓	✓	✓	✓	✓		✓
Scientific Modeling	✓		✓		✓			

Note: *The concepts of math and science set forth in these tables reflect a summary of topics that support IT skill cluster areas. This data provides a generalized link between IT skill clusters and math/science topics. It is not intended to be prescriptive with regard to content depth, or to imply particular instructional modes.*

applied to information technology. The methods by which students acquire these skills may vary, however, from well-developed discrete courses all the way to "embedded" content supporting technical instruction.

Preliminary analysis suggests that development of an information technology-specific math and science core course may ensure required concepts and skills are, in fact, taught and accurately assessed where appropriate discrete courses do not exist. In some cases, it is most effective to identify specific elements of math and science that support topic areas and to embed these elements in their related courses, so long as they are appropriately assessed.

The NWCET will conduct further studies to determine what core math and science concepts pertain to the information technology industry at large, and what specific math and science elements are recommended for community college students who intend to transfer to university or for working professionals seeking graduate level education.

Developing an E-Commerce/ E-Business Program

Completing sales and processing order and financial transactions from customers over the Internet has grown from a faltering start to become a major consideration in consumer marketing. Storefronts and physical sales locations, once the prerequisites for business credibility, are giving way to web sites and virtual addresses. Even long-established retailers have scrambled to join the rush to web-based sales. At the time of publication, there are many different sales and marketing strategies employed, including auctions, large warehouses directly selling to end users, and specialized electronic boutiques. While the long-term financial viability of the various methods has yet to be fully proven (as of this writing), there is almost universal agreement that, as more computer users find themselves at ease with e-commerce, and as computer penetration in households increases, web-based sales will become a major component of many businesses' sales plans. This phenomenon may create opportunities for web sales and marketing specialists, and will almost certainly increase local opportunities for skilled persons to set up and maintain web sites and their associated databases, and to install and configure the hardware to support them.

Firms of every size will put more information in the hands of end-users electronically. Whether a consumer ordering a part or a vendor acquiring specifications or drawings to bid on a request for purchase, the trend is toward continued "dis-intermediation." Purchasers will increasingly order from web pages and vendors will deal with wholesalers, suppliers and customers electronically as well.

E-business (business-to-business transactions) will be completely compelling in terms of dollars and number of transactions. It will also present significant high-level implementation challenges. As more information is exchanged and shared, the requirements for efficiency and security will be of

Note: For additional context on e-commerce/e-business refer to the section on Trends in Information Technology.

*A 33-page chart that relates most-often-cited math and science core skills to specific information technology competencies is available from NWCET.

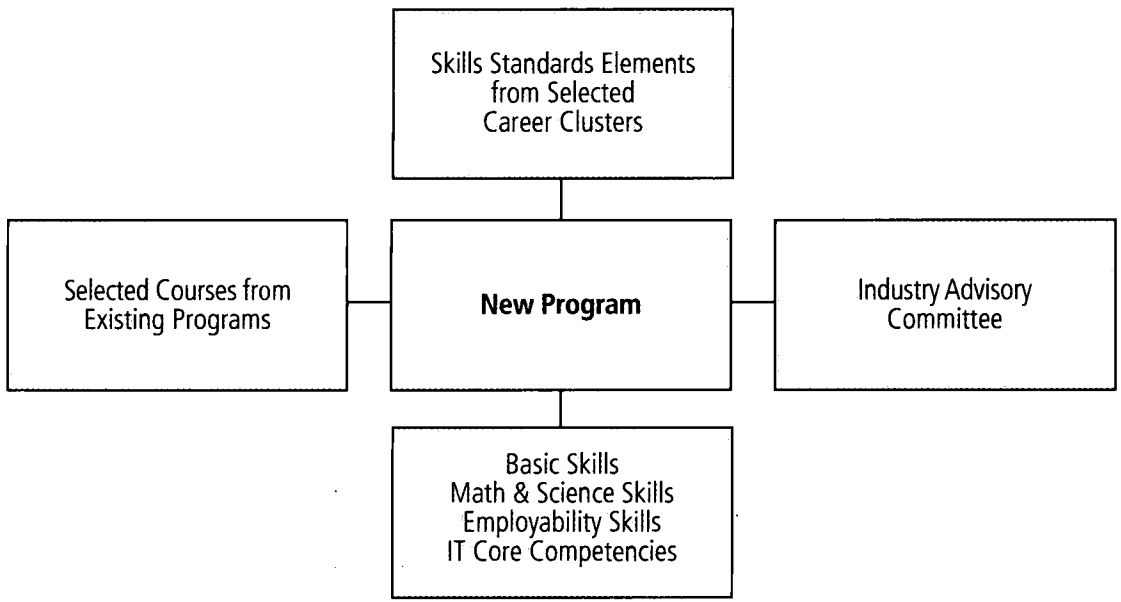
**The NWCET math and science research data was summarized and interpreted by Douglas Brown, Ph.D., Professor of Physics, Bellevue Community College, and Michèle Royer, Ph.D., Independent Consultant and Adjunct Staff, NWCET.

paramount importance. Integrating disparate databases and systems while designing uniform web-enabled user interfaces, and ensuring the security and transparent interoperability of the end result will require individuals with an enterprise-level perspective who possess expert technical knowledge coupled with advanced business education.

Program Mapping

As illustrated in the following diagram, several elements come into play in the design of a new program.

- Skill standards inform the structure and content of the program. In particular, skill standards give guidance as to which areas should be emphasized both in technical and foundation competencies.
- Existing courses from already established programs can be incorporated in the new program either in their existing form or with some adaptation. In particular, activities, projects and assessments from existing courses may be contextualized to fit the new program emphasis.
- Math and science skills, IT core competencies and employability skills are incorporated to support and complete the learning process for the selected IT career.
- Finally, the input and ongoing review from an industry advisory committee helps the program maintain its relevance and currency with the changes in technology and the industry. If the skill standards inform the general structure and emphasis of the program, a strong advisory committee helps fine tune the organization and the content of the courses.



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Skill Standards Information for an E-Commerce/E-Business Program

The e-commerce/e-business career may emerge from several IT cluster areas. In particular, selected functions and tasks from the following clusters are relevant to the design of the program.

Web Development and Administration Cluster

E-commerce/e-business specialists are responsible for the development and administration of the e-commerce/e-business web site. They are closely involved in the development of site specifications and the review of the site design. They write specific web applications to support the e-commerce/e-business functions. They also participate in the testing of prototypes and the maintenance of the web site. They especially focus on issues regarding security and usability of the web site.

Database Administration and Development Cluster

E-commerce/e-business web sites interface with databases managing product, ordering and billing information. Even though the e-commerce/e-business specialists may not be the actual developers of the databases, they are closely involved with the design of specifications and implementation of the databases. They need to understand database capabilities and limitations, as well as have a solid knowledge of security and administration issues and procedures.

Network Design and Administration Cluster

E-commerce/e-business specialists need a basic knowledge of network capabilities and constraints as these affect the number of electronic transactions that can be processed and the processing speed. They do not usually perform troubleshooting or maintenance of the network, but will give input to network upgrade decisions to support e-commerce/e-business functions.

Note: This approach does not necessarily exclude elements of other IT career clusters. Local advisory committee input should be sought to integrate skills from the IT career clusters as appropriate.

Courses from Existing IT Programs

Technology courses in the following areas can be incorporated into the E-Commerce/E-Business program from existing programs:

- Web Concepts, Development and Administration courses from an existing Web program
- Database Concepts, Introduction to Design, Introduction to Security and Administration courses from an existing Database program
- Introduction to Networks and Network Security courses from an existing Network or Technical Support program
- Programming courses, with an emphasis on Internet application development, from an existing Programming or Web program

Business courses in the following areas can also be incorporated into the E-Commerce/E-Business program from existing programs:

- Order Processing, and Business Transaction Economics and Law courses from an existing Business or Economics program
- Marketing and Marketing Law courses from an existing Business or Marketing program
- Accounting, and Business Organization, Principles and Management and similar courses from an existing Business and Accounting program

The following table summarizes the review process of how to leverage existing curriculum and courses in the development of a new program.

Basic Skills

In addition to the above areas, math and science skills should be included with a special emphasis in estimation and cost/benefit analysis, graphing and statistical analysis. Core IT and employability skills important for all IT careers need to be infused throughout the program, with a special focus on business and economics skills.

Industry Advisory Committees

Advisory committees can help define the specific technology tools and procedures involved in e-commerce/e-business careers. The committee members can help develop relevant activities and projects and identify opportunities for internships. They will also give direction to the program organization to specifically emphasize the key responsibilities in the e-commerce/e-business jobs that are most in demand.

Curriculum Elements from Existing Courses	E-Commerce/E-Business Curriculum Requirements	Areas of Match	Areas of Gap
The following elements from relevant courses, modules or units of learning should be evaluated: • Outcomes and competencies • Outlines and syllabi • Reference material and supporting textbooks • Activities and projects • Assessment methods and tools	Based on relevant skill standards information and industry input, new program outcome and competency requirements can be identified. These requirements are used to evaluate existing curriculum for relevancy in developing the new program.	Areas of match are assessed to identify which existing courses and curriculum elements can be incorporated into the new program.	Areas of gap help identify new curriculum elements and courses to be developed, and give direction on how to adapt existing curriculum. In particular, it is important to identify which activities, projects and assessments should be contextualized to the new IT field. Identify resources (industry partners, internships, guest instructors), and needs (faculty, program, etc.)

Assessment

Employers are interested in national standards as a benchmark for assessing worker competency. Success on a battery of assessments developed by an independent third-party organization provides the information technology specialist with the documentation that the necessary skill levels have been attained.

Proper assessment and certification programs can offer benefits to employers, employees and customers. The employer benefits from having knowledge workers who have demonstrated a high level of competency. The fast-paced world of information technology requires workers to operate in a context of constant changes, a capability closely linked to mastery of the IT competencies.

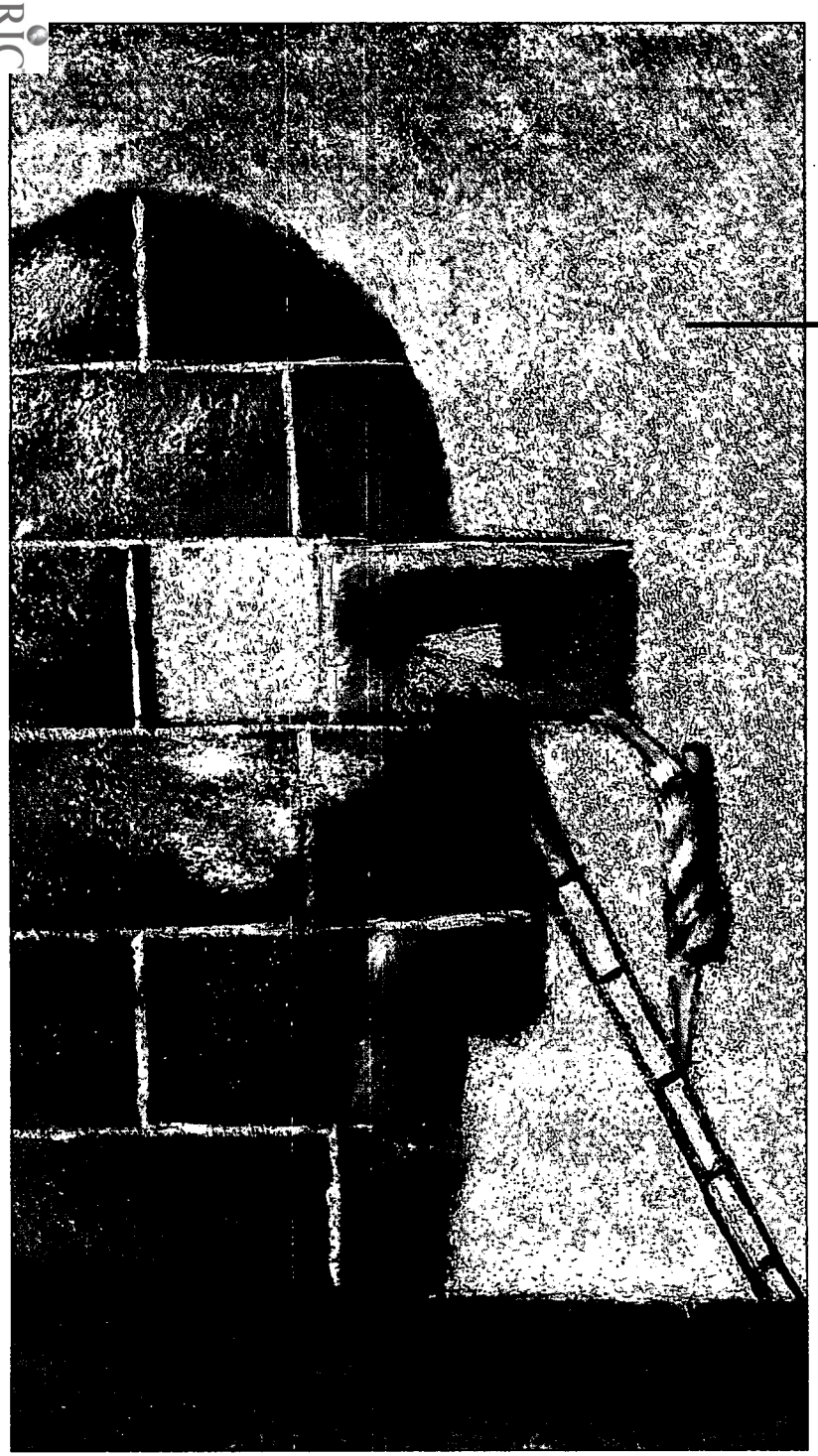
Employees who are properly certified against national standards demonstrate that they have the necessary knowledge, skills and abilities relevant to their jobs in the information technology field, and that they possess a suite of skills valued by employers.

Customers are more satisfied when the organizations they deal with have a high performance work force—a workforce benchmarked against nationally-validated and vendor-neutral skill standards.

Assessments based on the NWCET IT skill standards provide the link between educational efforts and the employers' desire for consistent application of those standards. Vendor-neutral assessment and certification, based on NWCET skill standards, provide assurance that the candidate is evaluated against nationally-validated and industry-generated knowledge, skills and abilities.

The Chauncey Group International, a subsidiary of Educational Testing Service, designs, develops, administers and maintains an independent testing program that evaluates the competencies of graduates from IT educational programs, job candidates and incumbent workers. Making full use of the nationally-validated skill standards developed by NWCET, the Chauncey Group builds upon its core strength in developing state-of-the-art assessment systems that meet the highest professional and ethical standards for test development, validity and reliability.

Contributed by Nancy Thomas Ahluwalia
of the Chauncey Group International,
a subsidiary of Educational Testing Service



SKILL STANDARDS

Information Technology Skill Standards

Database Development and Administration

Digital Media

Enterprise Systems Analysis and Integration

Network Design and Administration

Programming/Software Engineering

Technical Support

Technical Writing

Web Development and Administration

On the following pages, you will find skill standards for eight career clusters in information technology. Career clusters are groupings of representative job titles, related by a close association with a common set of technical skills, knowledge and abilities. The career cluster approach was used because it more closely reflects how work is organized today, especially in illustrating mobility and progression among representative job titles.

The skill standards for the eight career clusters researched for this project are:

Cluster Titles

Database Development and Administration

Digital Media

Enterprise Systems Analysis and Integration

Network Design and Administration

Programming/Software Engineering

Technical Support

Technical Writing

Web Development and Administration

These career clusters represent a broad range of job titles, from entry level through senior management. In the Millennium Edition, we have endeavored to capture, at a high level, skill sets that are reflective of the range of work represented by the cluster, thereby helping to illustrate pathways for mobility and progression. By so doing, we hope to have made the skill standards usable to educators at every level, and to human resource professionals, training, certification and assessment developers, students and job seekers, and organizations and individuals conducting research into information technology workforce issues.

Common Elements Across Clusters

There are several elements that appear in all clusters. This commonality reflects the desire of virtually all employers for employees with a set of common qualities that support specific technical knowledge and skills. These common categories are project management, task management and problem-solving/troubleshooting.

To avoid redundancy and improve usability, these elements have not been repeated at the end of every cluster, but are included in the appendix. Users of the skill standards should assume that these core elements are part of every cluster.

Either explicitly or implicitly, certain other process skills appear repeatedly across all eight clusters. These skills include: analysis, design, development, testing, implementation and documentation.

The nature of each of these skills differs depending on the job level, and from cluster to cluster. By inference, however, employers want employees who can:

- apply a systematic, methodical approach to solving problems;
- research to see who else knows about the problem;
- develop a rational set of possible solutions;
- test the solutions in a cost-effective and efficient manner;
- verify that the problem is truly solved; and
- document the solution for others.

Regardless of the career cluster, certain other skills appear to be "givens" in today's workplace. The ability to use common software applications such as word processing and email, knowledge of

Information Technology Skill Standards

Internet terminology, and a basic understanding of computing hardware, infrastructure and networks are virtually foregone conclusions in the minds of the majority of employers.

About the Skill Standards Templates

There is a wealth of information presented in a very compact form in the skill standards that follow. The information includes:

- Career cluster descriptions and sample job titles.
- A summary template for each cluster listing functions and tasks.
- An overview (called "The Scene") and scenarios describing typical job situations and the challenges faced by entry level (new hire), proficient (one to three years' experience) and expert workers.
- A detailed template listing the performance criteria, technical skills, knowledge and abilities, and the foundation/employability skills associated with each function and task.

Functions

Functions represent the general areas of responsibility within a career cluster. Functions state what must be done to achieve the key purpose of the occupation.

Tasks

Tasks are duties related to the functional areas of a career cluster. Tasks are a listing of key activities performed by workers. They answer the question, "What are the key activities needed to perform each function?" Tasks are observable, measurable work activities with a definite beginning and end, which result in a product, service or decision.

Performance Criteria

Performance criteria answer the question, "How do we know when a task is performed well?" They are specific evidence of the competent completion of a task, or the achievement of a defined skill or knowledge level. While functions and tasks help define the general work requirements of an occupational cluster, performance criteria help complete the picture by describing the employer-defined level of competent performance.

Technical Knowledge, Skills, Abilities and Tools

This category lists the specific items of technical knowledge, skills, abilities, attributes and use of tools associated with a function or task. This information is presented at a high level and avoids reference to specific vendors, versions or equipment. This allows maximum flexibility in adapting the skill standards to local specifications while preserving the general requirements of employers for specific skills.

Employability/Foundation Skills

These skills are general requirements associated with a function or task. They reinforce the performance criteria and are the competencies that allow workers to interact and participate in the high-performance workplace. Employability/foundation skills reflect the SCANS terminology and may be thought of as the competencies that allow one to put technical knowledge to work. They include basic skills in reading, writing and arithmetic, as well as thinking/reasoning skills, interpersonal skills and the abilities required to interact productively with complex and dynamic systems.

Database Development and Administration

As a database administrator, you will first gather data to determine user requirements. You may also gather the information to design reports and forms so users can create data queries and interpret the results. You'll determine needed changes either to new systems or existing systems as they grow, and test everything before it's put into operation. To keep data secure and protected from catastrophic events, you create security procedures and implement backup and recovery processes. You need to be creative in your approach to problems and willing to help everyone get the data they need while maintaining system security and reliability.

SAMPLE TITLES

- Data Administrator
- Data Analyst
- Data Architect
- Data Management Associate
- Data Modeler
- Data Modeling Specialist
- Database Administration Associate
- Database Administrator
- Database Analyst
- Database Developer
- Database Manager
- Database Modeler
- Database Security Expert
- DSS (Decision Support Services)
- Knowledge Architect
- Senior Database Administrator
- Senior Systems Analyst
- Systems Administrator
- Systems Analyst
- Tester

Database ERIC

The Iterative Nature of IT Work

"Math, statistics and business make you ask questions and help you understand what is going on. No matter where you are at in the business, you need to understand the workings of the business, so you can understand what's going on."

A Database Development Manager

The development of skill standards necessarily requires an analytical approach that results in the classification of functions and tasks in a discrete, linear and sequential form. When using skill standards data, it should always be remembered that the actual nature of this work is iterative, with ongoing cycles that build over time to a completed task. It should not be inferred that the skill standards set forth unalterable steps of procedure for the accomplishment of a task.

As with all professions, the nature of information technology jobs is precise yet flexible, with processes and tasks subjected to continuous feedback, improvement and refinement, based on available resources and customer/client needs. The ability to respond to the iterative nature of information technology work should be considered a key employability skill.

DATABASE ADMINISTRATION AND DEVELOPMENT

Summary of Critical Work Functions

KEY ACTIVITIES

A. Analyze and Design Database	B. Develop and Implement Database	C. Perform Administration and Maintenance	D. Perform Security Administration	E. Provide Client Services
A1 Perform research and analyze requirements	B1 Develop physical database characteristics and user interface	C1 Develop and implement monitoring plan	D1 Gather and document security requirements	E1 Provide and support development environments
A2 Create and refine conceptual and logical data models	B2 Create database objects	C2 Analyze monitoring data	D2 Design and document security plan	E2 Plan user training
A3 Identify high-level business rules for data model	B3 Select unique identifiers and normalize the data model	C3 Manage backup and recovery both on-site and off-site	D3 Implement and enforce security requirements	E3 Deliver user training
A4 Adapt conceptual and logical data models to enterprise model	B4 Support population of database	C4 Create and implement maintenance plan for regular integrity checks	D4 Maintain and improve security in response to industry developments and user experience	E4 Identify additional requirements
A5 Validate conceptual and logical data models with clients	B5 Integrate high-level business rules with code	C5 Maintain physical organization of database objects		E5 Adapt existing structure to new business environments
A6 Determine target environment/platform	B6 Develop and implement testing of database components	C6 Apply software upgrades and fixes		
A7 Identify backup and recovery requirements	B7 Develop and validate database implementation plan	C7 Plan and manage physical resource requirements		
A8 Identify access and concurrency requirements	B8 Deploy database	C8 Administer and enforce standards		
A9 Design distributed model	B9 Produce business and technical documents	C9 Audit database systems		

"Internal and external clients. Every project starts with customer and returns to customer when effectiveness is judged. If we don't have a customer, we don't have a project."

A Database Programmer

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The Scene

The use of databases to manage and access information has become prevalent in most industries. Databases are used in every area of the organization to store employee, customer and vendor information, and control inventory and manage resources. The power of relational databases lies in their ability to relate and sort information to answer a wide range of user questions, and to present the information in a format that meets specific user needs. Simple databases are designed using standard database office software while complex custom databases are based on high-level programming languages. The increased use of the Internet, with the associated increase in electronic business transactions, brings a new dimension to the application of databases. Live links between web sites and databases allow customers to research and select products online. Online orders may be automatically entered into the client information, order information and inventory control, credit reporting, marketing and billing databases.

Databases are critical to the daily functioning of every part of the organization. Comprehensive and efficient designs that meet the current and future needs of users are crucial to organizational productivity and profits. As database access is extending to more internal and external users, concerns with security and integrity are becoming stronger. The balance between access to information to support business efficiencies and the need to protect critical or confidential data is continually reassessed and directly affects database design strategies.

As a beginning database developer, you work as part of a development team. Even though you are expected to contribute to the data model development, your main role is to design and test specific elements of the database. Your involvement with the users may be limited to helping develop and implement user testing and analyze test results. You spend a major part of your time becoming familiar with software development and testing tools, and with design and implementation methodologies. Documentation is critical as your work will be reviewed by others and may be later revised by a different team. Part of your role may also be in the monitoring and maintenance of existing databases, identifying and reporting problems, and implementing solutions to routine problems.

As you gain more experience with database design, you are asked to become more involved in the requirements analysis and data modeling. Interviewing users to define their needs to manage and access information and developing product specifications are now a large part of your work. You are responsible for the creation of data models and structures, for the development of security and access requirements, and for the development and implementation of a test plan. You are assigned increasing project responsibilities and are asked to review the work of junior developers. You spend much time keeping up with technology, possibly learning a new database programming language or developing proficiency with new software tools. While interacting with users and working with team members, your ability to communicate and to manage cooperatively will become important to the success of your projects. As the business grows, you will be required to enhance the operation of existing databases, allowing for more users while still providing rapid response and maintaining necessary security. This role may be critical enough to your firm that it is the major area of responsibility for you or your work group.

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As you acquire a broader understanding of the organization dynamics and flow of information, you start influencing the policies surrounding the development and use of databases. You are asked to manage large and multiple development projects, and to organize development teams. System integrity is a major concern in your role and you analyze system performance for continuous improvement. Your interactions with management and clients are more frequent and involve a higher level of negotiation and decision making. Your ability to identify underlying issues, organizational constraints and connections between different groups is valued in developing consistent strategies and directions. You may find opportunities as a contractor or consultant, where your up-to-the-minute technical skills enhanced by real-world application experience in a variety of settings will be of value to clients for both long- and short-term assignments.

"The key to working in teams and high performance? Be self-directed, set your own goals, be available, provide input to allocate resources and duties. Scope, schedule, budget. Everybody is expected to understand that you control some, but not others of these. Coordination and communication are critical."

A Data Analyst/Modeler

"Of course, we are always working to improve and to identify and resolve problems before they actually arise. It is important to be able to show a trend of improvement and improved performance."

A Database Administrator

Scenarios

Entry Level

- Gain understanding of database design structure.
- Develop database objects as assigned by project manager.
- Apply tests to database objects and analyze test results.
- Identify and resolve problems, and escalate if necessary.
- Participate in technical reviews.
- Document problems, solutions and design changes.

You were recently hired to be part of a team to develop a large database to support the tracking of customer orders and the analysis of ordering patterns. The database needs to interface with already existing software that generates billings and updates inventory information. Senior developers have already gathered and analyzed the product requirements, and generated the theoretical design of the database structure.

Your role is to help in the creation of tables and queries based on the database model. As you are new to the project you spend a lot of time up front studying the overall design to gain an understanding of how the parts for which you are responsible interact with other parts of the design. You work closely with one of the senior developers who reviews your work and is available to answer your questions. You attend all the technical review meetings and a few of the project evaluation meetings. Since this is a long-term development project, you acquire a better understanding of the role of each team member and their specific technical strengths and expertise. Your strength in working with persons of different backgrounds and with varying communication styles is important to your success and your ability to gain respect from others.

Once the database objects are created, they are tested with data that simulates the user information. Your role is to apply specific test scenarios and identify problems. If the problems are minor, you implement changes to resolve the issues. If they fall beyond your expertise, you report them to senior developers for further analysis and resolution. Problems, solutions and resulting design changes are carefully documented. Your contribution to the documentation process is primarily in the form of a technical log. Your attention to detail and clarity of communication are recognized and valued by the members of the team.

As the development proceeds, some refining of the original database structure takes place, resulting in further modifications of the database objects. The process is iterative—looping back on itself between design, development and testing, leading to a final prototype ready for field testing.

At this point in the project your role is complete and you are assigned to a new development project and a new team. However, you are very interested in hearing about the user test results and you keep informally connected with some of the members of your "old" development team. Moving from project to project, you start building a technical network of support within the organization, as well as building valuable relationships with potential mentors and broadening your base of experience.

Proficiency Level

- Analyze existing test design, procedures and results.
- Identify and acquire missing information.
- Develop and implement new tests as needed.
- Develop, test and implement solutions to identified problems.
- Report to management on status of resolution process.
- Make decisions on readiness of product for implementation.

You have been working in database development for several years and have been a part of many projects. Your strength has emerged especially in the area of test analysis and troubleshooting of beta test prototypes. A database development team in your company recently completed the design and prototype of a large database to support the tracking of customer orders and the analysis of ordering patterns. The database is designed to interface with existing software that generates billings and updates inventory information.

The functional and user tests were recently completed and major problems were identified. Problems surfaced especially in the area of data transfer between the new database and the inventory control system which is based on a different platform, and in the lack of ease in customizing statistical reports. You have been charged to analyze the issues and implement solutions. You are assigned two junior developers to help you in this task.

Your team's first task is to review the details of the tests and test results. You identify several flaws in the testing procedures that may have resulted in erroneous or incomplete results. Sorting through all the information must be done in a consistent, thoughtful and thorough manner, and takes a lot of time. Some of the documentation is unclear and you have to go back to the author for clarification or more detail. As many of the developers have already been moved to other projects it takes time and energy to puzzle back together the sequence of events and the distribution of roles. After several weeks of fact finding and analysis, you feel that you have a complete and coherent set of information. You and your team analyze the data and design additional tests to be run. In parallel you start developing an idea of what the problems might be and some potential solutions. It is a systematic process of developing assumptions as to the source of the problems and verifying these assumptions through testing and testing solutions.

The original development plan did not allow enough time for contingencies and the implementation of the database has already been delayed beyond management's level of comfort. As a result pressure is building on your team to solve the problems very quickly. You have to make difficult decisions on whether to conduct more tests, before going back to full scale usability testing, to verify functionality under a wide range of conditions. You evaluate the risks carefully and decide when the product is ready to turn over to the user. You expect that small problems will arise after implementation, but you feel confident that they will not have major impacts on productivity and functional efficiency.

In this role, analysis and decision-making skills are critical. Your decisions can have major impacts and need to be carefully derived. Your technical expertise is broad enough to address a wide range of problems even though you may rely on inside "experts" to develop specific solutions. Management depends on you to assess the seriousness of problems and accurately estimate the time to resolution. Management also depends on your timely and accurate status reports, and for your thoughtful evaluation and concise presentation of alternative actions and potential consequences.

"In terms of today's technology environment, lifelong learning is essential. Skills obtained are always a basis for more skills that are necessary to career progression and survival. I find I'm usually involved in some skill-building curriculum every 18 months. These range from specific skills to keep pace with technology to general skills required to improve my performance as a team member and manager."

A Database Developer and Manager

"Database developers often take on task management assignments. Everybody does problem solving. Project managers tend to be experienced developers who have the capability and desire to perform that function. Obviously, it varies from company to company."

A Systems Administrator Commenting on the Employability Skills of Task Management, Project Management, and Problem Solving

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Expert Level

- Interview users to assess current and future needs and current use of technology.
- Analyze information in light of the company's long-term strategic goals.
- Research and assess available database technologies and trends.
- Develop recommendations for database use and information management procedures and standards.
- Make presentations to high-level management on the business impacts of technology alternatives.
- Develop analysis and recommendation reports.

You have been with your company for several years in various database-related positions and have managed successfully a wide range of database projects. Your understanding of the company's structure, mission and goals has been recognized and you have been given increasing levels of responsibility. Management relies on your input to strategic decisions regarding the flow of information and the use of database tools throughout the organization. Your company has been more involved in the use of electronic transactions with its customers. However, this evolution has occurred without a coordinated corporate plan or standards. Management is particularly concerned about security issues in the current structure, as well as about the fact that every group operates under a different format and set of standards. Several mergers and acquisitions are under consideration, and you are also expected to analyze and evaluate the database integration issues that may result.

You have been committed to professional development and have taken business courses, in addition to staying current on database technology. As a result, you have been asked to review the current and future needs of the organization regarding electronic business, analyze the current enterprise model and existing standards, assess security risks to data integrity and develop recommendations that will be implemented company-wide. At this point in your career you have acquired an in-depth knowledge of the different needs and goals of each organizational group. You also have a thorough grasp of the company's strategic direction and how it impacts future use of technology and the management of information. Even though you are not working first hand with database software and tools as you did earlier in your career, you have developed a broad knowledge of database and information management technologies and trends. This is critical in your development of technology recommendations that fit the enterprise model.

Your assignment requires you to interview managers and key representatives throughout the organization. Your communication skills and ability to understand underlying issues are critical. Each group tends to have a focused perspective on their needs but you have to take into account efficiencies at the organizational level. You may need to develop a presentation that explains to various groups the problem you're trying to solve and what contributions you need. Your ability to analyze information, identify patterns and extrapolate implications is a critical element in the success of this work. You will also be called upon to develop and make presentations to high-level management and to communicate benefits and risks of proposed technology in terms of business impact. This project will result in the production of a complete report including the current status, projected needs, solutions considered and a solid recommendation with supporting information. What makes this job most satisfying to you is its balance of technology and business skills, as well as the variety of interaction with employees from diverse areas of the organization.

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DATABASE ADMINISTRATION AND DEVELOPMENT

Critical Work Function: Analyze and Design Database

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A1. Perform research and analyze requirements	• Business objectives and goals for the project are well defined. • Necessary project information is complete, accurate and free of conflicting requirements. • Sources of information are reliable and current. • Complete set of requirements is communicated to and approved by client/user. • Final set of requirements is documented in an accurate, complete and succinct form. • Third-party tools are identified and agreed upon by all parties. • Client/users are properly educated regarding requirements, technology and tools.	• Knowledge of basic business objectives and requirements analysis. • Knowledge of database software and design principles. • Knowledge of operating systems and third-party tools.	• Ability to identify key sources of information. • Ability to analyze information for accuracy and consistency. • Ability to work cooperatively with others and contribute ideas, suggestions and assistance. • Ability to ask relevant questions. • Ability to accurately summarize and document information. • Ability to resolve conflicts in available information and expressed needs.
A2. Create and refine conceptual and logical data models	• Conceptual model is documented accurately and completely. • Entities, attributes and relationships are identified and defined in a complete and accurate form within scope. • Clients/users are consulted during conceptual data modeling process as appropriate.	• Knowledge of data modeling and database software and tools. • Ability to translate client/user requirements into data model. • Ability to define attributes and align to entities. • Ability to resolve discrepancies in different/multiple models. • Ability to relate user specifications to data model.	• Ability to create, store and distribute documentation according to requirements. • Ability to recognize and resolve conflicting specifications. • Ability to work cooperatively with others and contribute ideas, suggestions and assistance. • Ability to ask relevant questions. • Ability to accurately summarize and document information.

Critical Work Function: Analyze and Design Database

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A3. Identify high-level business rules for data model	• Pertinent business rules are identified or defined during modeling. • High-level business rules are documented. • Data ownership is clearly defined. • Data definitions are fully developed and agreed upon in accordance with company procedures. • High-level business rules are integrated within the data model. • Validation rules are identified and documented.	• Knowledge of business structure. • Knowledge of business entities and relationships. • Knowledge of business policies and procedures. • Knowledge of validation rules and data constraints.	• Ability to synthesize information. • Ability to create detailed supporting documentation. • Ability to visually analyze relationship between parts/whole.
A4. Adapt conceptual and logical data models to enterprise model	• Conceptual and logical data models are consistent with enterprise model. • Possible adaptations of enterprise model are considered. • Company data and objects standards and standardization policies are thoroughly followed.	• Knowledge of company modeling policies and company development standards. • Ability to communicate modeling issues to a variety of audiences. • Ability to visualize and integrate conceptual and logical model to conform with the enterprise model. • Knowledge of database software and database modeling techniques.	• Ability to examine data for relevance and accuracy. • Ability to pay attention to detail. • Ability to analyze structure and organization of information. • Ability to negotiate and resolve conflicts. • Ability to present technical information clearly.
A5. Validate conceptual and logical data models with clients	• Data model is presented clearly and completely and approved as appropriate. • Issues are resolved and recommendations are fed back into the modeling process. • Conceptual and logical models are reconciled with appropriate level process models. • Conceptual and logical data models are validated by client. • Changes or modifications to all models and validation process and outcomes are accurately, concisely and completely documented. • Data ownership and reuse are properly validated.	• Knowledge of validation procedures and processes. • Ability to recognize and resolve conflicts between models. • Ability to read and understand process model. • Ability to negotiate changes or modifications in models with a variety of audiences. • Knowledge of database software, operating systems and the particular business or domain.	• Ability to understand and respond to client/user concerns. • Ability to negotiate and resolve conflicts and compare multiple viewpoints. • Ability to use word processing and database software. • Ability to analyze structure and organization of information. • Ability to examine data for relevance and accuracy.

Critical Work Function: Analyze and Design Database

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A6. Determine target environment/platform	• Available options are researched, analyzed and documented. • Decisions are based on technical and business information, resources and strategies. • Target environment/platform is agreed upon by key people. • Database technology is properly selected. • Platforms and environments are reviewed, and options and recommendations are effectively communicated to appropriate personnel.	• Knowledge of computer platforms and environments. • Knowledge of platform capabilities and limitations. • Knowledge of platform implication on database design, performance and usability issues. • Knowledge of installed base and preferred products. • Knowledge of database software.	• Ability to synthesize information. • Ability to compare multiple viewpoints. • Ability to generate alternative solutions. • Ability to analyze alternatives, consider tradeoffs and make decisions. • Ability to work with a diverse group of issues and people.
A7. Identify backup and recovery requirements	• Backup and recovery requirements are consistent with corporate policy and business needs. • Requirements are specific to database and are documented completely. • Users are appropriately consulted and educated regarding backup and recovery methods.	• Knowledge of corporate policy and business data requirements. • Knowledge of backup and recovery technology of platform. • Knowledge of user needs and skill levels.	• Ability to create detailed supporting documentation and write technical documents for a variety of audiences. • Ability to integrate multiple items of data and synthesize information. • Ability to analyze system configuration/ stability. • Ability to analyze goals and constraints. • Ability to use word processing and database software.

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A8. Identify access and concurrency requirements	• Requirements are specific to database and are documented completely. • Access requirements include input, output and volume of every user view. • Access plan is integrated with backup and recovery plan. • User views are categorized by type of transaction. • Access to data is documented by type of access. • Record locking mechanism is selected and provides maximum data integrity and acceptable performance. • Locking alternatives are examined, analyzed and documented and locking granularity is documented and justified. • Users are appropriately consulted and educated regarding access and concurrency procedures.	• Knowledge of corporate policy and business data requirements. • Knowledge of alternative concurrency control methods. • Knowledge of user views and user access requirements. • Knowledge of locking mechanisms and tradeoffs between lock types.	• Ability to write technical documents for a variety of audiences. • Ability to analyze and synthesize information. • Ability to analyze system configuration/ stability. • Ability to analyze goals and constraints. • Ability to use word processing and database software.
A9. Design distributed model	• Each site has the appropriate datasets. • Site autonomy is assured and replication remains consistent. • Access to fragments is seamless. • Accuracy of data and response meet client/ user needs. • Distribution model meets security concerns.	• Knowledge of network structure and protocols. • Ability to use appropriate modeling tools and methodologies. • Ability to document decisions about database distribution. • Knowledge of database software. • Ability to plan adequately distributed model.	• Ability to analyze organization of information. • Ability to create detailed technical documentation. • Ability to identify and resolve technical issues. • Ability to communicate clearly to a variety of audiences. • Ability to visually analyze relationship between parts/whole.

DATABASE ADMINISTRATION AND DEVELOPMENT

Critical Work Function: Develop and Implement Database

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B1. Develop physical database characteristics and user interface	• Attributes have uniform structure. • Table and file names follow naming conventions. • Data types are consistent between attributes. • Physical design is reconciled with the processing requirements. • Entities are uniformly and logically linked throughout the database structure. • User interface meets client/user requirements. • Database characteristics and user interface are completely documented.	• Knowledge of naming conventions and standards. • Ability to recognize and resolve conflicts between models. • Ability to read and understand logical model. • Knowledge of data types and attributes. • Knowledge of user interface requirements and standards.	• Ability to create detailed documentation. • Ability to analyze and synthesize information and write clearly and concisely. • Ability to compare multiple viewpoints and negotiate changes. • Ability to apply logic to structures and processes. • Ability to examine data for relevance/ accuracy. • Ability to pay attention to detail.
B2. Create database objects	• Database objects are created and tested in a timely manner. • Database objects are created in accordance with best practices and/or company procedures. • Database objects are created to meet user requirements and usability specifications.	• Knowledge of database object design and testing procedures. • Ability to relate database usability and user requirements to object design. • Ability to present data and database tools in a user-friendly manner. • Knowledge of user preferences and expertise levels.	• Ability to attend to detail in checking model/database. • Ability to clarify, interpret and influence communication. • Ability to work with minimal supervision. • Ability to identify and resolve conflicts in data and requirements.
B3. Select unique identifiers and normalize the data model	• Logical model is consistent with conceptual model. • Logical and data models and identifiers have been validated by client. • Identifiers are selected and documented and primary and foreign keys are properly identified. • Rationale behind selection is documented. • Data model is normalized to match user specifications. • Attributes of entities and relationships between entities are defined in a complete and accurate form.	• Ability to transform conceptual model into logical model. • Ability to identify and define attributes and align attributes to entities. • Knowledge of operating systems and database software and principles. • Ability to choose and document identifiers and relate identifier selection to business domain. • Knowledge of normalization rules and processes.	• Ability to organize data in a usable form. • Ability to track information efficiently and effectively. • Ability to use logic to draw conclusions from available information.

Critical Work Function: Develop and Implement Database

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B4. Support population of database	• Data entry is complete and accurate. • Data conversion is complete and accurate. • Where applicable, third-party vendors are used to solve problems. • Data transfer strategies are applied effectively. • Users are consulted to determine new database content.	• Knowledge of database software. • Knowledge of database querying methods. • Knowledge of various database attributes. • Ability to re-engineer off-the-shelf databases. • Knowledge of operating systems and the domain.	• Ability to generate/evaluate solutions. • Ability to devise/implement plan of action. • Ability to organize information and reports. • Ability to compare multiple viewpoints and relate intent to desired results. • Ability to pay attention to detail and follow up on assigned tasks.
B5. Integrate high-level business rules with code	• Pertinent business rules are examined and their impact on database is accurately determined. • Database triggers and procedures are implemented to reflect business rules. • Database code supports high-level business rules.	• Knowledge of business structure. • Knowledge of business entities and relationships. • Knowledge of user interface and database rules. • Knowledge of database code development.	• Ability to synthesize information. • Ability to create detailed supporting documentation. • Ability to visually analyze relationship between parts/whole. • Ability to integrate multiple items of data and research additional information sources. • Ability to organize technical reports and select methods of communication.
B6. Develop and implement testing of database components	• Acceptance testing and regression testing are satisfactorily completed based on specification criteria. • Benchmarking is carried out in accordance with proper procedures. • Components are systematically and thoroughly tested. • Testing methods follow company guidelines. • Testing process is clearly documented. • Testing is completed according to schedule. • Technical conflicts are identified and resolved.	• Knowledge of acceptance testing and regression testing procedures. • Knowledge of database testing methods, tools and processes. • Knowledge of contingency procedures. • Knowledge of benchmarking procedures. • Ability to evaluate defect impact on overall system performance and integrity. • Knowledge of appropriate validation process and database system error resolution procedures. • Ability to evaluate importance of defect and communicate to relevant personnel.	• Ability to work with minimal supervision. • Ability to attend to detail in testing database components. • Ability to identify and resolve technical conflicts. • Ability to organize and communicate technical ideas/information.

Critical Work Function: Develop and Implement Database

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B7. Develop and validate database implementation plan	• Implementation plan development involves key team members. • Database implementation plan is completed in a timely manner. • Clients/users are consulted as required. • Implementation plan is complete and congruent with project plan. • Implementation plan meets user specifications and timeline. • Transition plan is implemented with minimal impact on overall productivity.	• Knowledge of implementation and transition process. • Knowledge of productivity factors and risk management techniques. • Knowledge of contingency procedures. • Ability to evaluate overall system performance and productivity. • Knowledge of database software.	• Ability to synthesize and organize information. • Ability to create detailed supporting documents. • Ability to manage resources and timelines to maximize effectiveness. • Ability to identify underlying issues and resolve technical conflicts to client/user satisfaction. • Ability to assume responsibility for accomplishing team goals. • Ability to provide feedback to relevant personnel.
B8. Deploy database	• Software and dataset are installed according to implementation plan. • Internal and external feedback and user issues are presented clearly and concisely, and user questions about conversion are completely and professionally answered. • New database management system is fully operational, users have proper access to data and database is accessible through the network, where applicable. • Issues and questions concerning acceptance and validation are resolved to user satisfaction. • Post-implementation reviews are thoroughly conducted in accordance with company procedures. • Nonpressing issues are documented for next design upgrade. • Database is thoroughly tested to ensure proper installation.	• Knowledge of appropriate validation process and database system error resolution procedures. • Ability to evaluate acceptance testing plan. • Knowledge of feedback generation techniques and procedures. • Ability to evaluate overall system performance and productivity. • Knowledge of the domain.	• Ability to relate intent to desired results. • Ability to evaluate/adjust plan of action. • Ability to judge effectiveness and efficiency of solution. • Ability to evaluate and summarize user input, recognize critical issues and analyze communication. • Ability to make recommendations for intervention.

Critical Work Function: Develop and Implement Database

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B9. Produce business and technical documents	• Business and technical documents are accurate and complete. • Business and technical documents meet user requirements. • Business and technical documents are created, stored and distributed according to company procedures. • Business and technical documents are updated and disseminated as needed.	• Ability to use advanced word processing features. • Ability to translate technical information into user-appropriate formats. • Knowledge of technical document update procedures.	• Ability to create and organize business and technical reports. • Ability to use effective communication and presentation methods. • Ability to document technical procedures for users. • Ability to use integrated/multiple software applications.

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Critical Work Function: Perform Administration and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C1. Develop and implement monitoring plan	• Monitoring criteria are identified and agreed upon with design and user groups, and are consistent with business requirements. • Monitoring criteria are documented completely and accurately. • Monitoring plan is congruent with project scope and resources. • Monitoring information is captured in a timely manner. • System configuration parameters are properly calibrated to tune database design for optimum performance and meet client/user requirements. • System down time is minimized.	• Knowledge of monitoring methodologies. • Ability to evaluate plan for completeness and congruency. • Knowledge of database principles, performance factors, monitoring tools and tuning procedures. • Knowledge of production resources and company production processes. • Knowledge of database software performance and availability. • Knowledge of business requirements.	• Ability to create detailed supporting documents. • Ability to evaluate alternative solutions. • Ability to formulate plan of action. • Ability to create data gathering processes. • Ability to judge system effectiveness and efficiency. • Ability to evaluate impact of resource distribution.
C2. Analyze monitoring data	• Problem criticality is relevant to business requirements and properly documented. • Monitoring data is analyzed completely. • Solutions to problems are clearly identified and implemented in a timely manner with minimal disruption to productivity. • Database performance meets design specifications and client/user requirements. • Continuous efforts are made to identify and address problems before they become critical. • Error, performance and availability metrics are accurately documented and demonstrate a trend of improvements.	• Ability to identify solutions to technical and application problems. • Knowledge of database software and ability to understand impact of problem on overall database performance. • Knowledge of productivity factors. • Knowledge of solution implementation planning procedures. • Knowledge of monitoring and tuning processes and procedures. • Knowledge of quality assurance methods and practices.	• Ability to analyze data. • Ability to document analysis in appropriate detail. • Ability to demonstrate innovative thinking and resourcefulness in solving problems.

Critical Work Function: Perform Administration and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C3. Manage backup and recovery both on-site and off-site	• Backup and recovery plans are identified and agreed upon by technical support group and user. • Backup and recovery plans are documented completely and accurately, and include both on-site and off-site storage. • Backup procedures are implemented on a regular schedule and according to plan. • Recovery plan meets client/user needs. • Unforeseen outages and data loss are effectively resolved. • Production environment is supported to minimize system down time and ensure system availability.	• Knowledge of backup and recovery procedures. • Ability to identify user needs for backup and recovery. • Knowledge of testing tools and procedures and productivity factors. • Knowledge of database software and operating systems. • Knowledge of resources required to implement backup and recovery plans.	• Ability to analyze information to solve problems. • Ability to systematically organize information. • Ability to evaluate criticality of problems, identify possible causes and propose solutions. • Ability to communicate effectively with clients/users. • Ability to evaluate impact of resource distribution.
C4. Create and implement maintenance plan for regular integrity checks	• Maintenance plan documents procedures for updates and upgrades. • Database integrity is checked according to plan and corrected when needed. • Production environment is supported to minimize system down time and ensure system availability. • Criteria for determining integrity problems are agreed upon with design and user groups, and are accurately and completely documented.	• Knowledge of maintenance tools and processes. • Knowledge of fault detection and resolution processes. • Ability to translate client/user needs into maintenance requirements. • Knowledge of resources required to implement regular integrity checks.	• Ability to devise and implement plan of action. • Ability to create plan to monitor and correct system. • Ability to evaluate impact of resource distribution.

Critical Work Function: Perform Administration and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C5. Maintain physical organization of database objects	• Database performs efficiently with no unacceptable lags in response. • Fragmentation of database is addressed in a timely manner. • Integrity errors are measured, documented and demonstrate a trend of improvement. • Plan for the detection of integrity problems is congruent with project scope and resources. • Database organization is updated and corrected according to technical specifications, user input and business priorities/requirements.	• Knowledge of how to query and report system objects. • Knowledge of system model. • Knowledge of database software.	• Ability to devise/implement plan of action. • Ability to visually analyze relationship between parts/whole, process/procedure. • Ability to analyze client/user needs and evaluate effectiveness of solutions.
C6. Apply software upgrades and fixes	• Software upgrades are applied in a timely manner. • System operation is restored with no unintended consequences. • Software upgrades are based on tangible benefits to clients and business. • Software upgrades are applied with minimal disruptions to clients/users and service.	• Knowledge of system models. • Knowledge of impacts of upgrades. • Knowledge of database software. • Knowledge of operating systems and system administration.	• Ability to integrate systems technology. • Ability to analyze operational problems and recommend solutions. • Ability to predict technological results. • Ability to adapt rules/principles to new applications. • Ability to formulate new approaches and generate unique solutions.
C7. Plan and manage physical resource requirements	• Resource requirements are accurately and completely defined. • Resource utilization is optimized and meets software, client and business needs. • Access issues are properly addressed. • Risk analysis is properly applied. • Trends of resource requirements are correctly measured, utilized and documented.	• Knowledge of resource constraints and capacities. • Knowledge of resource acquisition. • Knowledge of system hardware, network and operating systems. • Knowledge of database software.	• Ability to determine variables and constraints. • Ability to monitor safe and efficient use of materials. • Ability to coordinate acquisition, storage and distribution. • Ability to responsibly challenge existing policies.

Critical Work Function: Perform Administration and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C8. Administer and enforce standards	• Standards are identified and agreed to by applications design groups. • Standards are clearly documented and readily accessible. • Database is monitored to check that production applications meet standards. • Clients and users are educated regarding the standards. • Process, procedures and environment configuration comply with standards. • Automated controls are used whenever possible.	• Ability to monitor database. • Knowledge of requirements and parameters. • Knowledge of how to develop standards. • Knowledge of evolving industry standards.	• Ability to evaluate system performance and diagnose performance deviations. • Ability to distinguish between facts and inferences, and analyze underlying issues to resolve technical issues. • Ability to create detailed supporting documents. • Ability to analyze and integrate information. • Ability to responsibly challenge existing policies.
C9. Audit database systems	• Audits are properly performed. • Audits result in increased compliance with standards. • Audits are properly documented. • Results of audits are reported to appropriate personnel.	• Knowledge of database audit procedures. • Knowledge of audit reporting procedures. • Knowledge of performance standards.	• Ability to adhere to standards and demonstrate commitment to excellence. • Ability to recommend ethical course of action. • Ability to create detailed supporting documents. • Ability to use appropriate principles and previous training to predict outcomes.

Critical Work Function: Perform Security Administration

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D1. Gather and document security requirements	• Security requirements are derived from system specifications. • Security concerns of all participants have been addressed. • Proposed security requirements are complete. • Security requirements are documented, and have been reviewed and approved by appropriate authorities. • Potential security risks are identified and resolved.	• Knowledge of security system tools. • Ability to identify and resolve potential security conflicts. • Knowledge of security issues. • Knowledge of database software.	• Ability to create detailed supporting documents. • Ability to synthesize information. • Ability to apply principles to procedures and use logic to draw conclusions. • Ability to encourage cooperation and negotiation among all participants. • Ability to follow organizational processes and procedures.
D2. Design and document security plan	• Strategies are thoroughly reviewed and analyzed. • Security design and features are selected to meet client, user and business needs. • Security plan is developed and documented completely and accurately. • Security plan is accessible.	• Knowledge of security strategies. • Ability to select security design. • Knowledge of client, user and business needs. • Knowledge of security plan documentation procedures. • Ability to relate requirements to user privileges.	• Ability to identify and resolve conflicting data. • Ability to analyze information and formulate proposals. • Ability to write detailed supporting documents.

Critical Work Function: Perform Security Administration

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D3. Implement and enforce security requirements	• Levels of access and security are clearly identified, standardized and communicated. • Overall plan is considered when implementing and enforcing security requirements. • Implementation of security measures minimizes unauthorized access and addresses security tradeoffs and risks. • Users are notified about changes in their security access in accordance with company procedures. • Accounts are properly audited to determine that security requirements are being met. • Security breaches are accurately identified and communicated effectively to appropriate personnel.	• Knowledge of database security procedures and implementation. • Ability to collect security breach details and communicate to appropriate personnel. • Knowledge of network and operating systems.	• Ability to present practical alternatives. • Ability to responsibly challenge unethical practices/decisions. • Ability to write detailed supporting documents. • Ability to analyze and respond to client/user needs. • Ability to present security tradeoffs and risks and pose critical questions.
D4. Maintain and improve security in response to industry developments and user experience	• User input and practices are analyzed and documented to assess security issues. • Training results in continuous improvement in security awareness. • Security needs are forecast and incorporated in recommendations for system upgrades and/or redesign. • Industry and technology trends are continually monitored and incorporated to support system security.	• Knowledge of business, industry and technology security trends. • Ability to use forecasting methods and tools. • Ability to gather user input and observe user practices. • Knowledge of instructional design principles. • Ability to provide technical training on security procedures.	• Ability to analyze and respond to client/user needs. • Ability to identify issues and resolve technical conflicts. • Ability to organize and present technical information to nontechnical users. • Ability to monitor and interpret trends in technology and industry.

Critical Work Function: Provide Client Services

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E1. Provide and support development environments	• Guidelines for database application development are identified and application of methodology and modeling techniques are effectively communicated. • Support to client/user is delivered effectively and efficiently. • Changes in the data model are transparent to users. • Solutions that improve functionality/ performance are effectively proposed and implemented. • Changes in the database environment are thoroughly tested against user specifications. • Changes in the database are implemented with minimal adverse impact to developers.	• Knowledge of database applications, software, operations and limitations. • Knowledge of user applications and ability to assess user impact. • Ability to define and solve application problems. • Knowledge of change documentation procedures.	• Ability to organize and analyze data. • Ability to work with and demonstrate commitment to the client/user. • Ability to understand goals and constraints, generate alternatives, consider risks and evaluate options.
E2. Plan user training	• Training is designed to meet user needs. • User skill levels are identified and assessed. • Training materials are developed to meet user specifications.	• Knowledge of user training process. • Knowledge of user level of expertise. • Knowledge of instructional design principles. • Knowledge of database, presentation and word processing software.	• Ability to assess performance of others and provide constructive feedback and reinforcement. • Ability to work cooperatively with others and contribute ideas, suggestions and assistance. • Ability to analyze and respond to client/ user needs. • Ability to extract information and use logic to draw conclusions. • Ability to assess user learning needs and plan user training.

Critical Work Function: Provide Client Services

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E3. Deliver user training	• User training sessions are scheduled and conducted according to client/user plan. • Training sessions are presented in a clear, concise and user-friendly manner. • Feedback is gathered to determine additional training and support needs.	• Knowledge of user training process. • Knowledge of user level of expertise. • Knowledge of instructional design principles. • Knowledge of database, presentation and word processing software.	• Ability to help others learn and apply concepts. • Ability to assess performance of others and provide them with constructive feedback and reinforcement. • Ability to work cooperatively with others and contribute ideas, suggestions and assistance. • Ability to assess user learning needs and conduct user training.
E4. Identify additional requirements	• Additional requirements meet evolving user needs. • New requirements are documented and compared to current specifications. • Access and security trends are assessed and accommodated. • New transactional needs are identified and incorporated. • Requirements are continuously analyzed and appropriate recommendations are made.	• Ability to translate client/user needs into technical requirements. • Knowledge of data-gathering methods. • Knowledge of user community, needs and skill levels. • Knowledge of requirements analysis.	• Ability to clarify, interpret and influence communication. • Ability to identify and resolve conflicts in data and requirements. • Ability to use logic to draw conclusions from available information. • Ability to compare multiple viewpoints and negotiate changes. • Ability to present complex information regarding changes in models.
E5. Adapt existing structure to new business environments	• Current database structure is assessed for its ability to support changes. • Upgrade schedules are analyzed and forecast. • Client services and vendor reviews are continually evaluated and updated. • Cost/benefit, ROI and risk analysis are conducted to support recommendations.	• Knowledge of business structure, policies and procedures. • Ability to use forecasting tools and methods. • Ability to identify trends and relate them to current system. • Ability to present technical recommendations in a user-friendly manner.	• Ability to predict technological impacts and results. • Ability to analyze and assess technical information from a variety of sources. • Ability to generate and evaluate solutions. • Ability to relate intent to desired results.

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Digital Media

Information only has value when someone wants to read it. A riveting presentation is vital to getting your company's message across whether you're creating a hot web site, a training video or designing the latest computer game. As a digital media specialist you bring ideas to life. Before you jump in, you estimate costs and the length of the job and determine whether to call in additional help from inside or outside your company. You want the best tools to design and format your presentation, but the size of the project and budget sometimes put limits on how far you can go. When designing, you determine the look and feel, select colors and create a visually appealing layout. The tools you use change at an incredible pace, so you're constantly learning about the latest developments, often through vendor-sponsored training and user education meetings. "Mindshare," the attention customers pay to your company's name and products, is often determined by the visions you create through your sound and images.

SAMPLE TITLES

- 2D/3D Artist
- Animator
- Audio/Video Engineer
- Designer
- Media Specialist
- Media/Instructional Designer
- Multimedia Author
- Multimedia Authoring Specialist
- Multimedia Developer
- Multimedia Specialist
- Producer
- Production Assistant
- Programmer
- Streaming Media Specialist
- Virtual Reality Specialist
- Web Designer
- Web Producer
- Web Specialist

The Iterative Nature of IT Work

"You need to be ready to help yourself, to be curious, to want to find solutions—even if you're not the expert."

Heard Repeatedly Throughout the Focus Groups

The development of skill standards necessarily requires an analytical approach that results in the classification of functions and tasks in a discrete, linear and sequential form. When using skill standards data, it should always be remembered that the actual nature of this work is iterative, with ongoing cycles that build over time to a completed task. It should not be inferred that the skill standards set forth unalterable steps of procedure for the accomplishment of a task.

As with all professions, the nature of information technology jobs is precise yet flexible, with processes and tasks subjected to continuous feedback, improvement and refinement, based on available resources and customer/client needs. The ability to respond to the iterative nature of information technology work should be considered a key employability skill.

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Portions of the data for this cluster have been compiled with the assistance of the Bay Area Multimedia Partnership. For more detailed information, visit *www.bamp.com.*

Summary of Critical Work Functions

A. Perform Analysis	B. Produce Visual and Functional Design	C. Perform Media Production and Acquisition	D. Implement and Test Design
A1 Gather data to identify customer requirements	B1 Determine media types and delivery platform	C1 Develop, evaluate and revise text and scripts	D1 Implement functional and user interface design criteria
A2 Define scope of work	B2 Complete basic design and storyboard	C2 Create prototypes	D2 Identify, create and incorporate reusable components
A3 Develop and present concept alternatives	B3 Develop and produce rough cuts	C3 Identify available media and content sources	D3 Create and produce finished content
A4 Create preliminary design	B4 Design and evaluate user interface, visual appeal and functional design	C4 Produce or acquire content elements	D4 Develop and perform usability and functionality tests
A5 Research content	B5 Develop, evaluate and refine simulations	C5 Perform project mapping	D5 Identify and resolve defects
A6 Present cost and benefit data	B6 Select appropriate software and hardware tools	C6 Substantiate make-or-buy decisions	D6 Document implementation and testing process and results
A7 Prepare and present functional requirements	B7 Document design process	C7 Participate in iterative development with clients and team members	D7 Conduct customer acceptance testing and deliver product
A8 Identify technical constraints and prepare specifications			

"This is a big one. All projects get done through teamwork, so there must be a willingness to understand where others are coming from, and an effort to work within a team, not alone."

An Employer of Digital Media Contractors

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The Scene

Working in the multimedia career field for the first time you will face exciting personal and professional challenges. You may find the things you learned just a few months ago are already becoming outdated. Newer, better and faster are watchwords for this career field! You will keep learning all the time, continuously monitoring industry and technology trends to stay up to date. As the technology changes, your skill set will need to change as well. While you're mastering your new job tasks, always keep in mind that the methods you are using now will be continually changing. As you advance in your career as a multimedia specialist, you will be expected to acquire a strong working knowledge of at least one multimedia scripting language.

In addition to keeping your multimedia skills honed to their fullest potential, you will need to acquire project management skills and incorporate them into your service offerings. Employers and/or clients are more likely to hire you, promote you and keep you working if you are able to successfully perform as both a multimedia specialist and a project/team leader with good business savvy.

A typical day as an entry-level multimedia specialist may include the designing of an interface to demonstrate the capabilities of a software package, a new web site or a product. Or you may need to design a presentation to be used by the sales or marketing team members of an organization. To make this happen, you may be called on to produce graphics for the piece and incorporate them into the final deliverable. You will need to be able to work with source files that include sound, video and computer-generated animation. While some multimedia specialists do specialize in one area or another (i.e., sound, animation, etc.), most will need to know how to work with all forms of multimedia content.

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Scenarios

Note: The following three scenarios involve a three-person team (expert, proficient and entry-level personnel) that has been contracted by a customer to develop an interactive instructional CD-ROM to support the training of users on a new medical monitoring system.

Entry Level

- Give input to the project lead to help create the proposal and support presentations of concepts to the customer.
- Attend some of the requirements gathering sessions.
- Contribute elements to the creation of the first prototype and the skeleton of the application.
- Develop parts of the application and/or acquire media as assigned by the project lead.
- Monitor your task schedule and use of resources, and communicate schedule and resource issues to project lead.
- Coordinate with other developers and participate in project reviews.

You are so excited about your new career. It is great to be able to create such cool stuff and get paid for it. The project lead has landed a new contract for your team and this will be your first multimedia project. You attend some of the requirements gathering sessions with the rest of your team and your customer, and immediately you are at ease. The customer is very nice and friendly. They show you their new product and how important your contribution will be to its success. You can't wait to begin working on it.

The project lead designs the application your team will develop and assigns you a part of it to develop and some media to capture. You coordinate with the other members of your team to do the development. You build your part of the application and capture the media you're assigned on schedule, although making the schedule means working several late nights. You participate in project reviews with your team and in some of the reviews with the customer. Your team delivers the application to the customer on schedule.

"There's so much technology to be aware of that you must work effectively in teams to survive and thrive organizationally. When interviewing candidates, we look at their history to see if they've been effective in working with others. We try to find and screen out those who cannot work in teams. Then at another level, teams must work with other teams all the time."

A Multimedia Development Lead

"To remain viable, you need to look for opportunities to learn. Organizations won't necessarily hand them to you—you may have to go after them yourself. Stay open and stay tuned..."

A Media/Instructional Designer

Proficient Level

- Help the project lead create the proposal and contribute to presentations of concepts to the customer.
- Work with the project lead to design and create the first prototype, and the skeleton of the application.
- Attend requirements gathering sessions.
- Develop parts of the application and/or acquire media as assigned by the project lead.
- Coordinate with other developers and contribute to project reviews.
- Help track budget and schedule and communicate issues and recommendations to project lead.
- Are assigned by the lead to solve a technical problem.

The project lead finds a new customer prospect and she needs your help in creating a proposal. Because you have produced quality work on time and within budget and have developed your leadership skills over the past several years as a media specialist, you are given increased responsibilities on this project. You and the lead meet with the customer to understand the project requirements. You help the lead create a proposal for the development of the media product, and help present your team proposal to the customer. The contact is awarded to your team and you have eight weeks to deliver a product under a fixed price agreement.

You and your team meet with the customer several times to gather requirements. The customer lends your team a sample of the product for which you are developing a training module. With your contribution, the lead creates a first prototype to support further definition of the requirements and creates an application skeleton. The lead asks you to develop part of the application and to capture and edit sound and video files. You coordinate with the other developers on your team. You develop your part of the application and integrate the media-based material on schedule, although making the schedule means working several late nights. You help the project lead keep track of schedules and the use of resources. You contribute to, and sometimes lead, project reviews with your team and with the customer. You find the project lead and other managers rely on you to "fill in" during their absences. You may be encouraged to seek additional education such as management and business courses, in addition to your ongoing technical updates.

The lead identifies a problem with a key technology ("XYZ") being used in the application developed by your team. The lead assigns you to find a solution to that problem. You investigate this technology problem and, through debugging the application and doing Internet searches about "XYZ" technology, you find the answer. You give that information to the rest of the team and the required changes are incorporated into their parts of the application. Your team delivers the application to the customer on schedule. Your management asks you to write a technical report on the "XYZ" technology problem, your proposed solution, and its possible impact on users and developers. You are invited to travel to present your report at the next "XYZ" users conference.

Expert Level

- Create the proposal, present it to the customer and land the contract.
- Gather requirements and constraints from the customers.
- Design the application.
- Create the first prototype and the application skeleton.
- Divide the work and assign tasks to project team members.
- Manage project resources and keep track of the schedule.
- Develop parts of the application and/or acquire media elements.
- Coordinate with other developers and contract out parts of the project as needed.
- Lead project reviews with the team and customers.
- Resolve problems and issues as appropriate.

You meet with your customer prospect to learn all about their new product and how important your contribution will be to its success. You work with other departments in your organization such as accounting and contracting to generate proper proposal information, costing information and contract language. You create a proposal (with the help of your "proficient" team member and input from your "entry-level" team member) and present it to the customer. You are awarded the contract for your three-person team to deliver the multimedia product in eight weeks for a fixed price. You obtain a sample of the customer's product to work with while you create your application.

You and your team meet with the customer several times to gather requirements. Based on these requirements, you design the application that your team will develop. With input and contribution from your team you create a first prototype of the application, which you use as a vehicle for refining customer requirements. You create a skeleton of the application to be developed, incorporating the feedback received from the prototype. You divide the work and assign specific tasks to team members (including yourself).

You coordinate with the other developers on your team. You develop your part of the application and capture the media you've assigned yourself on schedule, although making the schedule means working several late nights. You contract or acquire outside resources to support the project. You keep track of the project schedule and the use of resources, and adjust the project plan based on current status. You resolve technology and personnel issues as they arise. You schedule and lead project reviews with your team and with the customer. You are responsible to the customer for the quality of the product, for the quality of your team's interaction and communication with the customer and for meeting contractual agreements. You may be encouraged to seek courses in business or other continuing education.

"Multi-tasking is an everyday affair."

A Web Designer/Producer

Critical Work Function: Perform Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A1. Gather data to identify customer requirements	• Sources and methods for gathering requirements are affordable and relevant. • Sources of requirements are reliable and current. • Information is accurate and complete. • Information gathering interviews follow appropriate company practices. • Information is gathered continuously in a cost-effective manner. • Theoretical knowledge of the application domain is demonstrated and aligned with actual customer requirements.	• Ability to identify and locate key sources of information regarding customer requirements. • Knowledge of information gathering methods. • Knowledge of quantity of data/information required. • Knowledge of iterative nature of development work.	• Ability to pose critical questions and analyze group/individual responses. • Ability to compile multiple viewpoints. • Ability to select/obtain data relevant to the task. • Ability to encourage cooperation. • Ability to summarize information and requirements. • Ability to analyze systems, scenarios and structures. • Ability to appropriately modify goals while aggressively pursuing goal attainment.
A2. Define scope of work	• Project objectives and scope are identified and agreed upon. • Criteria for successful completion are identified. • Major project tasks and interdependencies are identified and estimates of time, materials and capabilities are accurate. • Schedule is prepared based on resource availability and project timeline. • Scope of work is documented in an accurate, complete and succinct form. • Time, technology and resource constraints are accurately defined, and conflicts, risks, tradeoff analysis and contingency plans are discussed with key stakeholders. • Clients are diplomatically educated regarding realistic technological expectations.	• Knowledge of project management tools, multimedia software, hardware and systems technology capabilities and constraints. • Knowledge of risk analysis techniques.	• Ability to create detailed supporting documents and summarize information and requirements. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to analyze information for accuracy and consistency. • Ability to visualize tasks sequentially and identify interdependencies. • Ability to analyze customer needs, make exceptional effort on behalf of customer and resolve conflicts to customer satisfaction. • Ability to plan according to resource needs and constraints.

Critical Work Function: Perform Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A3. Develop and present concept alternatives	• Concept of project is designed and tested. • Concept meets overall customer requirements and fits technology constraints. • Concept is congruent with scope of project and resources. • Concept is presented to and approved by all relevant team members and by customer.	• Knowledge of concept design tools and procedures. • Knowledge of simulation and testing procedures for feasibility models. • Ability to use rapid prototyping tools to develop concept alternatives.	• Ability to create/develop and test new concepts. • Ability to value differences of opinion. • Ability to analyze underlying issues and resolve technical issues. • Ability to pose critical questions and analyze group/individual responses. • Ability to apply self-management skills and pursue goal attainment.
A4. Create preliminary design	• Initial design is in agreement with the conceptual design process. • Design prototype meets design specifications, project requirements and latest research on usability issues. • Design specifications are congruent with project scope and resources. • Preliminary design is tested. • Preliminary design is presented to and approved by all relevant team members and by customer.	• Knowledge of multimedia design tools and procedures. • Knowledge of simulation and testing procedures for prototypes. • Knowledge of the impact of technical limitations and resources on project design. • Knowledge of latest research on usability issues. • Ability to design alternatives and make recommendations. • Knowledge of graphics packages and other software design tools.	• Ability to apply creative solutions to new situations. • Ability to demonstrate creative thinking while solving problems. • Ability to identify and resolve technical conflicts. • Ability to formulate new ideas/designs.
A5. Research content	• Supplied or required editorial pieces are analyzed and qualified for appropriateness. • Rights of usage and copyrights for content are thoroughly researched. • Readability and usability are considered when selecting content. • Content sources are evaluated based on cost and value. • Content is secured from reliable and respected sources. • Content is organized into manageable sections.	• Knowledge of research techniques and tools. • Knowledge of writing and editorial processes and procedures. • Knowledge of organizational and departmental practices. • Ability to analyze readability and usability of content. • Ability to use word processing and editing tools.	• Ability to select/obtain data relevant to task, identify the need for data and contrast conflicting data. • Ability to analyze, synthesize and summarize research results.

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Critical Work Function: Perform Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A6. Present cost and benefit data	• Analysis is prepared comparing make-and-buy options for each element. • Recommendations are reviewed by relevant personnel. • Decisions made are congruent with project goal, scope and budget. • Cost and benefit data results are quantified for decision makers. • All media necessary for the application can be accessed. • Outsource requirements are accurately identified and include an evaluation of benefits and risks.	• Knowledge of the multimedia industry. • Knowledge of range of multimedia tools. • Knowledge of cost/benefit analysis and ROI tools and procedures. • Knowledge of multimedia software and hardware trends. • Knowledge of outsourcing procedures.	• Ability to evaluate alternative solutions. • Ability to analyze the situation and consider risks/implications. • Ability to identify sources of information and gather data relevant to the task. • Ability to present information clearly and concisely.
A7. Prepare and present functional requirements	• All functional requirements are complete and free of conflicts. • Functional requirements are documented in an accurate and complete form. • Functional requirements are prepared in accordance with overall project and customer requirements. • Functional requirements are presented effectively.	• Knowledge of multimedia system capabilities. • Ability to translate customer requirements into functional requirements. • Ability to identify and resolve conflicting functional requirements. • Knowledge of multimedia software and hardware.	• Ability to generate/evaluate solutions. • Ability to analyze information for accuracy and consistency. • Ability to accurately summarize and document information. • Ability to recognize patterns and relationships and use imagination to visualize events and outcomes. • Ability to organize, communicate and present required information.

Critical Work Function: Perform Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A8. Identify technical constraints and prepare specifications	• Technological constraints are identified accurately and completely. • Appropriate hardware and software are identified. • Functional specifications are complete and approved by all relevant parties. • Specifications are free of conflicts. • Specifications are assessed for feasibility. • Specifications meet overall user requirements, and are documented completely and accurately. • Resources are identified and matched to the tasks at hand.	• Ability to identify technological constraints of development and delivery platforms. • Knowledge of multimedia hardware and software. • Knowledge of multimedia requirements and specification procedures. • Knowledge of implementation procedures and user needs. • Ability to analyze and resolve conflicts in specifications.	• Ability to apply rules/principles to situation. • Ability to gather and analyze information. • Ability to use logic to draw conclusions from available information. • Ability to clearly present complex information. • Ability to resolve technical issues with team members and customer. • Ability to generate/evaluate solutions.

Critical Work Function: Produce Visual and Functional Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B1. Determine media types and delivery platform	• Chosen media elements and delivery platform support the project goals and scope. • Chosen media elements can be acquired and developed within the allotted budget and with available resources and expertise. • Media elements are compatible with the project's intended feel, look and message. • Media elements meet specifications. • Platform supports the selected media elements and is congruent with user environment.	• Knowledge of media types and capabilities. • Knowledge of media element costs and hardware requirements. • Knowledge of computer platform performance and limitations. • Knowledge of copyright laws and licenses.	• Ability to present technical information. • Ability to resolve technical issues with team members and customer. • Ability to use previous experience to predict outcomes and visualize the integration of separate elements. • Ability to generate/evaluate solutions and formulate plan of action.
B2. Complete basic design and storyboard	• Design elements and principles are used appropriately. • User interface elements are functional and aesthetically pleasing. • Design is usability tested, and performance is checked against requirements. • Navigation conforms to functional and interface requirements. • Storyboards are detailed and complete. • Storyboard supports functional design, selected media types and navigation schema. • Storyboard, design concepts and navigation schema are created with input from relevant team members, and are reviewed and approved by stakeholders.	• Knowledge of multimedia design elements, principles and testing procedures. • Knowledge of storyboarding techniques and tools and interface design principles. • Knowledge of navigation approaches. • Ability to evaluate graphic designs and assess visual impact and effectiveness. • Ability to use wide range of computer graphic tools. • Ability to relate design to performance predictions.	• Ability to manipulate technology for desired results and evaluate application of technology. • Ability to encourage/support team members and assume responsibility for accomplishing team goals. • Ability to apply creative solutions to new situations. • Ability to formulate new processes. • Ability to evaluate alternative solutions. • Ability to organize and clearly present ideas.

Critical Work Function: Produce Visual and Functional Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B3. Develop and produce rough cuts	• All media elements are properly integrated. • Multimedia product meets specifications and accurately portrays the desired concept, message and image. • A coordinated color scheme is used throughout the product. • The color scheme adheres to color rules for legibility and readability. • The color scheme demonstrates a consideration of cultural and contextual meanings. • Color usage meets specifications of hardware and software. • 3D shapes and textures are represented in both simplified and complex renderings as appropriate.	• Knowledge of multimedia integration software, tools and techniques. • Ability to evaluate product for look and feel. • Ability to assess visual and impact effectiveness. • Knowledge of principles of color and the cultural and contextual uses of color. • Knowledge of hardware and software color specifications and ability to use palette color manipulation tools. • Ability to create 3D shapes and textures on paper and by using technology.	• Ability to generate unique solutions and demonstrate creative thinking while solving problems. • Ability to evaluate alternative solutions. • Ability to recognize patterns/relationships of colors. • Ability to create comprehensive model/ simulation, mentally picture familiar actions and outcomes and visualize new concept/design.
B4. Design and evaluate user interface, visual appeal and functional design	• Design and interface specifications are complete, free of conflicts and properly approved. • Evaluation includes strengths and weaknesses, using the elements and principles of design and ease and quality of implementation. • Evaluation process includes appropriate team members and project stakeholders. • Visual design supports human factors and user interface specifications as outlined in the functional design and applies principles of user-centered design.	• Knowledge of design elements and principles and interface requirements. • Ability to assess visual impact and effectiveness. • Knowledge of multimedia software. • Knowledge of specification and implementation procedures. • Knowledge of usability testing methodologies. • Ability to analyze and resolve for conflicts in specifications. • Knowledge of human factors and user interface research.	• Ability to analyze visual appeal and recommend solutions. • Ability to apply appropriate principles/ laws/theories to situations. • Ability to visually analyze relationship between parts/whole, process/procedure. • Ability to consider risks/implications, generate and evaluate alternative solutions and formulate plan of action. • Ability to develop and apply creative solutions to new situations. • Ability to justify user interface design.

Critical Work Function: Produce Visual and Functional Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B5. Develop, evaluate and refine simulations	• The simulation accurately represents the phenomena it portrays. • The simulation is clearly recognizable and easily understood. • The simulation adheres to good design, interface and human factors principles. • Simulation evaluation includes strengths and weaknesses. • Simulations are tested for usability.	• Ability to produce simulations on paper and using technology. • Knowledge of the capabilities and limitations of simulation hardware and software. • Knowledge of good design, interface and human factors principles. • Ability to analyze strengths and weaknesses of multimedia software capabilities. • Ability to develop and administer usability tests.	• Ability to use imagination to visualize events/activities, mentally picture outcomes and visually analyze relationship between parts/whole. • Ability to create comprehensive model/ simulation and evaluate concept/ simulation. • Ability to evaluate/adjust plan of action.
B6. Select appropriate software and hardware tools	• Software and hardware support all functional and delivery specifications. • Software and hardware are the easiest to use and still meet the functional and delivery specifications. • Software and hardware are the most cost effective and still meet required criteria. • Design supports different software and hardware options when appropriate.	• Ability to use multimedia authoring tools, media editing tools and software design tools. • Knowledge of appropriate hardware. • Knowledge of industry trends and standards. • Ability to use web-based data resources.	• Ability to integrate multiple items of data and reconcile conflicting information. • Ability to develop creative solutions and demonstrate resourcefulness. • Ability to predict outcomes and results of selection of tools. • Ability to consider risks and implications.
B7. Document design process	• Design process is documented accurately and completely. • Design process document reflects the project goals, scope and budget. • Design process document is reviewed and approved by all relevant team members and customers. • Design process document includes appropriate testing environments and phases.	• Knowledge of testing and quality assurance criteria and processes. • Ability to anticipate how users will interact with the product.	• Ability to communicate clearly. • Ability to analyze and organize ideas and information. • Ability to use word processing tools. • Ability to resolve conflicts and present accurate results. • Ability to use previous training/experience to predict outcomes.

Critical Work Function: Perform Media Production and Acquisition

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C1. Develop, evaluate and revise text and scripts	• Text and scripts are complete, relevant and congruent with the application domain and flow. • Text content is free of conflict and inaccuracies. • Script flow is congruent with story. • Scripts reflect iterative and dynamic aspects of the application and the development process.	• Knowledge of script development techniques and tools. • Ability to organize flows according to a predetermined scheme. • Knowledge of media design.	• Ability to synthesize information. • Ability to evaluate consistency of written material. • Ability to write for the appropriate audience. • Knowledge of word processing software.
C2. Create prototypes	• Prototypes accurately reflect the design and meet customer needs. • Prototypes are created in a cost-effective and timely manner. • Prototypes are reviewed and approved by the customer.	• Ability to produce and develop multimedia applications. • Ability to use rapid prototyping tools. • Knowledge of prototyping standards. • Knowledge of multimedia software. • Knowledge of media production.	• Ability to demonstrate creative thinking while problem solving. • Ability to identify goals and constraints. • Ability to generate and evaluate alternative solutions. • Ability to formulate and implement a plan of action. • Ability to present ideas effectively.
C3. Identify available media and content sources	• Sources are identified and located in a timely manner. • Available content is matched to project needs and technical specifications. • Selected media and content sources are appropriate and effective. • Content is accurate and complete. • Media and content sources are reliable, current and affordable. • Permission has been granted for the use of any copyrighted material.	• Knowledge of information search and acquisition techniques and ability to use effective search skills for content and media. • Ability to select the most appropriate media type or combination of media types to communicate the content area. • Ability to evaluate the effectiveness of communication for selected media and content sources. • Ability to evaluate the media preferences of the customer. • Knowledge of copyright laws and licenses.	• Ability to interpret and apply new knowledge and experience. • Ability to revise plan as indicated by investigation of media sources. • Ability to implement new technologies and new applications. • Ability to research additional information sources. • Ability to analyze data and evaluate accuracy and appropriateness. • Ability to follow rules and procedures.

Critical Work Function: Perform Media Production and Acquisition

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C4. Produce or acquire content elements	• Graphic, animation, audio and video content are complete and relevant to message and script. • Content is free of conflict and inaccuracies. • Content style is congruent with customer image and project goals. • Simulations create the feel of the real environment. • Permission to use acquired elements is secured.	• Knowledge of copyright laws and licenses. • Knowledge of graphic, animation, audio and video development tools and multimedia software. • Knowledge of graphic, animation, audio and video industries and vendors. • Knowledge of virtual reality technology, simulation tools, video production and ability to use 3D graphic simulations to build virtual world.	• Ability to mentally picture outcomes. • Ability to think creatively while solving problems. • Ability to analyze effectiveness of graphics, animation, audio and video content. • Ability to analyze content and form and reconcile to overall project image. • Ability to compile multiple viewpoints and formulate plan of action. • Ability to generate and evaluate alternative solutions.
C5. Perform project mapping	• Each media element is uniquely identified using appropriate naming conventions. • Project map includes contingency plan. • Constraints and interdependencies are completely and accurately identified.	• Knowledge of critical path scheduling. • Knowledge of multimedia software. • Knowledge of industry standards. • Knowledge of media indexing. • Ability to develop and understand project management charts and work flow diagrams.	• Ability to consider risks and implications. • Ability to formulate plan of action and predict results. • Ability to organize information according to company procedures. • Ability to understand relevance of media components to various situations. • Knowledge of project management scheduling software.
C6. Substantiate make-or-buy decisions	• Make-or-buy decision includes product quality and cost. • Substantiation document includes vendor selection criteria. • Make-or-buy decision making includes appropriate people.	• Knowledge of basic business principles. • Knowledge of contract management. • Knowledge of multimedia software.	• Ability to analyze situation/information and consider risks/implications. • Ability to compare and evaluate alternative solutions. • Ability to justify purpose/result.

Critical Work Function: Perform Media Production and Acquisition

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C7. Participate in iterative development with clients and team members	• Design and production elements meet specifications. • A number of prototypes and evaluations are complete. • Prototypes have a positive effect on the development process. • The next iteration solves a problem that moves toward meeting the goals and objectives of the project. • Stakeholders review and sign off on critical iterative development steps.	• Knowledge of the iterative process. • Ability to use a variety of development strategies. • Knowledge of development and delivery platforms. • Ability to present technical information clearly. • Knowledge of multimedia software.	• Ability to analyze group/individual response and pose critical questions. • Ability to analyze alternatives, and make tradeoffs and decisions. • Ability to resolve technical issues. • Ability to encourage others to adopt new ideas.

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Critical Work Function: Implement and Test Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D1. Implement functional and user interface design criteria	• Each specified function/feature is available to the user through an appropriate interface. • The application can operate in the designated delivery environment in a manner acceptable to the client. • Human factors elements meet visual design and functional design specifications. • Human factors design meets budgetary requirements.	• Ability to design user interfaces. • Ability to creatively integrate user. specifications into a quality user interface. • Ability to use appropriate multimedia hardware and software. • Knowledge of human factors principles. • Knowledge of user needs and tasks.	• Ability to compile multiple viewpoints and analyze design criteria. • Ability to formulate plan of action and predict outcomes.
D2. Identify, create and incorporate reusable components	• Redundant code modules are minimized or eliminated. • Duplicate media are minimized or eliminated. • Standard templates and media are used if available. • New code modules are built with general use in mind and made available to group/ enterprise. • Media is updated and incorporated into the application without manual intervention whenever possible.	• Knowledge of authoring tools and languages and ability to apply software development techniques. • Knowledge of industry standards for media formats. • Ability to apply database software tools. • Knowledge of templates available. • Knowledge of roles and responsibilities of departments and personnel in the company. • Ability to use state-of-the-art automation.	• Ability to follow company policies and procedures. • Ability to develop predictions based on available information.

Critical Work Function: Implement and Test Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D3. Create and produce finished content	• All media meets design specifications and integrated media elements are balanced in relationship to the message. • Content is reviewed by an independent content expert for clarity, structure and accuracy. • All copyrights are signed for each media element. • Integration of media elements is consistent with initial design. • Media is combined in an effective manner for maximum communication of content. • Selected media and style of integration are a match with customer/audience media preferences.	• Knowledge of media production and acquisition processes. • Knowledge of research and content organization techniques. • Ability to use the Internet and multimedia software. • Knowledge of media format conversion principles and tools. • Ability to analyze hardware and software requirements for integrated media. • Knowledge of basic design elements of each media type and ability to evaluate customer/ audience media preferences.	• Ability to apply creative thinking to new situations. • Ability to examine task and technology relationship. • Ability to implement new technologies and new applications. • Ability to integrate system technology and predict technological results. • Ability to visualize integrated media product.
D4. Develop and perform usability and functionality tests	• Test plans are efficient and effective and follow appropriate company procedures. • Usability and functionality tests are designed to include customer expectations. • Usability and functionality tests are directed toward appropriate audiences, done in adequate numbers and use appropriate procedures. • Methods for testing are affordable and relevant and include summative evaluation. • Testing results in accurate information that can be used in the iterative development process, and deviations from specifications are clearly identified.	• Knowledge of company testing procedures. • Knowledge of iterative development process. • Knowledge of testing software and ability to track and resolve defects. • Knowledge of usability testing procedures and cost considerations in testing. • Knowledge of multimedia software and hardware. • Knowledge of specifications and ability to assess customer satisfaction.	• Ability to devise/implement plan of action and judge effectiveness of test plan. • Ability to examine information/data for relevance and accuracy. • Ability to analyze possible causes/reasons and recommend action plan. • Ability to monitor/adjust task sequence. • Ability to analyze operational problems and adjust system operation. • Ability to follow processes/procedures. • Ability to develop and ensure compliance to quality standards.

Critical Work Function: Implement and Test Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D5. Identify and resolve defects	• Design process identifies approaches to finding, managing and prioritizing errors. • Defects are identified completely and accurately. • Timely documentation of errors includes current status and person responsible for resolving. • A systematic testing program is implemented to identify hardware compatibility problems. • Navigation is mapped and checked for all links. • Critical error areas are identified and error trapping is embedded into product. • A debugging program is in place as the components are developed. • Previously identified errors have been resolved within allotted time and budget.	• Ability to use debugging tools. • Ability to analyze design, hardware and software problems. • Ability to use resources to resolve bugs. • Knowledge of version and revision control practices. • Ability to manage errors and use tracking software.	• Ability to adapt technology for alternative uses. • Ability to follow proper procedures and apply technology in an effective manner. • Ability to make recommendations for a higher quality product. • Ability to analyze possible causes and reasons. • Ability to generate and evaluate solutions, and devise and implement plan of action.
D6. Document implementation and testing process and results	• Implementation and testing process is accurately and thoroughly documented. • The results of implementation and testing are clearly and concisely communicated. • Implementation and testing process and results are reviewed by appropriate team members and stakeholders. • Steps for improvement in the implementation and testing processes are outlined.	• Knowledge of testing methods, tools and procedures. • Knowledge of company and departmental practices. • Ability to identify and track critical implementation milestones and deadlines.	• Ability to effectively organize, analyze and synthesize information. • Ability to communicate information and ideas clearly and succinctly. • Ability to use word processing tools.

Critical Work Function: Implement and Test Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D7. Conduct customer acceptance testing and deliver product	• Testing plan is complete and well coordinated. • Testing results in feedback that can be used in the iterative development process. • Appropriate people are included in acceptance testing. • Delivered product meets customer expectations.	• Knowledge of customer expectations. • Ability to assess acceptance testing for efficiency and effectiveness.	• Ability to interpret and clarify communication. • Ability to predict and communicate outcomes to the customer. • Knowledge of word processing software. • Ability to resolve conflicts to customer satisfaction. • Ability to organize acceptance testing procedure.

Enterprise Systems Analysis and Integration

As society increasingly depends on information technology for commerce, education, communication and entertainment, the smooth functioning and proper interaction of complex information technology systems become increasingly important. The increase in e-business and digital commerce will put even more emphasis on the inter-operability, usability and security of separate systems. Technician-level persons will install necessary software, program databases and configure networks to allow efficient and secure transactions among computer systems. Professional opportunities exist for persons with technical backgrounds plus business computer science education to perform high-level design and system integration functions either as a member of the enterprise team or as a consultant.

SAMPLE TITLES

- Application Integrator
- Business Continuity Analyst
- Cross-Enterprise Integrator
- Data Systems Designer
- Data Systems Manager
- Data Warehouse Designer
- E-Business Specialist
- Electronic Transactions Implementer
- Information Systems Architect
- Information Systems Planner
- Systems Analyst
- Systems Architect
- Systems Integrator

"Excellent written and oral communication required. We expect candidates to prepare and make a presentation on a technical topic of their choosing. We demand a high level of communication. Some are expected to publish."

From the Enterprise Systems Analysis and Integration Focus Group

The Iterative Nature of IT Work

The development of skill standards necessarily requires an analytical approach that results in the classification of functions and tasks in a discrete, linear and sequential form. When using skill standards data, it should always be remembered that the actual nature of this work is iterative, with ongoing cycles that build over time to a completed task. It should not be inferred that the skill standards set forth unalterable steps of procedure for the accomplishment of a task.

As with all professions, the nature of information technology jobs is precise yet flexible, with processes and tasks subjected to continuous feedback, improvement and refinement, based on available resources and customer/client needs. The ability to respond to the iterative nature of information technology work should be considered a key employability skill.

ENTERPRISE SYSTEMS ANALYSIS AND INTEGRATION

Summary of Critical Work Functions

A. Define Customer Requirements	B. Determine Systems Solutions	C. Provide Strategic Direction for Systems Configuration and Inter-operability	D. Provide High-level Technology Management	E. Implement Systems
A1 Identify and document customer requirements	B1 Evaluate current and emerging tools and technologies	C1 Evaluate company's technology strategies	D1 Define performance metrics	E1 Manage systems implementation projects
A2 Define security requirements	B2 Perform opportunity analysis	C2 Make recommendations regarding company's investment in technology	D2 Audit systems performance	E2 Coordinate systems testing
A3 Assess and document current systems capabilities and user trends	B3 Make fiscal recommendations regarding technology	C3 Define data warehousing requirements	D3 Provide capacity planning	E3 Perform implementation readiness review
A4 Develop and document business process model	B4 Define systems security specifications	C4 Provide uniform integration for legacy systems	D4 Provide long-term strategic consulting	E4 Coordinate systems user training
A5 Define training requirements	B5 Define delivery strategies	C5 Provide systems consulting to user groups	D5 Evaluate application of digital commerce to organization	E5 Put systems into production
A6 Identify performance metrics	B6 Define implementation strategies			E6 Provide systems documentation
	B7 Define systems interfaces			

"We try to understand the business first, then design the system to meet those needs and requirements."

A Systems Analyst/Integrator

The Scene

Most persons in the enterprise systems analysis and integration role are not just out of school, as they must understand the organization structure and how to be effective within the business. Their effectiveness in this position often develops over a period of time as a person successfully melds both business and technical education with progressively more responsible business situations.

As an enterprise systems analyst and integrator, you are a technology generalist and business strategist. You have a breadth and depth of knowledge across all computing platforms and IT technologies. Even though your strength and background may be in software or hardware, you need a thorough and up-to-date knowledge of both areas in terms of available solutions and trends. Your responsibilities require your expertise in networks, the Internet, operating systems, operations and applications. In most cases, you will not get involved in the detailed design of the actual solutions—you'll rely on technology specialists to do that. However, you will make decisions that impact the design and choice of technologies. You bear the final responsibility for the system choice and its ability to support business operations and enhance productivity.

Typical of most enterprise systems analysts and integrators, you probably moved into your current position from a more specialized job. You may have started out in networks or as a database administrator and you rely heavily on this strong technology base. What enables you to be successful in your enterprise position, however, is your ability to understand business issues and the implications of technology in business operations. You have a well-rounded perspective on business constraints and dynamics, can project operational needs into the future and are able to make solid decisions that take into account many technology and business-related requirements.

Depending on the size of the company in which you are employed, you may focus on one area of the organization such as data warehousing or information systems for manufacturing, or in smaller companies you may have responsibility for the enterprise-wide information system. You may specialize in security issues developing policies and procedures that affect the security of all the enterprise information systems. As a consultant, you may focus on transitioning old systems to new technology and integrating data, files and other information from multiple platforms. You may be the chief information officer or chief technology officer and called upon to analyze and evaluate different business case scenarios, make high-level presentations or develop strategic reports.

In a beginning position as an enterprise systems analyst and integrator, you will tend to focus on researching and analyzing requirements, researching and developing potential solutions and making recommendations to management. As you gain expertise in this job and develop a broader and more thorough understanding of the business, you will be expected to identify long-term technology-related issues, make wider-reaching technology decisions and develop recommendations in technology policies and strategies. You may manage a small group of analysts, act as overall project manager for technology development and implementation projects or serve as an internal consultant to the IT group.

As you gain further experience and move up in the organization, your leadership role in technology-related decision making increases. Your main goal and responsibility are to use technology to provide an ongoing and distinct competitive advantage for the business. Your analysis and strategic thinking skills are as critical as your technical knowledge. Communication skills at a high level are a strong requirement for your success.

Scenarios

Entry Level

- Participate in planning and organization meetings with the project team.
- Develop and conduct interview process with users.
- Identify gaps in information and key sources of information to fill them.
- Analyze, summarize and document findings.
- Participate in reviews and group discussion of findings.
- Develop an accurate picture of the situation and communicate to team members and management.

You were recently hired as a systems analyst by an international firm doing a significant part of their business in Europe. Europe is in the process of migrating from a set of different currencies for each separate European country to a common European currency—the Euro. You are part of the team formed to evaluate your company's current system and its ability to handle the change. The transition process is made more complicated from an information handling perspective by the fact that both European currency systems will continue to exist side by side for a couple of years. Your organization relies heavily on effective management of currency exchange rates and part of your responsibility is to characterize the impact of a single currency value on current practices.

Your team will be responsible for assessing gaps in the current systems, making recommendations for improvement and dealing effectively with the implementation of changes. Your team will work closely with representatives of the financial and sales departments as well as members of the technology group to assess current capabilities, procedures and limitations. You will also need to research some of the European regulations concerning currency and transactional procedures.

After several planning and organization meetings, team members are assigned specific roles in gathering of the necessary information. You are sent to investigate the current procedures in invoicing. You interview users—those who actually create and manage invoices—as well as managers to gain a broader perspective on the invoicing processes and constraints. You also gather information on the "edges" of the invoicing system—what types of interactions take place between the invoicing department and other departments, what type of information is transferred between these departments and how is it transferred. Once you have assembled the necessary information, you analyze and summarize your results and develop a management report. As your initial findings are further analyzed, some gaps and contradictions emerge. You are asked to go back to select personnel to resolve these issues and you find it necessary to seek clarification from the top levels of the organization.

Your ability to communicate in an effective manner, obtaining what you need to know, yet respecting boundary and sensitivity issues is critical to the validity of the analysis process. The analysis phase takes several months to complete and goes through multiple iterations of gathering and analyzing data. When you are not on your own sorting through pages of interview notes, you are communicating with users or engaged in active discussion with other team members. Your ability to see patterns in the data, recognize important issues and develop an accurate picture of the situation from isolated information is key to your success. Ultimately, your thorough and comprehensive evaluation of a very complex situation is found to be indispensable in developing the appropriate technological response.

"You need to focus on continuous education and know that all you've learned before will be obsolete in a couple of years. You have to be personally motivated to stay current on a whole barrage of 'latest developments.' You're constantly searching, analyzing and synthesizing new information."

A Systems Analyst

"You have to recognize that you are doing this work for others. It's not an end in itself. I want a long-term relationship with the client. We need to work together and ensure regular, meaningful feedback. It is arrogant to do otherwise."

A Business Systems Integrator

Proficiency Level

- Assess areas of need for personal growth and identify opportunities for further development.
- Acquire further technical and business knowledge and skills.
- Develop professional connections within and outside the company.
- Gain an understanding of business trends as they affect technology decisions.
- Make recommendations that take into account current systems, technology trends and future business needs and expected growth.
- Develop preliminary design of solutions and present to management for review and approval.

Five years ago you were working for a consulting firm in network implementation and after a successful project were hired by the client company. The company's management was very impressed by your skills—not only by your technical expertise in networks, but even more so by your ability to rapidly understand their business issues and develop technical recommendations aligned with business goals. You were hired as a systems analyst and integrator with responsibilities for division-wide systems. However, as you gained knowledge of enterprise-wide functions and goals and developed an intimate knowledge of specific parts of the company, your responsibilities broaden to encompass more of the enterprise system. In these few years you took many opportunities to acquire additional knowledge and skills. Although your duties do not require you to be technically proficient with every software application used by your company, you have developed and maintained an in-depth understanding of their capabilities, limitations and applications. You regularly attend management and business training seminars offered by your company and participate in several business technology groups to extend your professional network.

The company has grown rapidly in the last few years and the current system has become seriously overloaded and cannot be scaled to accommodate increased traffic, although the network technicians and administrators have done a fantastic job of upgrading the current system. It is clear the time has arrived for a new strategy. You have been asked to develop recommendations and the preliminary design for an enterprise-wide system to support the company's operations through the decade. Many considerations need to be included in your decision. Due to physical constraints of some of your buildings, existing hardware may have to be reused. This factor, along with capital and lifecycle cost data, outsourcing possibilities and employee training must all be evaluated to ensure a solution is selected that supports all desired business functions while enhancing productivity. You will need to gather and synthesize information from many sources to arrive at a decision. You are already intimately familiar with the current system but need to refine your up-to-date knowledge of technology trends in the context of your business environment. You spend time discussing business trends with the executive management in your company, as well as interviewing market research analysts within and outside of your company to gain a picture of the business future directions and potential expansions.

This is a lengthy process. You have a lot of unknowns, as trends are difficult to accurately forecast. Yet, your decision will significantly impact the success of your company in the future and its com-

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petitive position in the market. It sometimes feels as if you are walking on a tight wire with the weight of the organization on your shoulders. You don't have much to stand on, yet a lot is resting on your ability to make the best decision. However, you enjoy the balance of technology and business issues involved in your project. You also appreciate the opportunity to see and understand global aspects of the enterprise—technology, finance and marketing.

"Access and security are becoming even bigger issues. We have to make sound decisions based on both technology and business objectives. Developing and implementing the necessary range of overarching strategies, cut-over plans, relevant policies and adequate systems support is a constant challenge."

An Application Integrator

Expert Level

- Participate and lead strategic meetings.
- Contribute to high-level strategic decisions in many areas of the organization.
- Analyze and communicate technology trends and their impact on business.
- Review existing and develop new procedures for the processing and management of information.
- Act as leader in technology use throughout the organization.

You have been working as an enterprise systems analyst and integrator for close to ten years. Your ability to think strategically and communicate effectively in terms of business factors and technology impact has helped you move up in the organization. You spend a lot of your time in strategic meetings at various levels in the organization. Your counsel and recommendations are highly regarded by most managers within the company. As you have a broad and comprehensive view of the organization from both a business and technology usage perspective, your contributions are a major factor in many high-level decisions.

In the past few years, your role has included participating in task-force projects in specific areas of information management, as well as continuously assessing the effectiveness of the use of technology throughout the enterprise. You were recently involved in leading a team to review current information security practices and develop security procedures that are better suited to today's business practices and technology environment. Tactically, you are continuously looking for opportunities to use technology at the enterprise level to increase business efficiencies. Strategically, you are depended upon to ensure your organization does not get "behind the curve." Your decisions significantly impact the design and implementation of enterprise-wide and unit-wide systems.

Your ability to absorb and analyze a lot of information, rapidly identify the key issues and assess the significance of specific information is a key success factor in your position. Your ability to view and communicate the big picture and make decisions that have proven successful has strongly contributed to your effectiveness and influence throughout the company. You are tempted to take one of the offers from major consulting firms to join them and bring your expertise and experience to the service of other world-class firms.

Critical Work Function: Define Customer Requirements

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A1. Identify and document customer requirements	• Constraints are properly identified. • Customer requirements are complete, accurate and documented in a timely manner. • Requirements are signed off by user in accordance with company procedures. • Changes are incorporated as appropriate. • Configuration management processes are applied to documentation.	• Knowledge of continuous quality improvement tools. • Knowledge of company procedures regarding document sign-off. • Ability to incorporate changes to customer requirements. • Knowledge of configuration management processes. • Ability to draw requirements from customers and infer technological implications. • Knowledge of systems requirements and systems modeling.	• Ability to compare multiple viewpoints and analyze communication. • Ability to integrate multiple items of data, contrast conflicting data and research additional information sources. • Ability to establish rapport with co-workers and customers and modify actions to environment. • Ability to detect underlying issues and resolve technical conflicts. • Ability to present complex ideas/ information and pose critical questions.
A2. Define security requirements	• Security requirements are complete and accurate. • Security requirements are consistent with company standards and all applicable laws and regulations. • Security requirements are consistent with external customer requirements and transaction procedures.	• Knowledge of company standards and all applicable laws and regulations regarding security. • Knowledge of security limitations and capabilities. • Knowledge of networking and general systems security. • Knowledge of data integrity issues. • Knowledge of external customer requirements and transaction procedures.	• Ability to follow policies and procedures, pay attention to detail and follow up on assigned tasks. • Ability to compare multiple viewpoints. • Ability to examine information for relevance and accuracy and adapt principles/rules to new applications.
A3. Assess and document current systems capabilities and user trends	• Assessment accurately reflects current systems capabilities. • Proper tools and metrics are used to measure user trends. • Assessment includes infrastructure capacity trends. • Documentation is completed according to company procedures. • Documentation includes external customer requirements and transaction procedures.	• Knowledge of analysis tools and metrics to measure user trends. • Knowledge of company procedures regarding documentation. • Knowledge of the ability to measure infrastructure capacity. • Ability to audit customer use of systems against systems capabilities. • Knowledge of external customer requirements and transaction procedures.	• Ability to summarize and translate mathematical data. • Ability to create detailed supporting documents. • Ability to convert numerical data and predict arithmetic results. • Ability to analyze organization of information. • Ability to utilize networks and organize information and reports.

Critical Work Function: Define Customer Requirements

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A4. Develop and document business process model	• Appropriate diagramming methodologies and modeling techniques are used. • Business process model accurately reflects current operation. • Documentation is complete and accurate. • Documented process is validated by the customer in accordance with company procedures.	• Knowledge of diagramming methodologies and the ability to utilize modeling tools and techniques. • Knowledge of company procedures regarding customer validation. • Knowledge of the business process. • Knowledge of networks and systems infrastructure. • Knowledge of distributed computing.	• Ability to summarize and translate mathematical data. • Ability to convert numerical data and predict arithmetic results. • Ability to integrate and analyze information and organize technical reports. • Ability to actively participate in team activities and encourage/support team members. • Ability to respond to customer needs, relate to concerns and resolve conflicts to customer satisfaction.
A5. Define training requirements	• Training requirements are developed in accordance with company procedures. • End-user skill level is accurately evaluated. • Training strategies are appropriate and cost-effective. • Training is relevant and timely. • Training requirements are effectively communicated to training developers. • Where applicable, training curriculum is effectively developed and presented.	• Knowledge of company procedures regarding training requirements. • Knowledge of just-in-time training methods. • Ability to evaluate training modality for technical skills required by user. • Knowledge of instructional design principles.	• Ability to identify training needs. • Ability to analyze application of learning tools and investigate new learning techniques. • Ability to assess individual knowledge and skills. • Ability to develop appropriate training procedures and conduct task-specific training. • Ability to demonstrate honesty and trustworthiness.

Critical Work Function: Define Customer Requirements

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A6. Identify performance metrics	• Critical performance requirements are clearly identified. • Performance metrics are documented in accordance with company procedures. • Performance metrics are validated by customer.	• Knowledge of performance metric documentation procedures. • Knowledge of company procedures regarding customer validation. • Ability to translate customer requirements into quantifiable entities. • Ability to identify, collect and interpret metrics. • Knowledge of statistical process control methods. • Ability to draw performance metrics from customers and infer technological implications.	• Ability to detect underlying issues and resolve technical conflicts. • Ability to compare and interpret multiple viewpoints. • Ability to convert numerical data and predict arithmetic results. • Ability to summarize and translate mathematical data. • Ability to understand continuous improvement process and analyze goals/ constraints.

Critical Work Function: Determine Systems Solutions

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B1. Evaluate current and emerging tools and technologies	• Evaluation is complete, accurate and timely. • Alternative technologies are evaluated against customer requirements. • Appropriate information sources for current and emerging technologies are explored.	• Knowledge of sources of information for current and emerging technologies. • Knowledge of customer requirements. • Knowledge of tools and technologies. • Knowledge of programming languages. • Knowledge of distributed computing and computing platforms.	• Ability to research additional information sources and create data gathering processes. • Ability to analyze operational problems, evaluate computer utilization and judge information accuracy. • Ability to evaluate effectiveness of solutions for customer and forecast future customer needs. • Ability to adapt principles to new applications and judge logical consistency. • Ability to stay current on cutting edge technologies and processes.
B2. Perform opportunity analysis	• Existing resources are properly audited in accordance with company procedures. • Appropriate options are considered and alternative analyses performed. • Cost/benefit and ROI analyses are properly conducted. • Risk assessment is correctly documented. • Additional uses for the technology are identified to leverage development costs. • Opportunity evaluation is presented to appropriate personnel in accordance with company procedures. • There is a good match between needs and solutions.	• Ability to perform cost/benefit and/or ROI analysis. • Ability to perform risk assessment. • Knowledge of options for technology use. • Knowledge of company procedures. • Knowledge of business processes. • Knowledge of internal customer competency/literacy.	• Ability to justify systems modification and ensure quality control. • Ability to adapt technology for complex alternative uses, design new technology and evaluate application of technology. • Ability to evaluate effectiveness of solutions for customer and forecast future customer needs. • Ability to project hardware and software needs. • Ability to analyze, summarize and integrate information.

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Critical Work Function: Determine Systems Solutions

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B3. Make fiscal recommendations regarding technology	• Recommendations are in accordance with company procedures. • Recommendations are communicated appropriately. • Risk assessments are appropriately considered. • Recommendations are included in the business plan and meet strategic goals. • Recommendations are based on ROI and lifecycle costs.	• Knowledge of risk assessment and ROI analysis techniques. • Knowledge of business plan and strategic goals. • Knowledge of recommendation procedures. • Knowledge of lifecycle costs.	• Ability to implement technological improvements and generate technological solutions. • Ability to design programs, networks and systems, evaluate computer utilization and judge information accuracy. • Ability to justify positions/policies. • Ability to develop alternative systems designs. • Ability to compose well-organized presentations and debate issues. • Ability to develop formal and informal relationships with leaders in the enterprise.
B4. Define systems security specifications	• Requirements for systems security are properly identified. • Security policy and procedures are correctly identified. • Database security is correctly defined. • Systems security meets minimum standards identified by customer and required by all applicable laws and regulations. • Systems security procedures are properly documented and approved in accordance with company guidelines.	• Knowledge of database and systems security issues. • Ability to interpret and apply security policies and procedures. • Knowledge of customer security requirements and all applicable laws and regulations. • Knowledge of security procedures documentation guidelines. • Knowledge of company procedures regarding documentation approval. • Knowledge of security audit requirements.	• Ability to formulate new ideas/approaches and organize new processes/procedures. • Ability to generate and evaluate alternative solutions. • Ability to create and develop new rules/principles. • Ability to recognize organizational systems strengths/limitations and evaluate process/procedure. • Ability to demonstrate honesty and trustworthiness.

Critical Work Function: Determine Systems Solutions

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B5. Define delivery strategies	• Delivery strategies meet documented customer schedule requirements and prevailing business conditions. • Delivery mechanism meets cost, schedule and customer requirements.	• Knowledge of customer schedule requirements. • Knowledge of delivery strategies and mechanisms. • Knowledge of prevailing business conditions.	• Ability to resolve conflicts to customer satisfaction and obtain additional resources to meet customer needs. • Ability to resolve technical issues. • Ability to design programs, networks and graphics. • Ability to accept constructive criticism and responsibility for own actions. • Ability to create new rules/principles. • Ability to formulate new approaches and establish new processes/procedures.
B6. Define implementation strategies	• Implementation strategies meet customer priorities and prevailing business conditions. • Implementation strategies are properly coordinated with all customer schedules. • Implementation strategies make efficient use of available resources. • Full advantage is taken of iterative implementation processes. • Implementation is effectively coordinated with training schedule. • Data integrity is properly protected.	• Knowledge of implementation strategies such as concurrent processing, total systems change-over, data migration and data conditioning. • Knowledge of customer priorities and schedules. • Knowledge of efficient strategies for use of resources. • Knowledge of data integrity issues and protection techniques. • Knowledge of prevailing business conditions.	• Ability to formulate new ideas/approaches and establish new processes/procedures. • Ability to generate and evaluate alternative solutions. • Ability to create and develop new rules/principles. • Ability to recognize organizational systems strengths/limitations and evaluate process/procedure. • Ability to propose new technology applications, integrate systems technology and predict technological results.

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Critical Work Function: Determine Systems Solutions

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B7. Define systems interfaces	• All interfaces are accurately identified. • Agreements are established with all appropriate departments and/or personnel regarding delivery and exchange of data. • Access issues are appropriately resolved. • Collateral impacts are identified.	• Knowledge of systems and interfaces. • Knowledge of requirements regarding exchange of data. • Knowledge of access issues. • Knowledge of graphical user interface design and platforms.	• Ability to generate and evaluate alternative solutions. • Ability to create and develop new rules/ principles. • Ability to recognize organizational systems strengths/limitations and evaluate process/procedure. • Ability to propose new technology applications, integrate systems technology and predict technological results. • Ability to detect underlying issues and resolve technical conflicts.

Critical Work Function: Provide Strategic Direction for Systems Configuration and Inter-operability

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C1. Evaluate company's technology strategies	• Appropriate strategies are thoroughly explored including web-centric and network-centric strategies. • Appropriate personnel and departments are included in the evaluation process. • Technology and data strategies are incorporated into company's strategic plan.	• Knowledge of technology strategies including web-centric and network-centric strategies. • Knowledge of strategic plan, business conditions and future goals. • Knowledge of the nature of data and data communication strategies. • Knowledge of distributed computing. • Knowledge of current communication protocols and programming languages. • Knowledge of architecture framework and relational paradigm.	• Ability to compare multiple viewpoints and relate intent to desired results. • Ability to adapt rules/principles to new applications. • Ability to responsibly challenge unethical practices/decisions and formulate ethical course of action. • Ability to evaluate application of technology. • Ability to evaluate computer utilization and judge information accuracy. • Ability to mentally picture familiar processes and create models.
C2. Make recommendations regarding company's investment in technology	• Recommendations are complete and correct. • Recommendations are communicated appropriately. • Risk assessments are appropriately considered. • Recommendations meet strategic goals and are included in the business plan.	• Knowledge of risk assessment analysis techniques. • Knowledge of business plan, strategic goals and business conditions. • Knowledge of recommendation procedures. • Knowledge of architecture framework.	• Ability to generate unique solutions, formulate new ideas, plans and approaches and establish new processes/ procedures. • Ability to analyze information and formulate proposals. • Ability to present complex ideas/ information and pose critical questions. • Ability to create original documents. • Ability to evaluate computer utilization. • Ability to analyze goals/constraints and examine proposed modifications and improvements.

Critical Work Function: Provide Strategic Direction for Systems Configuration and Inter-operability

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C3. Define data warehousing requirements	• Warehousing requirements are thoroughly evaluated. • Requirements are properly documented and meet company standards and all applicable laws and regulations. • Appropriate departments and personnel are included in the process. • Warehousing requirements include computing platform considerations. • Warehousing requirements meet customer needs. • Reports are designed to meet customer, user or business needs.	• Knowledge of decision support strategies and modeling. • Knowledge of company standards and all applicable laws and regulations regarding documentation. • Knowledge of warehousing strategies. • Knowledge of meta-data dictionaries. • Knowledge of company data systems and relational paradigm. • Knowledge of computing platforms. • Knowledge of customer needs and report design.	• Ability to generate and evaluate alternative solutions. • Ability to create and develop new rules/ principles. • Ability to recognize organizational systems strengths/limitations and evaluate process/procedure. • Ability to propose new technology applications, integrate systems technology and predict technological results. • Ability to detect and summarize underlying issues and resolve technical conflicts.
C4. Provide uniform integration for legacy systems	• Legacy systems are thoroughly evaluated for inter-operability and security. • Cross-platform technologies are used appropriately and effectively. • User interface effectively accommodates relevant text, graphics and file conversions and interchanges. • User interface is transparent to systems. • Integration and testing are performed according to project and company schedules, priorities and guidelines.	• Knowledge of legacy systems. • Knowledge of inter-operability issues and constraints. • Knowledge of cross-platform technologies, tools and security considerations. • Knowledge of human factors principles and user interface design issues.	• Ability to propose new applications, integrate systems technology and predict technological results. • Ability to evaluate customer requirements and pose critical questions. • Ability to analyze goals/constraints and examine proposed modifications and improvements. • Ability to resolve conflicts to customer satisfaction.

Critical Work Function: Provide Strategic Direction for Systems Configuration and Inter-operability

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C5. Provide systems consulting to user groups	• Existing applications are supported and enhanced. • Custom applications are researched and recommended. • Systems options and solutions are analyzed, evaluated and recommended. • Enterprise IT units function together effectively. • Technical knowledge and solutions are provided as necessary. • Knowledge of existing systems, applications and infrastructure.	• Knowledge of business processes. • Knowledge of application support and development processes. • Knowledge of information sources for gathering and assessing customer requirements, specifications, solution alternatives, and training and documentation needs. • Ability to provide technical knowledge and support to a variety of customer groups.	• Ability to establish rapport with users and modify actions to environment. • Ability to detect and summarize underlying issues and resolve technical conflicts. • Ability to generate, evaluate and recommend alternative solutions. • Ability to communicate complex technical information effectively to users. • Ability to stay current on cutting edge technologies and processes.

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Critical Work Function: Provide High-level Technology Management

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D1. Define performance metrics	• Critical performance requirements are clearly defined. • Performance metrics are properly documented in accordance with company procedures. • Performance metrics are validated by customer.	• Knowledge of performance metric documentation procedures. • Knowledge of company procedures regarding customer validation. • Ability to translate customer requirements into quantifiable entities. • Knowledge of how to identify, collect and interpret metrics. • Knowledge of statistical process control methods. • Ability to draw out technical requirements from customers.	• Ability to summarize and translate mathematical data. • Ability to convert numerical data and predict arithmetic results. • Ability to create detailed supporting documents. • Ability to evaluate computer utilization. • Ability to make exceptional effort on behalf of customer and resolve conflict to customer satisfaction.
D2. Audit systems performance	• Audits are conducted in accordance with company audit schedule and procedures. • Audit results are thoroughly documented. • Exceptions are properly reported according to company procedures. • Escalation process is correctly followed. • Performance reports are reviewed as appropriate. • Knowledge of audit procedures and schedules.	• Knowledge of audit results documentation processes. • Ability to identify exceptions. • Knowledge of exception reporting procedures. • Knowledge of escalation processes. • Knowledge of systems performance and capacities.	• Ability to analyze systems operation, monitor systems, distinguish trends in performance and evaluate systems performance. • Ability to interpret and evaluate data. • Ability to verify data accuracy. • Ability to research additional information sources. • Ability to summarize, integrate and analyze information.
D3. Provide capacity planning	• Systems usage and response time are properly monitored and recorded. • Plans are developed to accommodate future capacity with respect to data and user-growth needs. • Capacity planning utilizes the appropriate performance metrics. • Global IT units are evaluated and organized for efficiency and effectiveness.	• Knowledge of systems usage and response time requirements. • Knowledge of monitoring procedures. • Knowledge of performance metrics techniques. • Knowledge of internal, external and global customer needs.	• Ability to analyze systems operation, monitor systems, distinguish trends in performance and evaluate systems performance. • Ability to propose new technology applications and predict technological results. • Ability to examine proposed modifications and improvements. • Ability to evaluate computer utilization and design programs, networks and graphics. • Ability to project future workloads.

Critical Work Function: Provide High-level Technology Management

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D4. Provide long-term strategic consulting	• Enterprise systems operation, infrastructure and performance are evaluated and forecast in light of emerging technologies and business trends. • Strategic and tactical technology plans are developed and implemented. • Enterprise marketing, sales and service strategies and campaigns are integrated and supported. • Revenue and product analysis forecasts are researched in light of emerging technologies and business trends.	• Knowledge of systems operation, infrastructure and performance. • Ability to track and interpret emerging technology and business trends. • Ability to develop and implement strategic and tactical plans. • Knowledge of enterprise marketing, sales and service requirements. • Ability to produce meaningful revenue and product analysis forecasts.	• Ability to evaluate effectiveness of solutions for customer and forecast future customer needs. • Ability to adapt technology for complex alternative uses, propose new strategies and evaluate application of technology. • Ability to formulate new ideas/approaches and organize new processes/procedures. • Ability to create new rules/principles. • Ability to recognize and evaluate enterprise system's strengths/limitations.
D5. Evaluate application of digital commerce to organization	• Strategic technology use and deployment are evaluated and organized in response to digital commerce technologies, enterprise goals and market trends. • Customer services, vendor reviews and revenue-generation strategies are continually evaluated and updated. • Sales and marketing strategies are continually revised to exploit emerging digital commerce technologies and maximize competitive advantage. • Plans for establishing and managing electronic transactions are developed and implemented.	• Knowledge of technology use and deployment strategies appropriate to enterprise. • Knowledge of business processes. • Knowledge of research and analysis techniques for identifying and evaluating technology and business trends. • Knowledge of market and competitive forces.	• Ability to generate, evaluate and communicate alternative solutions. • Ability to predict technological impacts and results. • Ability to propose new technology applications and integrate systems technology. • Ability to compare multiple viewpoints. and related intent to desired results. • Ability to evaluate computer utilization and judge information accuracy. • Ability to implement strategies successfully.

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Critical Work Function: Implement Systems

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E1. Manage systems implementation projects	• Project phases, sequence and milestones are identified and communicated. • Project scope and cost are approved by all stakeholders. • Human, physical and financial resources are mapped to project. • Project management plan is accepted and implemented.	• Ability to use project management tools and techniques. • Knowledge of company approval procedures. • Knowledge of systems technology and associated implementation issues.	• Ability to organize and present complex ideas/information and pose critical questions. • Ability to identify enterprise systems strengths/limitations and evaluate process/procedure. • Ability to plan effectively and integrate multiple perspectives. • Ability to encourage/support team members. • Ability to solicit and accept feedback. • Ability to align resources with project needs. • Ability to prepare and implement project management plan.
E2. Coordinate systems testing	• Testers are properly identified. • Test scope and schedule are properly developed. • Test resources are in place as required by testers. • Test scripts are supplied to testers. • Systems testing is conducted as appropriate. • Test results are documented in accordance with company procedures. • Test results are distributed to appropriate personnel.	• Knowledge of test scope, schedule and required resources. • Ability to identify qualified testers. • Knowledge of test script development. • Knowledge of test documentation procedures. • Knowledge of test result dissemination procedures. • Knowledge of automated testing tools.	• Ability to analyze and adjust goals. • Ability to promote cooperation. • Ability to encourage/support team members. • Ability to integrate multiple items of data and contrast conflicting data. • Ability to evaluate computer utilization. • Ability to demonstrate honesty and trustworthiness. • Ability to create original documents and write in a clear and concise style.

Critical Work Function: Implement Systems

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E3. Perform implementation readiness review	• All procedures and documentation are thoroughly reviewed. • Systems are reviewed and approved for production. • All stakeholders are included in the review process. • All schedules are confirmed. • All risks are communicated to the customer • Go or no-go decision is made. • Customer support document is reviewed and approved.	• Knowledge of procedures and documentation. • Knowledge of computing infrastructure. • Knowledge of stakeholder needs and expectations. • Knowledge of implementation schedule. • Knowledge of risk assessment procedures. • Knowledge of the overall project.	• Ability to detect underlying issues and resolve technical conflicts. • Ability to compare multiple viewpoints and relate intent to desired results. • Ability to present complex ideas/ information and pose critical questions. • Ability to generate and evaluate alternative solutions and predict outcomes based on prior knowledge/experience.
E4. Coordinate systems user training	• User documentation is complete and accurate. • Resources are available to support training needs. • Training schedule is communicated to the customer effectively in a timely manner. • Training is updated based on user feedback and evolving needs.	• Knowledge of user documentation. • Knowledge of just-in-time training. • Ability to identify and procure resources for training. • Ability to evaluate training modality for technical skills required by end user. • Knowledge of instructional design principles.	• Ability to analyze work assignments and delegate responsibilities. • Ability to manage timelines and recommend timeline adjustments. • Ability to accept responsibility for own actions and understand impact on others. • Ability to analyze application of learning tools and manipulate them. • Ability to identify training needs.
E5. Put systems into production	• Requirements are validated and approved by customer. • Discrepancies and exceptions are completely and accurately documented. • Defects are corrected. • Systems ownership is transferred in accordance with established agreements. • Security and user access parameters are confirmed. • Systems support agreement fulfills contract obligations.	• Knowledge of customer approval processes. • Ability to identify discrepancies and exceptions. • Knowledge of documentation procedures. • Knowledge of systems ownership transfer guidelines. • Knowledge of customer requirements, company procedures regarding access and business conditions. • Ability to create and document customer support policies.	• Ability to willingly help others. • Ability to diagnose performance deviations and distinguish trends in performance. • Ability to integrate systems technology. • Ability to respect the rights of others. • Ability to relate to customer concerns and make exceptional effort on behalf of customer.

Critical Work Function: Implement Systems

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E6. Provide systems documentation	• Documentation conforms to established standards. • Documentation completely represents the architecture model of the systems. • Information in the documentation is organized effectively. • Appropriate delivery medium is selected for the documentation.	• Knowledge of established standards for systems documentation. • Knowledge of systems architecture. • Ability to document systems architecture. • Knowledge of appropriate delivery mediums and the ability to evaluate them.	• Ability to analyze organization of information and transfer information between formats. • Ability to pay attention to details, monitor performance standards and follow up on assigned tasks. • Ability to create detailed supporting documents. • Ability to demonstrate commitment to excellence and adhere to standards.

Network Design and Administration

Network technicians make sure the network hardware and software are operating properly so people in your organization get the information they need when they need it. Using cable, fiber optics or even wireless communications, you connect users to your company's computer system. You will thoroughly understand networking technology for local area networks (LANs), and for connecting to larger networks and the Internet. You learn to quickly identify, document and solve problems. Because you work with the users all the time, you know the needs of your company and can recommend improvements based on user needs and technology advances. You will probably need to keep measurements on how the network is performing—charting network usage and downtime to help plan for the future. You document the network configuration and prepare backup plans and procedures. You will be responsible for adding users, making sure they have access to the files and network-connected equipment they need, while maintaining security and confidentiality of other files and data. You install upgrades with a minimum of disruption.

SAMPLE TITLES

- Communications Analyst
- Data Communications Analyst
- Information Systems Administrator
- Information Systems Operator
- Information Technology Engineer
- Network Administrator
- Network Analyst
- Network Architect
- Network Engineer
- Network Manager
- Network Operations Analyst
- Network Security Analyst
- Network Specialist
- Network Technician
- Network Transport Administrator
- PC Support Specialist
- PC Systems Support Lead
- PC Network Engineer
- Systems Administrator
- Systems Engineer
- Technical Support Specialist
- User Support Specialist

"The quality fad has passed. This and teamwork have passed. Not because they are not important, but because the bar has been raised so high that quality/teamwork are understood to be part of the game. They are the game, and we don't even think about these. These are mandatory (like getting your measles shot before school). They pervade every part of the organization."

A Network and Data Communications Professional

The Iterative Nature of IT Work

The development of skill standards necessarily requires an analytical approach that results in the classification of functions and tasks in a discrete, linear and sequential form. When using skill standards data, it should always be remembered that the actual nature of this work is iterative, with ongoing cycles that build over time to a completed task. It should not be inferred that the skill standards set forth unalterable steps of procedure for the accomplishment of a task.

As with all professions, the nature of information technology jobs is precise yet flexible, with processes and tasks subjected to continuous feedback, improvement and refinement, based on available resources and customer/client needs. The ability to respond to the iterative nature of information technology work should be considered a key employability skill.

Portions of the data for this cluster have been compiled with the assistance of the New England Center for Telecommunications Technology, an NSF-funded ATE Center. For a complete discussion of the application of wireless technology, visit *www.nctt.org.*

NETWORK DESIGN AND ADMINISTRATION

Summary of Critical Work Functions

A. Perform Analysis/Design	B. Perform Configuration/ Implementation	C. Perform Testing	D. Perform Monitoring and Management	E. Perform Administration and Maintenance
A1 Gather data to identify customer requirements	B1 Plan and document system configuration	C1 Define and document test specifications	D1 Analyze system performance to baseline	E1 Set up and maintain user accounts
A2 Identify, interpret and evaluate system and network requirements	B2 Implement new system configuration	C2 Develop test plan and procedures	D2 Monitor and report component, security and connectivity problems	E2 Develop maintenance and upgrade plans
A3 Define scope of work	B3 Perform workstation configuration and software loading	C3 Schedule and perform testing	D3 Perform functional verifications and system audits	E3 Schedule and coordinate network maintenance
A4 Review network architecture, topology, interdependencies and constraints	B4 Support, track and document change implementation	C4 Document, interpret and report test results	D4 Make recommendations for system optimization/ improvement	E4 Apply maintenance, upgrades and process changes
A5 Research technical alternatives and analyze technical options	B5 Assist in development of deployment plan and methods		D5 Generate and present reports	E5 Coordinate, communicate and document changes
A6 Participate in design reviews	B6 Develop and implement security procedures			E6 Perform system backups and restore data
A7 Prepare overall design and integration plan for new processes, protocols and equipment				E7 Manage inventory
A8 Recommend selection of architecture, topology, hardware and software				E8 Document maintenance activities

KEY ACTIVITIES

Network Design and Administration

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"We don't care as much about knowledge of a specific network. We'll teach. We need people who can think critically, who can problem solve. Critical thinking is key. Employees can get technical knowledge on the job or through vendor courses. Schools must teach critical thinking, problem solving, teamwork, how business works."

An Employer of Network Technicians

The Scene

Computer networks are the backbone of many organizations. Users depend on networks to be available, fast and secure. At the same time the demands on networks increase continually. Users are added daily to the system, causing more data to flow through the network and increasing the potential for bottlenecks and system overload. New application software programs are added to the network affecting the speed of information processing and access, as well as increasing the frequency of compatibility problems. As networks interact more frequently with outside systems through electronic mail and the Internet, the risks of security breach and serious damage from viruses increase to the level of becoming a primary concern of the network team. Network failures or malfunctions are almost always seen as disasters because they affect so many aspects of the organization's productivity and operations.

As a network specialist, you may focus on the design and implementation of new networks or on the maintenance and troubleshooting of existing systems. You may specialize in a given vendor technology, work with a mix of equipment, operating systems and technology, or look at the broader issues of selecting a network technology for a specific environment. You may choose to focus on security issues or develop expertise in migration and integration concerns. You may work in an environment of technically knowledgeable users or in an organization where the training of users becomes a large part of your job. As a network specialist you need to acquire technical knowledge and skills in all aspects of the network—network hardware and peripherals, network operating systems and application software.

As a beginning network technician, your role will be primarily in helping senior technicians install and troubleshoot systems. You may be involved in routine maintenance of the network, in installing upgrades to the system, or in network operations such as daily backup and monitoring of network functions. You are close to the technology and have a continuous need for acquiring and updating your technical knowledge and skills. You may also interact with vendors in researching products and gathering information to solve problems.

As you gain experience, you are given responsibilities at the system level and for resolution of more extensive and complex problems. You may organize and coach a small team of network technicians and be asked to organize the installation of additional network components. You give input to senior staff to support strategic decisions affecting the network, such as major upgrades and reconfigurations. You may be asked to give input to the design of a new system or the redesign of existing networks to increase efficiency and reliability. You develop a better understanding of productivity issues, cost and benefit analysis, and trend analysis as they relate to the network. Your interaction with users and management increases in frequency and you may be asked to develop and conduct training for users.

As a senior network specialist, you have acquired a broad range of technical expertise—knowledge of vendor products and services, technology trends, network topologies and security strategies. At the same time, the business expertise you have developed has enabled you to view technology from the perspective of needs and risk assessment, as well as to assess its impact on productivity. You are now involved in managing technicians, designers and other resources to support the network needs of the organization.

Scenarios

Entry Level

- Perform system backups, routine maintenance and routine monitoring.
- Follow system operation and maintenance procedures.
- Maintain technical log and document system performance.
- Identify problems and resolve or report to senior personnel.
- Support senior personnel in system installation, upgrade and implementation of system-wide audits.

You have been hired to be part of the network operations and maintenance group for a multinational company. All the company divisions are connected through a common network even though each site may have different computer and network systems at the local level. Your group resides at the company's headquarters and is charged to ensure proper functioning of the company-wide network. You perform system backups, routine maintenance and regular monitoring of the system. Most of your tasks are clearly defined through procedures, and you are required to keep a complete log of all your network activities as well as document system performance. You work closely with the other members of the team to coordinate tasks and follow maintenance schedules. The group manager allocates tasks and responsibilities according to system needs and individual strengths. This part of your job requires great attention to detail and the ability to carefully follow instructions and record technical information.

In addition to the routine part of your job, you are expected to recognize problems identified during audits or as they arise during system operations. Some of the problems are simple and fall within your expertise and responsibilities. You resolve and document these problems and solutions into the log. Other problems are more complex and you report them to senior personnel quickly and accurately. You need to be able to assess situations rapidly and make valid decisions, including escalating the problem to a higher level. As you gain experience, your ability to recognize trends in network functioning increases and you may be asked to give input and opinions on system performance to senior personnel.

This position is a good opportunity to gain more technical knowledge and experience and identify areas of network technology that are most interesting to you. You are sometimes called to assist senior technicians in installing new hardware on the system and testing it for functionality, or in conducting system-wide audits. Your ability to learn new technical skills quickly and your willingness to take on new challenges are noticed and rewarded with interesting assignments.

"I want people who will look ahead—anticipate problems and fix them before they really get serious, versus someone who waits to see them emerge and then tries to solve the problem."

A Network Technician Supervisor

"Everyone in the organization must be customer focused. And you must remember that the network person's audience is not technically inclined; this requires a sensitivity to communicating at all different levels."

A Network Administrator

Proficiency Level

- Attend training courses to learn new technologies.
- Participate in technical briefings and review meetings.
- Assist in the installation and testing of the network active equipment.
- Be flexible in accepting assignments.
- Complete tasks according to schedule and specifications.

You have been working as a network technician for a large university for several years. You started in network operations and maintenance, but moved rapidly to network upgrade, troubleshooting and optimization. Your rapid move through the organization resulted from your demonstrated interest in the technology—you attended several technology training courses on your own time and never missed an opportunity to learn from more experienced technicians. You have also demonstrated your skills in working effectively with peers and managers and in assessing problems and identifying their cause.

The university has begun a project to wire every on-campus student residence with Ethernet network cabling, providing all on-campus residents with full-time, high-speed access to the campus-wide network and the Internet. The university has hired an outside company to guide the design and install the wiring. However, several university network technicians are selected to work closely with the contracting personnel to complete the installation. You have been selected to be part of this group and are very excited to contribute to the launch of a new system. You spend several weeks acquiring technical information about the system technology to be implemented as well as background information on the contracting company.

You attend a kick-off meeting where the network design is presented to all the engineers and technicians involved in the installation. Some of the information is a little over your head, but you are pleased with how much of it makes sense, thanks to the studying you did in preparation. The tasks, milestones and schedule are also presented. Teams are organized to accomplish each part of the installation to meet the fairly aggressive installation schedule. Even though the teams often work independently, they reconvene in status meetings and work closely together when connecting and testing separate parts of the network. You are assigned to the team responsible for the installation and testing of the network active equipment—switches, servers, hubs, routers and gateways. The work is very detailed and systematic, using specific installation and testing procedures.

Once the network hardware installation is completed, you hope to be assigned to the software installation and configuration team. Your experience has been mostly with network hardware but you are eager to learn more about network software. You find that throughout this assignment your flexibility in accepting and completing tasks and your ability to learn quickly are strong assets. You work well with internal and external staff and your input is regarded as sound and valuable.

Expert Level

- Translate the needs of the organization into a set of technical requirements.
- Research potential network solutions.
- Assess the quality of vendor support and service.
- Design network solutions that meet the needs of the organization.
- Assess cost, benefits and risks of implementation.
- Present recommendations to management for review and approval.
- Organize and schedule work with contractors and internal staff.
- Keep track of tasks, milestones, material and budget.
- Plan for user training on new network systems and applications.

You are the head of the network group for a medium-sized bank with multiple regional locations. The company's need for management of information has surpassed the capabilities of the current network system. System overloads are becoming frequent, causing system downtimes that frustrate users and negatively impact productivity. Even though the system is designed for redundancy, there is a fear that catastrophic failure will result in the loss of critical data. You have been installing patches and making vendor-recommended changes to improve the current system performance, but it is becoming clear that a major upgrade is needed.

You have been asked to research and make recommendations for migration to a new system that is designed to meet the needs of the organization as they are projected over the next five to seven years. Based on your recommendations, it is expected that management will give its approval and allocate the budget for your group to coordinate the implementation of the new system. Your first task is to translate the needs as defined in the bank's strategic assessment report into technical features, considering the expected volume and types of transactions, the need for information transfer between branches and the need for local processing and analysis of information. Once a set of technical requirements and a draft of specifications are developed, you start researching possible solutions. You talk to several system vendors and read through a large amount of network technical literature and specifications. In your selection of candidate systems, you also consider the quality of vendor support before, during and after installation. The cost of the system is, of course, taken into account; however, the quality of the technology and the system's ability to expand are more important criteria in your selection process. Your knowledge of network technologies, your thorough understanding of the current system and its limitations, and of the needs of the organization, and your ability to analyze and synthesize information are strong contributors to your success in this job.

After thorough research and an analysis of benefits of each approach, you prepare your recommendations for management. As they rely heavily on your technical expertise, most of their questions revolve around cost, short-term impact and long-term benefits to productivity, as well as reliability of the system and the security of information. You are even asked to review outsourcing strategies before you are given the go-ahead to

"It's your responsibility, not your employers' (for you to continue learning). If your employer helps, you're lucky. You often will be on your own budget and time to take classes and grow, and you must accept that this is part of the growth process. You have to make a commitment to that growth on your own."

A Network Analyst

"Excellence versus perfection. Zero defect is a fantasy. We've learned to get within 80% of the ideal."

A Networking Professional Talking About the Practical Application of Quality and Continuous Improvement Processes

proceed with implementation. Your role now moves from one of strategist to project manager. You develop a project timeline with identified resources and an associated budget. You design an implementation plan to minimize impact on productivity and ensure the smooth transfer of information. You organize your team to facilitate the implementation process and work closely with the contractors responsible for the actual installation. You assign a part of your team to develop a plan to train bank employees on the new system. Your organization and management skills are now on the front line. Errors or slipped schedules often mean significant cost overruns and you feel that much of your time is spent putting out fires. However, you like the challenge of managing many tasks and enjoy seeing the different parts come into a coordinated whole.

Critical Work Function: Perform Analysis/Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A1. Gather data to identify customer requirements	• Sources of requirements are reliable and current. • Sources and methods for gathering requirements are affordable and relevant. • Information is accurate, complete and relevant. • Information gathering interviews follow appropriate company practices. • Information is gathered continuously in a cost-effective manner.	• Knowledge of key sources of information with respect to customer requirements. • Knowledge of information gathering methods/procedures and practices. • Knowledge of the amount of information required. • Knowledge of network architecture, topology, hardware and software. • Knowledge of the goals and scope of the research. • Knowledge of networking design principles and constraints.	• Ability to analyze group/individual responses. • Ability to select/obtain data relevant to the task and identify the need for data. • Ability to encourage cooperation. • Ability to ask open-ended and confirming questions. • Ability to organize and summarize information and requirements.
A2. Identify, interpret and evaluate system and network requirements	• All system and design requirements are complete and free of conflicts. • Requirements are documented accurately. • Requirements are in accordance with overall project requirements. • Requirements have been checked for compatibility and interdependencies. • Appropriate information and data analysis techniques are applied. • Priority needs are defined clearly for the customer and team. • Complete set of requirements is communicated to and approved by customer.	• Ability to transfer organizational computing requirements into system requirements. • Ability to identify and resolve conflicting requirements. • Knowledge and thorough understanding of system capabilities and systems integration. • Knowledge of networking and operating environments. • Knowledge of network architecture, topology, hardware and software.	• Ability to analyze information for accuracy and consistency. • Ability to resolve technical issues. • Ability to evaluate system configuration. • Ability to create detailed supporting documents. • Ability to compile multiple viewpoints. • Ability to relate intent to desired results.

Critical Work Function: Perform Analysis/Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A3. Define scope of work	• Project objectives are identified and agreed upon. • The size and the specifics of the work involved are identified accurately. • Criteria for successful completion of the work are identified. • Major project tasks and interdependencies are identified. • Estimates of time, materials and capabilities needed are accurately identified. • Schedule is prepared based on resource availability and project timeline. • Scope of work is documented in an accurate, complete and succinct form.	• Knowledge of networking and operating environments. • Knowledge of network architecture, topology, hardware and software. • Knowledge of resource availability and project timeline.	• Ability to create detailed supporting documents. • Ability to relate intent to desired results. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to plan resource needs and constraints. • Ability to visualize tasks sequentially or in parallel, and to identify interdependencies. • Ability to negotiate success criteria. • Ability to think nonsequentially and globally.
A4. Review network architecture, topology, interdependencies and constraints	• The constraints and potential conflicts are accurately identified. • Constraints are communicated clearly and documented in a timely manner. • Risk and tradeoff analysis and contingency plans are developed and clearly communicated. • Actual and projected technical and human resources are reviewed and analyzed. • Product and vendor architecture and equipment specifications/limitations are thoroughly researched.	• Knowledge of key sources of information with respect to architecture and topology. • Knowledge of risk analysis techniques. • Knowledge of technology constraints, and hardware and software standards and processes. • Knowledge of networking and operating environments. • Knowledge of network architecture, topology, hardware and software.	• Ability to create detailed supporting documents. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to analyze information and develop theories about interdependencies. • Ability to present technical information clearly and concisely using appropriate tools. • Ability to plan resource needs and constraints.

Critical Work Function: Perform Analysis/Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A5. Research technical alternatives and analyze technical options	• Several technical and design scenarios are outlined. • Tradeoff and risk analysis of technical alternatives is complete. • Alternatives are researched, documented and rated according to best match with current project. • Cost/benefit analysis report is completed. • Report is accurate, timely, and communicates information clearly. • Analysis report is understandable by nontechnical decision makers. • Ease of use is evaluated from the user perspective.	• Knowledge of key sources of information regarding technical options. • Knowledge of system design concepts and techniques. • Knowledge of research techniques and procedures and cost/benefit analysis techniques regarding technical options. • Ability to translate technical features into development and user benefits. • Ability to assess sources of information for new technologies and calculate risks of implementation. • Knowledge of hardware and software standards and processes. • Knowledge of network architecture, topology, hardware and software.	• Ability to present alternative solutions in concise, clear language. • Ability to accurately summarize and document information. • Ability to user previous training/experience to forecast how documentation will be used by others. • Ability to gather, synthesize and interpret data.
A6. Participate in design reviews	• All project phases have been thought out and addressed. • Outcomes of design reviews are accurately documented. • All project team members and customers understand and approve design.	• Knowledge of design review procedures and process. • Knowledge of networking and operating environments. • Knowledge of network architecture, topology, hardware and software.	• Ability to suggest modifications to technological systems. • Ability to recommend tradeoffs and negotiate to resolve technical issues. • Ability to responsibly challenge the status quo to achieve quality design. • Ability to respond appropriately to others.
A7. Prepare overall design and integration plan for new processes, protocols and equipment	• Design takes into account all aspects of technical and human resources. • Design is complete, understood and approved by all relevant parties. • Integration plan is developed, understood and approved by all relevant parties. • Design and integration are assessed for ease and quality of implementation. • Design and integration plans are documented completely, clearly and accurately.	• Knowledge of architecture design tools and methods, integration methods and traffic analysis tools. • Knowledge of implementation process and user impact. • Knowledge of networking and operating environments. • Knowledge of network architecture, topology, hardware and software.	• Ability to collect and analyze information. • Ability to present technical information in a clear and concise form. • Ability to interpret and summarize results. • Ability to manipulate information and integrate multiple platforms. • Ability to analyze situation/information and formulate a plan of action that is in line with business and financial constraints.

Critical Work Function: Perform Analysis/Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A8. Recommend selection of architecture, topology, hardware and software	• Recommended solutions are practical, cost-effective and meet system specifications. • Recommendations are clearly documented and justified. • Recommendations are communicated effectively to all stakeholders. • Alternatives are evaluated in light of system use and configuration.	• Knowledge of networking standards and processes. • Knowledge of network architecture, topology, hardware and software. • Ability to separate actual requirements from technical desires. • Knowledge of statistical concepts. • Ability to apply forecasting methodology and complete a trend analysis. • Ability to optimize recycling and redeployment of existing hardware.	• Ability to communicate technical information to a variety of audiences. • Ability to analyze and present technical information in a clear and precise way. • Ability to accept constructive criticism.

Critical Work Function: Perform Configuration/Implementation

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B1. Plan and document system configuration	• Configuration is clearly articulated and effectively documented. • Configuration uses appropriate resources to perform the current task and provides resources for future growth. • Configuration meets goals envisioned from start, balancing issues of reliability/stability versus innovation. • Configuration plan meets user needs. • Conversion of data and compatibility issues are addressed. • Maintenance procedures are outlined. • System specifications are clearly and completely documented.	• Ability to use flow charting and diagramming tools. • Knowledge of the business systems. • Ability to identify user expectations. • Knowledge of network architecture, topology, hardware and software. • Knowledge of operating systems. • Knowledge of system configuration procedures.	• Ability to predict outcomes/results based on prior knowledge. • Ability to plan and coordinate activities. • Ability to visually analyze relationship between parts/whole, process/procedure. • Ability to recommend and implement plan of action. • Ability to present complex ideas/ information. • Ability to use word processing tools. • Ability to apply technical documentation standards and procedures.
B2. Implement new system configuration	• Problems are identified and resolved in a timely and appropriate manner. • Implementation schedule and expectations are communicated to users, vendors and implementation team. • Disruptions in productivity and schedule changes are kept to a minimum. • Configuration plan is successfully implemented with minimal disruption. • New configuration is fully and accurately documented. • Configuration meets user needs.	• Knowledge of network architecture, topology, hardware and software. • Knowledge of standard roll-out practices and recovery procedures. • Knowledge of hardware and software standards and processes. • Knowledge of system configuration procedures.	• Ability to analyze situation/information, consider risks/implications, generate alternative solutions and formulate a plan of action. • Ability to understand technology applications. • Ability to follow proper procedures. • Ability to manipulate technology for desired results. • Ability to document work process flow in detailed supporting documents.

Critical Work Function: Perform Configuration/Implementation

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B3. Perform workstation configuration and software loading	• Software is loaded and configured with minimum disruption to process flow. • Conversion of data is performed and compatibility issues are addressed in a timely manner. • Software is configured appropriately for system and user application. • Software and hardware configurations are standardized. • User satisfaction is assessed after new installation and/or configuration.	• Knowledge of software loading and configuration procedures. • Knowledge of data conversion issues and procedures. • Knowledge of compatibility issues and resolution procedures. • Ability to understand user applications and relate user needs to configuration. • Knowledge of network and operating systems. • Knowledge of workstation hardware configuration.	• Ability to evaluate computer utilization. • Ability to analyze operational problems. • Ability to implement new applications. • Ability to present complex information to users. • Ability to listen attentively and respond to verbal/nonverbal communications.
B4. Support, track and document change implementation	• All relevant parties are involved and buy off on changes in accordance with company procedures. • Timeline for implementation is formulated and revised as needed. • Activities among workgroups are coordinated. • Documentation is reviewed by appropriate stakeholders. • Change procedures are tracked and updated in a timely manner.	• Knowledge of stakeholders and workgroups. • Knowledge of change procedures. • Knowledge of tracking and documentation procedures.	• Ability to pose critical questions and ask open-ended and confirming questions. • Ability to identify the need for information. • Ability to encourage cooperation. • Ability to analyze and summarize information. • Ability to use word processing, project management and spreadsheet software. • Ability to follow company procedures and support organization processes.
B5. Assist in development of deployment plan and methods	• Deployment strategy is developed and documented. • Deployment strategy is congruent with project scope, timeline and installation plan. • Deployment strategy is synchronized with training schedule. • Deployment strategy has minimal disruptive impact on user.	• Knowledge of installation processes and procedures. • Knowledge of enterprise-wide deployment practices and standards. • Knowledge of network architecture, topology, hardware and software.	• Ability to use continuous improvement strategies and tools. • Ability to resolve conflicts in a timely manner. • Ability to prepare and organize multiple schedules, manage timelines and recommend adjustments. • Ability to visualize and coordinate productivity impacts. • Ability to follow company procedures and support organization processes.

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Critical Work Function: Perform Configuration/Implementation

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B6. Develop and implement security procedures	• Security policies are written and distributed to all company employees. • Security procedures address auditing needs as well as policy issues. • Security procedures are followed and penalties are outlined for failing to follow appropriate procedures. • Stakeholders agree to system security guidelines. • Vendor security policies and standard practices for installation of equipment are followed.	• Knowledge of basic security concepts including system, end-user and operational security. • Knowledge of system security processes and audit procedures. • Knowledge of system security and potential holes in security. • Knowledge of organizational issues surrounding security. • Knowledge of system architecture. • Ability to assess needs for security.	• Ability to interpret data/information. • Ability to use prior training/experience to predict outcomes. • Ability to evaluate appropriateness and relevance of data/information. • Ability to recognize ethical issues. • Ability to assess and modify policies/ procedures. • Ability to present complex information/ ideas and analyze group/individual response.

Critical Work Function: Perform Testing

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C1. Define and document test specifications	• Appropriate tests are identified with agreement from key personnel. • Applicability of the test is clearly established and documented. • Scope of testing plan assures quality results. • Acceptance criteria are well defined.	• Ability to complete a system analysis. • Knowledge of testing tools and procedures. • Knowledge of business requirements. • Knowledge of networking environments.	• Ability to communicate and interpret information. • Ability to propose/formulate test process. • Ability to analyze system structure and organization.
C2. Develop test plan and procedures	• Test plan is developed and documented. • System test plan uses standard procedures. • Test plan includes appropriate financial resources, personnel and schedule. • Resources, including funding sources, new technologies, vendor products and participating parties, are accurately identified and appropriately scheduled. • Network impact, including systems integration impact, is clearly defined and assessed. • Security procedures are covered in the test plan. • End-user/customer testing is included in test plan.	• Knowledge of testing tools and procedures and ability to identify testing equipment. • Knowledge of error impact on system performance and ability to relate errors to system functionality. • Knowledge of financial requirements and organization structure and ability to complete a business case analysis. • Knowledge of operating systems. • Knowledge of network architecture, topology, hardware and software.	• Ability to analyze possible causes/reasons for problems and recommend action plan. • Ability to analyze data. • Ability to recognize patterns and relationships. • Ability to justify business case and system structure/organization. • Ability to negotiate for resource allocations. • Ability to recognize system strengths and limitations.
C3. Schedule and perform testing	• Test environment is clearly defined and prepared appropriately. • Tests are planned and conducted at every appropriate stage of development and production. • Testing is on schedule and within budget. • Testing is repeated until system is fully functional or scope is modified. • Stakeholders accept system performance.	• Ability to use tracking and scheduling tools. • Knowledge of testing methodologies and procedures. • Knowledge of network architecture, topology, hardware and software.	• Ability to responsibly challenge processes and procedures. • Ability to critically analyze details. • Ability to record testing results. • Ability to initiate corrective processes. • Ability to manage timelines. • Ability to encourage/support team members and assume responsibility for accomplishing team goals.

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Critical Work Function: Perform Testing

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C4. Document, interpret and report test results	• Error report is completed in a timely manner. • Document includes steps to reproduce the error/problem. • Document includes an accurate assessment of the problem/test. • Test report is accurate and complete. • Report includes recommendations for system improvement. • Continuous improvement plans are implemented as appropriate.	• Knowledge of the product and interdependencies in testing environment. • Knowledge of networking and operating system environments. • Knowledge of continuous improvement processes regarding testing. • Knowledge of company reporting practices.	• Ability to apply rules/principles to process/ data and use logic to draw conclusions. • Ability to present complex ideas/ information. • Ability to generate creative solutions and formulate new plans/approaches. • Ability to compile, interpret and communicate test results. • Ability to select and use appropriate office software tools.

Critical Work Function: Perform Monitoring and Management

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D1. Analyze system performance to baseline	• Baseline is updated as system configuration changes. • Systematic ongoing measurement data is collected and documented. • Deviations are identified for corrective measures. • System metrics are identified and updated.	• Ability to use networking measurement tools. • Ability to complete system analysis. • Ability to use testing tools. • Knowledge of network architecture, topology, hardware and software. • Knowledge of monitoring procedures. • Ability to use documentation tools and to follow standards and procedures.	• Ability to analyze data and to assess information accuracy. • Ability to integrate multiple items and resolve conflicting data. • Ability to analyze system operation. • Ability to distinguish trends in performance. • Ability to diagnose performance deviations.
D2. Monitor and report component, security and connectivity problems	• System is closely monitored and outages are recognized in a timely manner. • Disruptions of network services are monitored and recognized in a timely manner. • Problems are escalated according to company procedures. • Security violations are detected and reported in a timely manner. • System outages have minimal impact on business processes.	• Knowledge of network architecture, topology, hardware and software. • Knowledge of interoperability requirements. • Knowledge of corporate security policies and procedures. • Knowledge of documentation, storage and security tools. • Ability to identify and use appropriate reporting channels.	• Ability to interpret and evaluate data. • Ability to troubleshoot system malfunction and/or failure. • Ability to distinguish trends in performance and diagnose performance deviations. • Ability to use project management software. • Ability to analyze system operation and analyze system effectiveness/efficiency.
D3. Perform functional verifications and system audits	• Functional testing is performed in a timely manner and according to procedures. • Results from user testing are collected, verified and accurately documented. • Appropriate parties are notified of corrections. • System audits are performed correctly in accordance with company procedures.	• Knowledge of expected operations. • Knowledge of system audit procedures. • Knowledge of company practices and standards.	• Ability to ask open-ended and confirming questions. • Ability to identify the need for information. • Ability to encourage cooperation. • Ability to analyze, interpret and summarize information.

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Critical Work Function: Perform Monitoring and Management

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D4. Make recommendations for system optimization/ improvement	• Needs not met by existing tools are identified. • System performance is assessed accurately and in accordance with company procedures. • Recommendations result in improving existing processes. • Required modifications are identified and fixes are implemented prior to adverse impact.	• Knowledge of systems tools. • Knowledge of company resources and constraints. • Knowledge of systems monitoring processes and procedures. • Ability to use modeling and simulation tools.	• Ability to predict arithmetic results. • Ability to evaluate/adjust plan of action. • Ability to suggest system modifications and improvements and analyze goals/ constraints. • Ability to present recommendations in a clear, concise and persuasive manner.
D5. Generate and present reports	• Reports are accurate and complete. • Reports follow policy and procedure requirements. • Reports include current and potential problems and improvement recommendations. • Report includes both strengths and weaknesses of the system. • Reports are distributed to appropriate personnel/departments.	• Knowledge of company evaluation, monitoring and reporting procedures and policies. • Knowledge of software operations principles, components and connectivity. • Knowledge of tools to efficiently generate reports. • Knowledge of documentation standards and dissemination procedures within company.	• Ability to write detailed supporting documents. • Ability to analyze and synthesize information. • Ability to identify improvements. • Ability to use word processing software. • Ability to monitor quality standards. • Ability to follow proper procedures. • Ability to present well-organized reports to a variety of audiences.

Critical Work Function: Perform Administration and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E1. Set up and maintain user accounts	• User accounts are set up following standard operating procedures. • Users are provided with timely access to required systems and resources. • Security for user accounts is maintained across all systems.	• Knowledge of corporate policies and procedures. • Knowledge of escalation procedures. • Knowledge of documentation and storage tools. • Knowledge of security tools. • Knowledge of operating systems and network systems.	• Ability to apply rules/procedures to documents and accounts. • Ability to outline maintenance procedures. • Ability to follow rules, policies and procedures. • Ability to pay attention to details. • Ability to identify and resolve issues.
E2. Develop maintenance and upgrade plans	• Plans are clearly articulated and effectively documented. • Plans identify appropriate resources for current and future tasks. • Plans meet goals and balance issues of reliability/stability versus innovation. • Plans are successfully implemented with minimal disruption. • Plans and changes meet user needs. • Conversion of data and compatibility issues are addressed. • Maintenance and upgrade procedures are tested adequately.	• Ability to use configuration management tools. • Knowledge of the business systems. • Knowledge of network architecture, topology, hardware and software. • Knowledge of operating systems and system interdependencies. • Knowledge of backup procedures. • Ability to take appropriate financial and system integrity risks. • Ability to identify user needs and expectations.	• Ability to predict outcomes/results based on prior knowledge. • Ability to recommend and implement plan of action. • Ability to present complex ideas and information. • Ability to use project management and scheduling software. • Ability to evaluate system configuration/ stability. • Ability to keep informed on new products.
E3. Schedule and coordinate network maintenance	• Maintenance is scheduled according to scope, schedule and system availability requirements. • Maintenance requirements are clearly documented and communicated in a timely manner to appropriate parties. • Necessary changes are implemented in a timely manner. • Minimal disruption to productivity occurs. • Tasks are performed within scheduled guidelines.	• Knowledge of maintenance tools and procedures. • Ability to evaluate importance of errors. • Knowledge of company operating procedures. • Knowledge of network and operating system environments.	• Ability to document information clearly in detailed supporting documents. • Ability to negotiate agreements. • Ability to predict technological results. • Ability to interpret data and present information to different audiences persuasively and objectively.

Critical Work Function: Perform Administration and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E4. Apply maintenance, upgrades and process changes	• Upgrades are installed with minimal disruption to process flow. • Upgrade installation meets user needs. • Conversion of data is performed and compatibility issues are resolved. • Maintenance procedures are reassessed for applicability. • Changes are implemented using appropriate procedures.	• Knowledge of upgrade installation procedures. • Knowledge of elements required to justify an upgrade. • Knowledge of data conversion issues and procedures, compatibility issues and resolution procedures. • Knowledge of network architecture, topology, hardware and software.	• Ability to implement technological improvements/changes. • Ability to analyze organization of information. • Ability to propose/formulate new processes. • Ability to evaluate system configuration/ stability. • Ability to plan implementation processes.
E5. Coordinate, communicate and document changes	• Conflicts are addressed and resolved. • Change management documents address existing and future personnel and technical resources. • Appropriate stakeholders are involved and approve the changes. • Documentation is clear, understandable and distributed appropriately.	• Knowledge of company change management processes. • Knowledge of network architecture, topology, hardware and software. • Ability to use software tools to support change implementation.	• Ability to negotiate agreements and consolidate viewpoints. • Ability to present complex technical terms and concepts and debate issues. • Ability to analyze, interpret and summarize information. • Ability to use word processing tools. • Ability to understand organizational structure/hierarchy.
E6. Perform system backups and restore data	• System backups are performed according to schedule and procedure. • System backups are documented accurately and completely. • Problems are assessed for criticality and reported to appropriate personnel in a timely manner. • Revisions to system backups are incorporated in the change management process. • Data is restored in a timely and effective manner.	• Knowledge of system backup and restoration procedures. • Ability to identify system problems and evaluate for criticality. • Knowledge of network architecture, topology, hardware and software.	• Ability to follow procedures. • Ability to organize and document information and processes in detailed supporting documents. • Ability to evaluate effectiveness of process.

Critical Work Function: Perform Administration and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E7. Manage inventory	• Inventory of parts includes accurate identification, tagging and location. • Accurate documentation of system configuration is consistently maintained. • Appropriate individuals are notified of inventory changes in a timely manner.	• Knowledge of inventory systems access. • Ability to use computerized inventory databases. • Knowledge of corporate procedures for acquisition and asset management.	• Ability to create detailed supporting documents. • Ability to monitor safe and efficient utilization of materials. • Ability to coordinate storage and distribution. • Ability to monitor configuration and efficient utilization of assets.
E8. Document maintenance activities	• Appropriate personnel are involved in developing and reviewing policies and procedures. • Maintenance procedures are documented and approved by appropriate stakeholders. • Maintenance documentation is distributed to appropriate personnel in a timely manner.	• Knowledge of maintenance procedures. • Knowledge of maintenance documentation procedures and standards.	• Ability to follow proper procedures. • Ability to understand system operation/ interaction. • Ability to interpret and evaluate data received. • Ability to present information clearly and concisely.

Programming/ Software Engineering

Computer programmers design and create software. You may analyze, design, develop, test and maintain computer and Internet-based applications. Possibly you'll write specialized applications or make custom programs to satisfy a user's particular needs. Not all programmers write code all day. You may evaluate the project requirements, participate in design meetings, determine the best solution to a problem or feature and develop detailed design specifications. You use development tools and programming languages in creating and testing the software. You must also be good at documenting your work so others will know what you did and how. And of course, you have to test your work with real users to make sure it's free of errors and meets specifications.

SAMPLE TITLES

- Applications Analyst
- Applications Engineer
- Business Analyst
- Computer Engineer
- Data Modeler
- Operating System Designer/Engineer
- Operating System Programmer/Analyst
- Program Manager
- Programmer
- Programmer/Analyst
- Project Lead
- Software Applications Specialist
- Software Architect
- Software Design Engineer
- Software Design Engineer and Tester
- Software Development Engineer
- Software Engineer
- Software QA Specialist
- Software Tester
- Systems Analyst
- Systems Administrator
- Test Engineer
- Tester

"She started out as a software tester and now is a program manager. But new people starting out certainly have to do problem solving and task management also. It's rare to have only one thing to work on, and you must manage multiple tasks. As you get more seniority, you begin to do more project management, whether that's your title or not— you grow into that."

A Software Development Engineer Discussing One of Her Employees

The Iterative Nature of IT Work

The development of skill standards necessarily requires an analytical approach that results in the classification of functions and tasks in a discrete, linear and sequential form. When using skill standards data, it should always be remembered that the actual nature of this work is iterative, with ongoing cycles that build over time to a completed task. It should not be inferred that the skill standards set forth unalterable steps of procedure for the accomplishment of a task.

As with all professions, the nature of information technology jobs is precise yet flexible, with processes and tasks subjected to continuous feedback, improvement and refinement, based on available resources and customer/client needs. The ability to respond to the iterative nature of information technology work should be considered a key employability skill.

Summary of Critical Work Functions

A. Perform Analysis	B. Develop Structure	C. Design/Develop Program	D. Implement Program	E. Test Program	F. Validate Program	G. Release Product
A1 Gather data to identify customer requirements	B1 Choose an architecture	C1 Develop design and interface specifications	D1 Write code	E1 Develop test plan and system	F1 Perform user acceptance test	G1 Participate in development of release plan
A2 Define scope of work	B2 Identify major subsystems and interfaces	C2 Identify system platform, components and dependencies	D2 Perform unit testing	E2 Develop test procedures	F2 Validate user documentation	G2 Train technical support staff
A3 Define system and software requirements	B3 Assist with selecting design tools	C3 Develop appropriate data model	D3 Integrate subsystems	E3 Perform tests	F3 Validate security features	G3 Participate in development of user training plan
A4 Establish measurable performance requirements	B4 Develop models	C4 Prepare and conduct design review	D4 Lead and/or participate in peer code review	E4 Document test results and make recommendations		G4 Transition to new system
A5 Develop test requirements	B5 Validate design scheme and models	C5 Identify maintenance requirements	D5 Resolve defects and rework code			G5 Evaluate, correct and document defects
A6 Gather data on development standards		C6 Create and test prototypes	D6 Revise and adapt existing code			G6 Evaluate, implement and document enhancements
A7 Develop high-level systems and functional specifications		C7 Review and provide input to user documentation				
A8 Determine security requirements		C8 Incorporate security requirements into design				

KEY ACTIVITIES

"The time of the analyst 'hero' who works alone is long gone. Systems are complex enough that no one person can be an expert in all areas required. This necessitates working as a "team." Interpersonal dynamics, both with customers and coworkers, are critical to career success."

A Software Programmer/Analyst

The Scene

Programming and software development careers cover a wide range of jobs and skills. Some will specialize in defining customer requirements and become functional analysts. Others will concentrate on writing code and will be called programmers. Others still will focus on testing programs both for functionality and usability and will become software testers. Many developers work on the creation of software applications, ranging from widely used office software to more specialized software products used only in specific industries. A smaller percentage of developers write specialized programs for intelligent devices, or research and create control and monitoring programs that serve as the operating backbone of PCs or large computing systems. Regardless of which industry or specialty they have chosen, software developers need to be detail-oriented and systematic in their approach to developing and documenting programs. They often interface with users and need to be able to translate highly technical information into a language that is accessible to non-technical persons, as well as translate user needs into technical features. Many developers work as consultants or as part of a consulting firm. This requires them to possess business skills in proposal and scope-of-work development and contract negotiation. A significant part of their time is spent updating skills—mostly keeping up with technology early in their career, and developing management and organizational skills as they acquire more responsibilities.

As a programmer/software engineer you are usually part of a development team. At the beginning of your career, you are assigned specific tasks such as gathering customer requirements, developing sections of code or implementing functional and usability tests. Your work interfaces with work produced by others and is reviewed by members of the team. Your ability to demonstrate creative problem-solving skills, keep accurate and clear documentation, complete tasks according to specifications and on schedule, and effectively interface and productively work with members of the team are highly valued. You make recommendations on program structure and features, which are usually subject to review by project managers and senior developers.

As you acquire experience with the development process you start taking on more management responsibilities. Depending on the size and structure of the company, your management role may be formal or informal. Officially your title may still be functional analyst, but you're really a project manager. You may be asked to review the work of and give feedback to more junior developers. You may also have opportunities to acquire management training, especially courses related to project and cost management. Communication and organizational skills are becoming more critical in this new role, as you may find that you are "roughing in" program design concepts that others must now turn into functional code.

As you move up in the organization, you may become an official manager of a software development team. In this role, you will need to acquire a broader understanding of the business and the organizational structure, and be able to predict time and cost and capital expenditures for projects. You may be asked to mentor others or to forecast and implement training programs for your department. You interface with internal and external customers. You have good people skills and you know how to network within the company. You rely increasingly on planning and negotiation

skills and are asked to make decisions in line with the trends and mission of the organization. A typical set of responsibilities in this new role would be to run three to five projects that have a duration of up to six months, with staggered completion dates. The projects will vary in complexity and in the size of the teams involved. Although your title may now officially recognize your management status, your knowledge of programming concepts and your programming experience give you the blend of technical and administrative skills to function effectively in this role. You moved into this role because you assessed the organization's needs, stepped in, did double duty for a while, demonstrated value added and created good relationships with managers throughout the company.

"Teamwork is key. In engineering it's rare that anyone works solo. You must work with a number of others. You may work alone on occasion, but in completing your work you'll have to deal with getting and giving information to and being with others. You'll be doing team projects and making team presentations. You need to be aware of and sensitive to personality and style differences."

An Applications Engineer

"As an independent, continuous improvement is the same as self-learning. You always want to be striving for a better product and way of doing things. After the "rah-rah" goes away on a new project and constraints set in, you don't always have the resources you want or need. You have to personally take responsibility for what you're giving out as your standard of work."

A Software Design Consultant

Scenarios

Entry Level

- Interview marketing staff to define user needs.
- Document input and develop preliminary set of specifications.
- Present findings and recommendations to team members and management.
- Develop functional design document for product.
- Develop and test code within project scope and with existing resources.
- Interface with system engineering team.

You are part of a large development team for a medical electronics firm. You are assigned the task of updating the user interface of an existing product to include a new feature. You work with marketing and systems engineering to help define the change to the user interface. You are also responsible for implementing the changes and testing the updated product for functionality.

You interview several members of the marketing group to define user requirements. You need to understand how customers will use the added feature and how this feature will interact with the rest of the product. One of the typical challenges you may run into is that the marketing staff may be calling something a feature when it is really a service. Your role is to translate their input into technical and functional specifications. Once the interviews are completed, you analyze the information and develop a set of specifications that best meets the expressed need. You may choose to segment the set of specifications in "necessary" and "nice-to-have," or develop several options to allow management to make decisions based on available budget and schedule.

Once your findings and recommendations are documented, you make a presentation to the rest of the team. You are asked to answer clarifying questions and give further input to the decision. The project manager selects a course of action and allocates resources to the development and implementation of the new feature. Based on management input, you develop a preliminary design document. The document is reviewed by the team and management and is then presented to the marketing and production groups for final approval. At this point, most of the negotiation process takes place between managers of the groups represented in the meeting with input from engineers and developers. You document requested changes and incorporate them into the document. Several iterations may be necessary before a final functional design document is approved by all parties.

You then move into the development phase, writing and testing the necessary code to implement the new feature. At critical points in the development process you ask for help from other team members in locating necessary resources or resolving difficult problems. Your work is also reviewed in project review meetings by other developers. Since your industry is governed by FDA regulations, the documentation of the development and test processes, program structure and code changes need to be thoroughly detailed following a prescribed format. The last step of your involvement with this project is to interface with the systems engineering team to verify functionality of the product with the added feature. You then hand off the project to the user-testing group that will beta test the revised product with actual users.

Proficiency Level

- Interview client and develop preliminary set of requirements.
- Draft proposal outline, scope of work, timeline and budget.
- Present proposal to management for discussion and approval.
- Refine draft proposal and present to client.
- Conduct the negotiation process bringing in decision makers as required.
- Finalize proposal outline, scope of work, timeline and budget.

You have been working for a software development consulting firm for the past five years. You were recently asked to assume more responsibilities and effectively become team manager for a large project. An OEM manufacturer has approached your firm to develop a new manufacturing resource planning system within the next six months. You must assess the actual needs of the customer, define the scope of work and develop a proposal to be sent to the client.

At this point in the project you are assigned two team members to help in requirements definition and proposal development. You need to interview selected members from several groups in the client's organization—inventory, engineering, manufacturing and accounting. Your communication skills are put to the test, as you need to quickly gather meaningful information and resolve inconsistencies, while navigating through the client organization's political structure. While you are conducting interviews, your support staff sorts through the information and starts developing a rough draft of specifications. Based on this draft and your experience with prior projects, you develop a scope of work and estimate resources and timelines. Using successful proposals your firm has won in the past as models, you draft a proposal outline, timeline and budget. To finalize your information, you make frequent calls to the key people in the client organization with clarifying questions.

Because of the accelerated project schedule, you have been working nights and weekends and are ready to present your proposal to your firm's management within two weeks. Your presentation includes several options with associated risks and benefits. The review lasts all day with much management discussion about risks associated with the project and long-term benefits to the firm, as well as questions from the developers as to the validity of the defined specifications. Finally, all agree on a proposed approach and you spend the next two days refining the proposal to be presented to the client.

Since this is your first major project, you receive increased scrutiny from management as well as support from other project managers. A senior project manager assists you in the presentation to the client. Even though you have been given some latitude in the negotiation process, some of the decisions need to be deferred to your management. After the meeting with the client a few remaining issues need to be resolved, and you set up a conference call between the client's representatives and your management. Finally, agreement from all parties is obtained and the project is a go. Based on your success in completing the proposal phase of the project, you are now given responsibility for the development and implementation phase. The proposed timelines and deliverables now take on a whole new meaning for you, and you start organizing your team and resources to meet the project goals.

Expert Level

- Define product features and identify program sub-modules and reusable modules.
- Identify tasks and priorities and organize team to meet project goals.
- Manage development team and interact with contractors.
- Keep management informed of progress and problems, and request support and resources as needed.
- Resolve problems with team members and outside support when necessary.
- Organize testing procedures and schedules.
- Motivate team members and manage interpersonal conflicts.
- Interface with the technical documentation team and the marketing group.

You are the manager of a large development team working for a software development company. You have been tasked with the development of a new office software product. The competition is scheduled to release similar software on the market in the next few months and your company wants to introduce its own version with superior features as soon as possible. Your project has been put on the "hot list," which means that it receives a lot of attention from management. This can be an advantage when you need additional resources, but it certainly increases the pressure on you and your team to succeed.

You and your team spend several days planning for the development—defining product features, identifying sub-modules, identifying modules already developed that can be incorporated in this product, and assigning development and testing tasks. Task priorities and contingencies are defined and the team is organized accordingly. Planning for resources will be done on-the-run as there is little up-front time to develop a thorough plan, and management has committed to support the project until it is completed.

Besides managing the team, interfacing with contractors and bringing resources in, you spend a lot of time answering questions from management and reassuring them that the project is moving as quickly as humanly possible and without any major problem. As problems do arise, you get involved in fixing them—from rearranging priorities in resources to troubleshooting the code yourself. Because of the very tight schedule and importance of the project the roles of the team members are flexible as members are moved to support areas with the most need. This gives an impression of managed chaos upon which you tend to thrive.

As elements of the program are completed your team starts the testing. While parts of the program are still in the coding phase, some are already in the final stages of testing and approval. The challenge is to bring all the separate parts into a functioning system. Interface problems arise, sometimes requiring the major redesign of a submodule. Your ability to keep track of many tasks and make quick decisions is critical to the success of the project. The effectiveness of the team also relies heavily on your ability to motivate and recognize team members, offering support to resolve difficult problems, praise successes and coach in redirecting effort and energy. Even though you do not often call directly upon your programming skills, your knowledge of programming development and testing are necessary to track of progress and assess the criticality of problems, and in relating to the team developers.

In parallel with the development effort, you set up meetings with the technical documentation group

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and with marketing. The writing of the manual begins while the product is still in the development phase and the writing team needs to be apprised of changes in technical and user features as they occur. The product is announced before the product is actually ready to be released to secure as large an initial market as possible. Your challenge is to move back and forth between your highly technical team and nontechnical groups, and adapt your communication style accordingly.

After several months of a chaotic schedule and putting out fires to smooth the path of the development team, the product is ready to go into final testing, including usability and user acceptance testing. A limited number of users is selected to test the software and give input that will be fed back to your development team for product modification. Some changes will be incorporated in the current version, while others will be logged to be included in a later update. You must decide which changes are compelling enough to delay release and which can be logged for inclusion in later updates. You must get the "gold" version produced and distributed as close to the projected release date as possible—if a competitor goes to market ahead of your firm, sales will suffer.

"Lifelong learning has high importance. The field changes incredibly fast. There's an accelerating rate of change in industry. Without the desire to continue learning, you'll be left behind."

A Software Test Specialist

Critical Work Function: Perform Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A1. Gather data to identify customer requirements	• Sources and methods for gathering requirements are affordable and relevant. • Sources of requirements are reliable and current. • Information is accurate and complete. • Information gathering interviews follow appropriate company practices. • Information is gathered continuously in a cost-effective manner.	• Knowledge of problem domain. • Knowledge of key sources of information with respect to customer requirements. • Knowledge of information gathering methods. • Knowledge of quantity of information required.	• Ability to identify and prioritize the need for data. • Ability to pose critical questions and analyze and prioritize group/individual responses. • Ability to summarize information and requirements. • Ability to encourage cooperation. • Ability to gather and present cost data.
A2. Define scope of work	• Project objectives and scope are identified and agreed upon. • Major project tasks and interdependencies are identified. • Project plan is prepared based on resource availability and project timeline. • Estimates of time, materials and capabilities needed to meet customer requirements are clearly presented. • Life of product or application is accurately estimated and is consistent with comparable products and customer expectations. • Time, technology and resource constraints are defined, alternatives are presented, and risk analysis and contingency plans are developed. • Requirements are properly interpreted and evaluated, and conflicting requirements are identified and resolved.	• Ability to define measurable criteria for completion of work. • Knowledge of technology constraints. • Knowledge of risk analysis techniques. • Knowledge of the market, product history and user business needs, and the ability to analyze competing products. • Knowledge of operating systems and problem domain.	• Ability to create both detailed supporting documents and cogent summaries appropriate to the audience. • Ability to relate key strategies and actions to desired results. • Ability to plan resource needs and constraints. • Ability to visualize tasks sequentially, identify interdependencies and predict outcomes/results based on experience, prior knowledge or expert input. • Ability to resolve conflicts to customer satisfaction. • Ability to analyze product/service quality.

Critical Work Function: Perform Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A3. Define system and software requirements	• All system and software requirements are completely free of conflicts and thoroughly documented. • System and software requirements are in accordance with overall project requirements. • Overall system and software requirements are integrated. • Overall requirements have been checked for compatibility and interdependencies. • Requirements are clearly stated and free of internal conflicts. • Technical specifications are assessed for feasibility.	• Knowledge of system capabilities and operations. • Knowledge of software capabilities. • Knowledge of system and software integration. • Ability to transfer customer requirements into system and software requirements. • Knowledge of development process and capability. • Knowledge of human factors pertinent to software systems.	• Ability to identify and resolve conflicting requirements. • Ability to analyze information for accuracy and consistency. • Ability to accurately summarize and document information, and to write clearly and succinctly. • Ability to see patterns and relationships between separate pieces of information. • Ability to respond to system demands and apply technology in an effective manner.
A4. Establish measurable performance requirements	• Criteria for adequate system performance level are defined. • Criteria for customer satisfaction and acceptance are defined. • Performance requirements are documented in an accurate, complete and succinct form.	• Knowledge of system requirements. • Ability to determine attainable performance levels. • Ability to extract performance requirements from system and software requirements.	• Ability to assess performance requirements. • Ability to formulate proposals. • Ability to effectively communicate performance expectations and actual results. • Ability to examine the situation, analyze possible causes/reasons and recommend plan of action.
A5. Develop test requirements	• Appropriate internal and external test participants are identified. • Testing methodology is selected. • Scope of testing is clearly identified.	• Knowledge of the testing tools. • Knowledge of company operating procedures. • Knowledge of databases and tools to track and resolve test results.	• Ability to create detailed supporting documents. • Ability to examine information/data for relevance and accuracy. • Ability to analyze logical consistency.

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Critical Work Function: Perform Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A6. Gather data on development standards	• Sources and methods for gathering standards are affordable and relevant. • Information is accurate and complete. • Information gathering interviews follow appropriate company standards and practices. • Sources of standards are reliable and current. • Information is gathered continuously and in a cost-effective manner.	• Knowledge of problem domain. • Ability to identify key internal and external sources of information with respect to development of standards. • Knowledge of information gathering methods.	• Ability to identify and prioritize the need for data. • Ability to pose critical questions and analyze group/individual responses. • Ability to summarize information and requirements. • Ability to elicit and encourage cooperation. • Ability to suggest process modifications/ improvements.
A7. Develop high-level systems and functional specifications	• Systems and functional specifications meet customer requirements. • High-level subsystems are identified accurately and documented completely.	• Knowledge of internal systems and their relationship to project goals. • Ability to write detailed and accurate functional specifications following organizational standards.	• Ability to synthesize information. • Ability to propose new technology applications. • Ability to integrate systems technology. • Ability to predict technological results.
A8. Determine security requirements	• Types of risk exposure are identified. • Current security policies are followed. • Security options are evaluated. • Security plan is documented and updated.	• Knowledge of security risks. • Knowledge of current security policies. • Knowledge of security tools. • Knowledge of network protocols.	• Ability to analyze data. • Ability to integrate multiple items of data and contrast conflicting data. • Ability to analyze possible causes of problems and recommend action plans for resolution.

Critical Work Function: Develop Structure

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B1. Choose an architecture	• Main alternatives are researched. • Alternative technical and design scenarios are outlined and presented. • Analysis of tradeoffs and risks is complete. • Alternatives are documented and rated according to best match with current project. • Selected alternative has been reviewed and approved by management and all members of the team. • Selected alternative meets functionality, timeline and budget requirements. • Selected alternative is documented in a clear, accurate and detailed form.	• Knowledge of research techniques and procedures and ability to identify key sources of information with respect to architectures. • Knowledge of design concepts, techniques, processes and tradeoffs. • Ability to translate technical features into performance functionality, project timeline and budget impacts. • Knowledge of risk analysis techniques. • Ability to translate technical features into development and user benefits. • Knowledge of operating systems and hardware architecture.	• Ability to evaluate options and formulate a plan of action. • Ability to present complex issues and analyze responses. • Ability to identify and resolve conflicts. • Ability to accurately summarize and document information.
B2. Identify major subsystems and interfaces	• All major subsystems and interfaces are clearly delineated. • Minimum of overlap and interaction exists between major subsystems. • Major subsystems and interfaces are clearly documented.	• Knowledge of overall system. • Ability to classify related components into a subsystem. • Ability to evaluate degree of connectivity of system components. • Ability to rearrange systems.	• Ability to analyze logical consistency. • Ability to research additional information sources. • Ability to design new organizational systems and processes. • Ability to analyze system configuration/ stability. • Ability to recognize system strengths/ limitations.
B3. Assist with selecting design tools	• Design tools are cost-effective and adequate for scope of work. • Necessary resources are available within the scope and budget of the project. • Design tools are appropriate for available level of expertise. • Recommendations regarding design tools are communicated effectively to appropriate personnel in a timely manner.	• Knowledge of design tools and tradeoffs. • Knowledge of company tool selection procedures. • Knowledge of key sources of information regarding design tools.	• Ability to evaluate options and make decisions. • Ability to present complex issues and analyze responses. • Ability to determine resources required. • Ability to resolve technical conflicts. • Ability to project timeline and budget requirements.

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Critical Work Function: Develop Structure

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B4. Develop models	• Scope and purpose of models are defined. • Models are developed cost-effectively and according to schedule. • Models are representative of design and functionality. • Models are exercised and tested for performance. • Model development procedures, test results and recommendations are documented. • Appropriate business, physical, interface, logical, data models are developed.	• Knowledge of model development options and methodologies. • Knowledge of model testing procedures. • Ability to work within the constraints of simulations and models.	• Ability to develop new/alternative system designs. • Ability to integrate system technology. • Ability to interpret/evaluate data. • Ability to create comprehensive models and simulations. • Ability to create original documents. • Ability to prioritize results and generate and present recommendations. • Ability to synthesize information from different tests.
B5. Validate design scheme and models	• Design scheme meets specifications. • Design scheme and models meet customer, marketing and peer review requirements. • Deficiencies are clearly documented.	• Knowledge of design scheme and models. • Ability to contrast models and design scheme with specifications.	• Ability to analyze system effectiveness and efficiency. • Ability to analyze system structure and organization. • Ability to follow rules/principles. • Ability to analyze logical consistency. • Ability to clearly explain the design scheme.

Critical Work Function: Design/Develop Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C1. Develop design and interface specifications	• Design and interface specifications are complete and approved by all relevant parties. • Design and interface specifications are checked and corrected for conflicts. • Design and interface specifications are assessed for ease and quality of implementation. • Design and interface specifications are documented in a complete and accurate form. • Interface is consistent with industry, company and product standards. • Entity relationships are developed properly and diagrams are prepared accurately.	• Knowledge of interface requirements, specification procedures and operating systems. • Knowledge of implementation procedures and user needs, and ability to analyze and resolve conflicts in specifications. • Knowledge of industry, company and product standards. • Ability to perform entity-relationship analysis. • Knowledge of normalization, relational theory and data modeling tools.	• Ability to recall and apply basic rules/ principles. • Ability to analyze organization of information. • Ability to analyze system configuration/ stability. • Ability to apply creative solutions to new situations. • Ability to analyze and relate to customer needs and concerns. • Ability to construct an efficient sequence of actions to accomplish a task.
C2. Identify system platform, components and dependencies	• Rationale for choices is clearly stated. • System platform, components and dependencies are clearly delineated. • Reasons for constraints are documented. • Subsystems clearly delineate all components and interfaces to ensure a minimum of overlap and interaction between components.	• Knowledge of available platforms. • Knowledge of components and their compatibility with platform. • Ability to evaluate alternate configurations. • Knowledge of system configurations. • Ability to identify isolated but related functions and evaluate degree of connectivity.	• Ability to analyze system configuration/ stability and organization/hierarchy and recognize system strengths/limitations. • Ability to compile multiple viewpoints. • Ability to use logic to draw conclusions. • Ability to apply appropriate processes/ procedures.

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Critical Work Function: Design/Develop Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C3. Develop appropriate data model	• Data model is laid out clearly. • All functionality in the logical data model is present in the physical data model. • There are no unnecessary functions in the physical data model. • Performance criteria for the data model have verifiable assumptions. • Business process model contains user workflow analysis and accurate data flow diagram. • User processes are optimized.	• Knowledge of data techniques and tools. • Knowledge of CASE tools. • Ability to transform logical data model into physical data model. • Knowledge of object orientation principles. • Knowledge of general business principles.	• Ability to apply rules/principles to process/ procedure. • Ability to extract information and use logic to draw conclusions. • Ability to apply technology for desired results. • Ability to understand system organization/ hierarchy. • Ability to respond to system demand. • Ability to design programs, networks and graphics. • Ability to interpret symbols, diagrams and schematics.
C4. Prepare and conduct design review	• Appropriate personnel participate in design review. • Appropriate information is gathered from other parts of the system. • Review is complete, follows operating procedures and is conducted in accordance with the project flow chart. • Internal and external design reviews are performed in a regular and timely manner. • Design reviews are called when team decisions need to be made and/or when a major issue is encountered. • Overview summaries are complete, concise and prepared for the particular audience.	• Knowledge of operating procedures and the existing system. • Knowledge of the design review process. • Knowledge of personnel/process requirements for meetings.	• Ability to analyze/integrate information and prepare basic summaries/reports. • Ability to present complex ideas/ information and pose critical questions and analyze group/individual response. • Ability to clarify, interpret and influence communication. • Ability to encourage others to adopt new concepts. • Ability to use word processing tools and techniques.

Critical Work Function: Design/Develop Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C5. Identify maintenance requirements	• Maintenance requirements and resources are identified. • Maintenance requirements are documented and communicated to user and support groups. • Maintenance requirements are congruent with application and customer requests. • Potential add-ons and enhancements are identified.	• Knowledge of software maintenance requirements and procedures. • Knowledge of customer/user groups. • Knowledge of structured design principles of programming.	• Ability to define maintenance procedures, evaluate performance of technology and analyze operational anomalies. • Ability to follow specified maintenance and release schedules and procedures. • Ability to identify, classify and document symptoms. • Ability to summarize/paraphrase information and compose/edit correspondence and documentation. • Ability to generate/evaluate solutions and devise/implement a plan of action.
C6. Create and test prototypes	• Scope and purpose of prototypes are defined and meet customer expectations. • Prototypes are created cost-effectively and according to schedule. • Prototypes are tested and performance checked against models. • Prototype performance is checked against specifications. • Prototype development procedure, test results and recommendations are documented. • Impact on existing systems is correctly identified, integrated test systems are developed and problems are resolved.	• Knowledge of prototype design methodologies. • Knowledge of prototype building and testing processes. • Ability to relate prototype test results to model performance predictions. • Knowledge of existing system. • Knowledge of research and testing tools and online resources. • Knowledge of version and revision control practices and procedures.	• Ability to analyze task/technology relationship. • Ability to propose simple technological solutions. • Ability to consider risks/implications and compile multiple viewpoints. • Ability to generate/evaluate solutions and devise/implement plan of action. • Ability to recognize system strengths/ limitations.
C7. Review and provide input to user documentation	• The major features of the product are communicated to the technical documentation group. • Documentation needs and timelines are identified. • Documentation plan is communicated to the technical documentation group.	• Knowledge of documentation process. • Ability to translate technical specifications and requirements into a language appropriate to audience technical level.	• Ability to interpret information. • Ability to prepare basic summaries. • Ability to select methods of communication. • Knowledge of word processing software.

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Critical Work Function: Design/Develop Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C8. Incorporate security requirements into design	• Obvious security matters are identified. • Latent security risks are anticipated. • Security matters are presented to users and designers. • User security requirements are specified in the design.	• Knowledge of security issues. • Knowledge of design and programming techniques that provide security. • Ability to translate customer security requirements into functional specifications.	• Ability to evaluate system performance and suggest improvements. • Ability to examine task/technology relationship and integrate systems technologies. • Ability to generate unique solutions. • Ability to predict outcomes based on prior experience. • Ability to collect, interpret, and synthesize and communicate information to stakeholders.

Critical Work Function: Implement Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D1. Write code	• Code is developed using efficient software design processes. • Reusable components are employed whenever possible. • Code is well documented so that it can be understood by other software engineers.	• Knowledge of code development procedures. • Knowledge of programming language required for application. • Knowledge of reusable component programming processes. • Knowledge of code documentation process. • Ability to evaluate alternatives in code implementation and make decisions.	• Ability to write simple documents. • Ability to generate and evaluate alternative solutions and formulate plan of action. • Ability to apply rules/principles to process/ procedure and use logic to draw conclusions. • Ability to manipulate technology for desired results. • Ability to understand system organization/ hierarchy. • Ability to interpret symbols, diagrams and schematics.
D2. Perform unit testing	• Units are tested using standard and appropriate testing procedures. • Testing on each unit is repeated until the unit is free of errors. • Errors are correctly analyzed and resolved. • Errors and solutions are documented in a complete and concise form.	• Knowledge of unit testing procedures. • Knowledge of iteration process. • Knowledge of error analysis and resolution processes. • Knowledge of software testing practices and procedures.	• Ability to analyze system configuration/ stability and recognize system strengths/ limitations. • Ability to use logic to draw conclusions. • Ability to document errors and code modifications in detailed supporting documents. • Ability to examine the situation, analyze possible causes/reasons and recommend action plan. • Ability to identify, troubleshoot and correct malfunctions/failures.

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Programming/ Software Engineering

Critical Work Function: Implement Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D3. Integrate subsystems	• Subsystems are tested for compatibility. • Conflicts are resolved. • Subsystems are integrated iteratively until integration is complete. • Conflicts and solutions are documented. • Comprehensive system testing occurs to resolve all conflicts.	• Knowledge of subsystem integration processes and interdependencies. • Knowledge of subsystem conflict analysis and resolution. • Knowledge of system testing procedures. • Knowledge of operating systems. • Knowledge of continuous improvement processes for subsystem integration.	• Ability to apply processes to new information. • Ability to interpret and manipulate information. • Ability to integrate multiple platforms. • Ability to utilize networks. • Ability to understand system organization/ hierarchy. • Ability to organize and document process and outcomes in detailed supporting documents.
D4. Lead and/or participate in peer code review	• Code reviews are conducted in accordance with the project flow chart. • Code reviews are called when major team decisions need to be made. • Appropriate personnel are present at reviews. • Meetings are well organized and allow for individual contribution.	• Knowledge of peer code review process and procedures. • Ability to use project flow chart. • Knowledge of software testing practices and procedures. • Knowledge of personnel/process requirements for meetings.	• Ability to compare multiple viewpoints. • Ability to analyze situation/information, generate solutions and formulate action plans. • Ability to establish rapport with colleagues and customers and resolve conflicts. • Ability to encourage others to adopt new concepts. • Ability to summarize work in progress. • Ability to present complex information/ data.

Critical Work Function: Implement Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D5. Resolve defects and rework code	• Timely documentation of defects includes current status and person responsible for resolution. • A systematic testing program is implemented to find hardware compatibility problems. • Navigation is mapped and checked for all links. • Critical error areas are identified and error trapping is embedded into product. • A debugging program is in place as the components are developed. • Defects are evaluated for impact on functionality and recommendations are formulated. • Defects are fixed or logged for input into next design iteration, depending on impact.	• Ability to use debugging tools. • Ability to analyze design, hardware and software problems. • Knowledge of resources available to resolve defects. • Knowledge of system error resolution procedures. • Ability to evaluate importance of defect. • Knowledge of procedures for documenting and tracking problems and resolutions. • Knowledge of version and revision control practices.	• Ability to adapt technology for alternative uses. • Ability to follow proper procedures and apply technology effectively. • Ability to make recommendations for a higher quality product. • Ability to determine system components to be modified or improved. • Ability to demonstrate sensitivity to customer concerns/interests.
D6. Revise and adapt existing code	• Compatibility issues are resolved. • Solutions are documented completely and concisely.	• Knowledge of compatibility analysis and resolution processes. • Knowledge of procedures for documenting and tracking problems and resolutions. • Knowledge of software testing practices and procedures.	• Ability to analyze problems and recommend solutions. • Ability to identify, troubleshoot and correct malfunctions/failures. • Ability to document errors and code modifications in detailed supporting documents.

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Critical Work Function: Test Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E1. Develop test plan and system	• Test plan is completely documented in accordance with accepted policies. • Test plan is relevant to application and test requirements are in compliance with legal requirements, policies, procedures and customer requirements. • Test system accurately mimics external interfaces. • Test scenarios are automated where feasible. • Comprehensive set of test cases and expected results are developed. • Testing resources are identified and schedule is established.	• Knowledge of user application. • Knowledge of testing impact on timeline and budget. • Knowledge of external interfaces. • Knowledge of test domain and ability to distinguish edges and critical points. • Knowledge of operating systems and testing tools. • Knowledge of legal requirements, policies, procedures and customer requirements.	• Ability to understand system organization/ hierarchy. • Ability to follow processes/procedures. • Ability to respond to system demand. • Ability to write technical documents and detailed supporting documents. • Ability to consider risk implications and compile multiple viewpoints. • Ability to use word processing tools and techniques.
E2. Develop test procedures	• Test procedures explicitly verify specifications. • Test procedures define test conditions. • Test procedures are documented in detail. • Regression tests are properly developed and performed to thoroughly exercise the software according to plan and schedule.	• Knowledge of external interfaces. • Knowledge of test domain and ability to distinguish edges and critical points. • Knowledge of specifications. • Ability to construct automated test sequences and recognize errors in test procedure and system. • Knowledge of test discipline and testing methodology.	• Ability to understand system organization/ hierarchy. • Ability to follow processes/procedures. • Ability to respond to system demand. • Ability to consider risk implications. • Ability to analyze technology output and examine task/technology relationship. • Ability to interpret, clarify and influence communication.
E3. Perform tests	• Test process includes appropriate team members. • System is tested according to plan and schedule. • Test results are documented completely and communicated as appropriate. • System integration testing and volume/ performance testing are performed when appropriate.	• Knowledge of system test procedures and test systems. • Knowledge of system and ability to recognize problems identified by test procedure. • Knowledge of testing methodology. • Ability to recognize errors in test procedure and test system.	• Ability to understand system organization/ hierarchy. • Ability to follow processes/procedures. • Ability to analyze technology output and examine task/technology relationship. • Ability to appropriately refer complaint/ discrepancy. • Ability to identify and evaluate system performance.

Critical Work Function: Test Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E4. Document test results and make recommendations	• Errors and preceding conditions are clearly documented. • Recommendations for modification are included in documentation. • Problems are identified and corrected.	• Knowledge of documentation procedures. • Knowledge of testing tools and methodologies.	• Ability to understand system organization/ hierarchy. • Ability to respond to system demand. • Knowledge of word processing software, networks and operating environments. • Ability to evaluate system performance and devise plan to monitor and/or correct system. • Ability to modify process/procedure.

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Critical Work Function: Validate Program

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
F1. Perform user acceptance test	• Test procedure is prepared and documented for user. • System performance is tested according to plan and schedule. • Test results are documented in a complete form. • Issues and recommendations are communicated to design team.	• Knowledge of test procedures for user acceptance. • Knowledge of application environment and user requirements. • Knowledge of user level of expertise. • Knowledge of software quality assurance practices.	• Ability to understand system organization/ hierarchy. • Ability to follow processes/procedures. • Ability to respond to system demand. • Ability to interpret, clarify and influence communication. • Ability to identify major issues and make recommendations.
F2. Validate user documentation	• User feedback is analyzed and documented. • User documentation is complete, accurate and easy to use. • Documentation meets user requirements and is accepted by user.	• Knowledge of application environment and user requirements. • Knowledge of user level of expertise. • Knowledge of validation procedures.	• Ability to present complex ideas/ information, analyze group/individual response and pose critical questions. • Ability to understand system organization/ hierarchy.
F3. Validate security features	• Security measures are implemented and tested in actual application. • Access is granted or denied according to user role and company policies.	• Knowledge of data and access security procedures and standards. • Knowledge of user interfaces.	• Ability to pose critical questions. • Ability to integrate multiple items of data and contrast conflicting data. • Ability to document findings in detailed supporting documents. • Ability to recommend ethical course of action. • Ability to interpret and analyze information.

Critical Work Function: Release Product

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
G1. Participate in development of release plan	• Release plan is outlined in detail, with necessary phases, timeline and decision points. • Release procedures and feedback processes are defined and agreed upon by decision makers. • Test groups are identified and relevant to the application. • Test feedback is clearly documented and reviewed by appropriate personnel. • Results are communicated to design team for design modification as necessary. • Knowledge of release procedures.	• Knowledge of feedback processes. • Ability to consider risks/implications.	• Ability to compile multiple viewpoints. • Ability to present complex ideas/ information. • Ability to analyze group/individual responses. • Ability to interpret, clarify and influence communication.
G2. Train technical support staff	• Training procedures are developed and documented. • Training sessions are scheduled and conducted according to plan. • Feedback system from technical support staff to design group is in place. • Technical staff is able to fully support the product.	• Knowledge of design of technical training processes. • Knowledge of requirements of technical support groups. • Ability to design, organize and present technical material to a technical audience. • Ability to identify important technical training issues and provide feedback to appropriate personnel. • Knowledge of evaluation techniques for technical training effectiveness.	• Ability to identify training needs. • Ability to conduct task-specific training. • Ability to coach others to apply related concepts. • Ability to present complex ideas/ information. • Ability to analyze group/individual responses.
G3. Participate in development of user training plan	• Training materials are clear, effective and satisfy training objectives. • Training is adjusted for learning needs.	• Knowledge of instructional design principles. • Knowledge of training objectives. • Knowledge of user needs and skill levels.	• Ability to assess and analyze training needs and conduct effective training. • Ability to present complex information. • Ability to develop appropriate training procedures and materials. • Ability to encourage learner independence. • Ability to assess and recommend training alternatives. • Knowledge of word processing, presentation software and online resources.

Critical Work Function: Release Product

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
G4. Transition to new system	• Transition plan is outlined in detail, with necessary phases and timeline. • Contingency plan is in place. • Impact on productivity has been analyzed and communicated to appropriate personnel. • Transition plan is implemented with minimal impact on overall productivity. • New system is fully operational.	• Knowledge of transition process. • Knowledge of productivity factors. • Knowledge of contingency procedures.	• Ability to respond to customer needs. • Ability to demonstrate sensitivity to customer concerns/interests. • Ability to moderate discussion. • Ability to interpret complaints and concerns. • Ability to evaluate system performance and productivity. • Ability to examine situation/information, analyze possible causes/reasons and recommend plan of action.
G5. Evaluate, correct and document defects	• Feedback procedure is in place and adequate to meet user needs. • Defects are documented and communicated effectively to appropriate personnel in a timely manner. • Defects are evaluated for impact on functionality and recommendations are formulated. • Defects are corrected or logged for input into next design iteration, depending on impact.	• Knowledge of system error analysis and resolution procedures. • Ability to evaluate importance of defect.	• Ability to respond to verbal/nonverbal communication. • Ability to demonstrate sensitivity to customer concerns/interests. • Ability to determine system components to be modified or improved and adjust system operation. • Ability to troubleshoot system malfunction/failure. • Ability to present complex/technical information/data.
G6. Evaluate, implement and document enhancements	• Proposed enhancements are congruent with technical support and user feedback. • Recommendations for enhancements are documented. • User comments are accurately recorded, evaluated and prioritized. • Recommendations are implemented or logged for input into next design iteration.	• Ability to translate available feedback into recommended system enhancements. • Ability to formulate tradeoffs regarding enhancements. • Knowledge of operating systems. • Knowledge of data gathering methods/ procedures for enhancements. • Knowledge of document control and revision control practices.	• Ability to demonstrate sensitivity to customer concerns/interests. • Ability to write simple documents. • Ability to suggest system modifications/ improvements and determine system components to be modified or improved. • Ability to analyze impact of modification on overall system performance.

Technical Support

As a technical support representative, you are a vital part of the contact between customers and your company. Educating users is part of your job, as well as solving hardware or software operation and application problems. Experience with the problems users face in daily operation is a valuable asset. When a problem occurs, you listen carefully, ask the appropriate questions to gather needed information and then take steps to solve it. Dealing directly with customer issues, you are one of the best sources of information on the product, and are consulted for information about what customers want and what gives them the most trouble. You may start out on the help desk, walking users through the steps required to solve a problem over the telephone. As your experience and training increase, you may work with hardware and software installation and configuration.

SAMPLE TITLES

- Analyst
- Call Center Support Representative
- Content Manager
- Customer Liaison
- Customer Service Representative
- Customer Support Professional
- Help Desk Specialist
- Help Desk Technician
- Maintenance Technician
- PC Support Specialist
- PC Systems Coordinator
- Product Support Engineer
- Sales Support Technician
- Senior Systems Analyst
- Systems Analyst
- Technical Account Manager
- Technical Support Engineer
- Technical Support Representative
- Testing Engineer

The Iterative Nature of IT Work

"We depend on 'Rolodex Power' (from Tom Peters). The power of human networking. You know who to call, how to connect people to people. Our effectiveness in an organization can be measured by the size of our Rolodex. You can't hide in an office and do this work anymore."

A Technical Support Supervisor

The development of skill standards necessarily requires an analytical approach that results in the classification of functions and tasks in a discrete, linear and sequential form. When using skill standards data, it should always be remembered that the actual nature of this work is iterative, with ongoing cycles that build over time to a completed task. It should not be inferred that the skill standards set forth unalterable steps of procedure for the accomplishment of a task.

As with all professions, the nature of information technology jobs is precise yet flexible, with processes and tasks subjected to continuous feedback, improvement and refinement, based on available resources and customer/client needs. The ability to respond to the iterative nature of information technology work should be considered a key employability skill.

Summary of Critical Work Functions

A. Perform Troubleshooting	B. Provide Facilitation and Customer Service	C. Perform Hardware and Software Installation, Configuration and Upgrades	D. Perform System Operations, Monitoring and Maintenance
A1 Analyze problem and research solutions	B1 Gather and analyze customer input	C1 Identify and interpret customer requirements	D1 Operate computer system and run system applications
A2 Query existing knowledge base	B2 Manage working relationships with customers	C2 Evaluate present data and system configuration	D2 Perform system diagnostics
A3 Identify, test and implement solutions	B3 Perform negotiated services	C3 Develop installation plan	D3 Monitor and analyze system performance
A4 Manage system resolution with available resources	B4 Act as liaison between groups	C4 Install, configure and test system hardware and peripherals	D4 Develop and implement preventative maintenance plan
A5 Communicate technical solutions and implementation processes	B5 Provide training to customers	C5 Install, configure and test new operating and application software, and software upgrades	D5 Evaluate maintenance processes and outcomes
A6 Implement long-range solutions	B6 Manage demands from multiple customers	C6 Optimize system performance through software and hardware configuration	D6 Communicate and document maintenance procedures and system status
A7 Document hardware and software problems and resolutions	B7 Solicit customer feedback and apply input to improve quality of service	C7 Perform quality checks on outcomes of work performed	
	B8 Document and communicate customer feedback and requests	C8 Document system installation, configuration procedures and current configuration	

"The successful technical support person will analytically use a process of elimination to arrive at a real problem by sleuthing and troubleshooting, and applying problem-solving skills. Must be able to move past what appeared to be the problem, eliminate things that are just the symptoms and get to the real problem. The math and science ways of thinking—deductive reasoning, analysis—are great, but we cannot ignore the human sciences, like psychology. Should have courses to understand that there is a human, personal side to things. We need to cover the human skills as diligently as we do the technological skills."

An Employer of Technical Support Technicians

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The Scene

As a beginning technical support representative, you'll work closely with more experienced technicians and your supervisor as you learn the details of your system. You'll probably concentrate in one area or problem type, and gradually increase scope and responsibility as your experience with the system, the people and the applications they use grows. You're often operating in a reactive mode, addressing problems as they arise. You are still struggling to familiarize yourself with available resources and how to translate these resources into value for your customers. As you gain experience on the job, you develop a more conceptual approach to problem solving, looking ahead to forecast and prevent problems before they become critical. Starting with small parts of the computing system, you are given greater responsibility for larger sections as you move up in the technical support organization.

When you first come on the job, you spend a lot of time learning new skill sets. Besides acquiring new technical skills and honing your existing skills, you need to understand the organization's policies and procedures. As a technical support representative, customer relations skills are critical to your success. The development of customer relations skills and keeping up to date with technology are key elements to your job. You will need to acquire further technical knowledge and skills through on-the-job and course training throughout your career.

As you gain a broader perspective of what technical support represents, you are expected to understand issues beyond the realm of technology. Organizational structure, culture, politics and goals influence technology decisions and as you begin to contribute to larger projects, you need to be cognizant of how these factors interrelate.

A typical day as an entry-level technical support representative may include calling vendors to research a piece of equipment or find information to solve a technical problem. You may install or troubleshoot software or hardware components on workstations. You may interact, in person or on the phone, with users who are experiencing technical problems or have technical questions. In most cases, you will need to manage multiple requests and tasks at the same time, and keep a complete and accurate record of events and interactions. Organizational skills and the ability to set and change priorities, and pay attention to detail are critical to your success in the technical support profession.

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Scenarios

Entry Level

- You respond to and log in customer calls.
- You prioritize customer requests based on the criticality of the problem and organizational constraints.
- You identify resources and solutions to problems.
- You recognize issues that are outside of your expertise or responsibilities and refer them to appropriate personnel.
- You keep a clear and accurate documentation of problems and resolutions.
- You research solutions and equipment.
- You participate in technical support staff team meetings.

You currently have multiple open incidents from multiple customers. Each incident has a different sense of urgency and different implications. All your customers believe that their incident is critical and must be addressed immediately. You, as the support professional, must log in each customer call, prioritize customer issues and manage appropriate resources to resolve these issues.

You must continually work with the customer to set expectations as to when you can resolve their problems. How do you go about setting priorities? Where do you find appropriate resources to engage? These are issues that you need to evaluate based on the specific situation and current context.

In some cases, you can identify the problem by asking the customer critical questions. You may know a solution and walk the customer through its steps over the phone. Often, you need to do some research, or go to the customer's office to further define the problem or implement the solution. You find that much of your job is training the customers and adjusting your communication to their skill level. In some cases, you decide to refer the problem to other personnel because the issue falls outside of your expertise. In any case, you are expected to deal with the customer in a professional manner, recognize and report critical issues and make sound technical decisions.

You record each call, problem and solution following your department format and procedures. You attend meetings of the technical support team and are asked to report on specific issues. From time to time, you present information on technical material and equipment you have obtained from vendors. You may be asked to help contribute to verbal or written reports on recurring problems and possible suggestions for solutions. In your beginning position, you end up doing quite a bit of research to gain experience with various technical equipment and problems. You quickly discover that learning from the more experienced technical support personnel is a very effective way to save time and acquire valuable knowledge.

"There's not a task that a technical support person does that doesn't require excellent time management and prioritization."

A Technical Support Representative During a Focus Group

"Continuous process improvement is the key both to your customer and to your own organization. If a customer keeps calling in with simple questions, you need to educate that customer so they can solve the simple-level problems themselves and call you only with the more complex situations to help with. That's the best use of your resources and theirs."

A PC Support Specialist

Proficiency Level

- You research equipment for a specific use.
- You compare solutions based on technology, cost and ease of use and make recommendations.
- You develop and deliver technical presentations to nontechnical audiences.
- You test and troubleshoot technical subsystems and systems.
- You work effectively as a member of the technical support team.
- You set up and run technical systems under difficult time constraints.
- You anticipate most likely problems and derive effective solutions.
- You develop and document technical procedures and solutions to problems.

Your support group has been asked to set up a computer system to support an off-site meeting at a local hotel. Some of the meeting participants will join the group through video-conferencing. Some of the presenters want to have live access to the Internet. Several laptops will be available with some limited online connectivity. This is not something your organization has done in the past and only parts and pieces of the solutions are currently available to you.

Your group has been asked to research a solution, using as much as possible hardware and software already available. Your management has asked your group to present to them your recommendations with an analysis of cost and schedule, as well as technical risks. You conduct general research using the Internet to identify solutions and vendors. You call vendors and ask for information on components to build the requested system. After a thorough analysis and many group discussions, your group selects recommendations and prepares a presentation for management. Management is very receptive to your proposal and is impressed by your ability to address their questions and concerns. You receive the go-ahead to purchase the necessary equipment.

After you receive the hardware and software, you work in teams to assemble and test parts of the system. You run into several problems and spend quite a bit of time on the phone with vendors and reading technical documentation to troubleshoot the hardware and software. After the subparts are functional, your group assembles the system and stages a test run. Several noncritical issues are uncovered and resolved. Your group compiles a set of instructions for setting up and running the system, and documents problems and recommended solutions that are most likely to be encountered during the live meeting. You and another member of your team are designated by the group to attend the meeting to run the equipment during the conference.

Expert Level

- You evaluate existing systems in terms of current and future efficiency.
- You survey and analyze current system use and future user needs in technology.
- You assess migration timelines and costs.
- You develop recommendations for system migration and present them to customers and management.
- You develop implementation plans for new systems and system expansions.
- You base your system recommendations on technology as well as corporate culture and policy considerations.

As an experienced technical support representative, you are a strategist and have a clear understanding of business policies and procedures as well as technologies. You look three to five years into the future, in terms of preparing the customer for the technology of tomorrow. You help the customer have a plan in place to get there and take advantage of what's coming. You're focused on improving processes to help their organization grow and mature.

You may find yourself working with a corporation that has based its IT infrastructure on obsolete technology. The corporation has bought a support contract with your company. You have analyzed the customer's environment and discovered the obsolete technology. Their current technology is not easily supported and it would not make sense to invest more into it. You need to work with the customer to convince them to migrate to a more up-to-date system.

In order to convince the customer, you need to assess the risks and costs of staying with the current technology, develop a plan to take the customer from where they are today to the new technology, and provide a business justification for upgrading to a new system.

To prepare your presentation you meet with various system users in the organization to study how they are currently using their tools to perform their work. You prepare a summary of your observations and discuss the implications of the findings first with your technical team, then with the customer. Based on your findings and on the tactical and strategic organizational objectives, you propose a technology plan that meets the current and future needs of each department. If possible, you set up a testing/demonstration scenario on a limited scale. You develop a forecast for technical personnel to implement the new proposal, and provide suggestions or strategies of ways your client company can keep their human and technical resources updated.

You also develop an estimated timeline and an estimated installation and training cost to present to the customer. To make your presentation more real to the customer you draw an outline of an implementation plan that will disrupt the flow of regular business as little as possible. You also emphasize the benefits of the new system in terms of increased long-term productivity and increased personnel satisfaction.

"Lifelong learning is absolutely essential. As an organization, we succeed only through those open to learning about new things, themselves and other people. We ask each prospective technical support representative: 'Can you imagine yourself as the customer? Can you understand why they are irritated and frustrated?' If you can't do that, you won't be able to deliver complex instructions to all types of people."

A Help Desk Manager

"Customer orientation is a top focus. My job is 50% technical skills and 50% people skills for the technical support reps who are dealing with customers, each other, management, development teams, process teams, etc. We must have a customer focus."

A Technical Account Manager

Critical Work Function: Perform Troubleshooting

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A1. Analyze problem and research solutions	• Problem is correctly identified. • Problem causes are isolated. • Solutions are thoroughly researched. • Solutions are practical and relevant to problems. • Risk analysis is conducted for candidate solutions.	• Knowledge of troubleshooting methods. • Knowledge of sources of relevant technical data. • Ability to prioritize possible solutions based on technical criteria.	• Ability to analyze and prioritize information. • Ability to use written and electronic documentation. • Ability to gather information. • Ability to troubleshoot failures.
A2. Query existing knowledge base	• Searches are effective through use of proper key words. • Data is correctly identified. • Relevant data is retrieved. • Appropriate databases are used.	• Knowledge of how data is gathered, stored and manipulated in a database. • Knowledge of Boolean concepts applied to search engines. • Knowledge of how to read and query a database. • Knowledge of networks and online tools and resources. • Ability to read and interpret technical diagrams and decision trees.	• Ability to select appropriate information. • Ability to identify basic concepts and relevant details. • Ability to clarify communication. • Ability to qualify/analyze information. • Ability to interpret and summarize information.
A3. Identify, test and implement solutions	• Solutions are clearly defined with possible impact to system. • Solutions are selected based on technical benefits and cost effectiveness. • Solutions are tested in a complete and realistic manner. • Test scenarios are representative of actual use and environment. • Test process results in permanent solution to problem reported or diagnosed.	• Knowledge of test instruments. • Knowledge of test methods. • Knowledge of systematic methods of solving technical problems. • Ability to replace components when appropriate. • Ability to remove, repair or replace modules and subassemblies as appropriate. • Knowledge of applications and diagnostic programs.	• Ability to interpret information. • Ability to apply rules/principles to process/procedure and use logic to draw conclusions. • Ability to approach problem in a logical and systematic manner. • Ability to read and follow written instructions. • Ability to interpret pictures and diagrams. • Ability to analyze situations and formulate task sequence. • Ability to predict outcomes based on experience. • Ability to think creatively while analyzing problems.

Critical Work Function: Perform Troubleshooting

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A4. Manage system resolution with available resources	• Relevant and available technical resources are identified. • Technical expertise is sought when appropriate. • Problems are escalated or referred to another group when appropriate. • Resources are requested through appropriate channels and procedures, and organized to optimize use and results.	• Knowledge of relevant technical data. • Knowledge of resolution processes. • Knowledge of relevant physical inventory access and control procedures.	• Ability to present complex technical information. • Ability to follow proper procedures and work within established guidelines. • Ability to apply technology in an effective manner. • Ability to create original documents and detailed supporting documents.
A5. Communicate technical solutions and implementation processes	• Technical solutions and implementation processes are communicated in a timely manner. • Technical solutions and implementation processes are communicated in a form understandable to users. • User concerns are considered and addressed in the communication process. • Communication is clear, accurate and targeted appropriately.	• Knowledge of technical communications processes. • Ability to translate technical language into lay terminology when necessary. • Ability to communicate appropriately to different audiences and organizational levels.	• Ability to analyze and consider multiple viewpoints. • Ability to demonstrate awareness of diversity. • Ability to work in a team environment. • Ability to recognize and respond to customer needs and demonstrate commitment to customer. • Ability to interpret information, prepare basic summaries and reports and select method of communication. • Ability to present complex technical ideas/ information. • Ability to demonstrate commitment to team goals, work to improve team skills and encourage/support team members.

Critical Work Function: Perform Troubleshooting

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A6. Implement long-range solutions	• Implementation is conducted according to plan. • Problems are identified and resolved in a timely and effective manner. • System performance is verified after implementation and compared against specifications. • Implementation is conducted with minimum disruption to users. • Implementation is properly documented.	• Knowledge of technical specifications. • Knowledge of relevant indicators of system performance. • Knowledge of documentation procedures.	• Ability to analyze situations and predict outcomes based on knowledge or prior experience. • Ability to plan according to resource constraints and requirements. • Ability to prioritize tasks. • Ability to analyze and interpret technical data/information. • Ability to examine the situation, analyze possible causes/reasons and recommend action plan.
A7. Document hardware and software problems and resolutions	• Documentation is clear and accurate. • Documentation follows organization format and procedures. • Hardware and software problems are clearly identified. • Resolutions are documented to the appropriate level of detail. • Documentation is organized for most efficient access by other users.	• Knowledge of documentation tools. • Knowledge of technical presentation tools. • Knowledge of technical terms. • Knowledge of documentation processes and procedures.	• Ability to create detailed supporting documents. • Ability to mentally picture situations. • Ability to use appropriate language and terminology. • Ability to accurately summarize and document information. • Ability to communicate effectively with diverse audiences. • Ability to organize and present technical information in a logical and consistent manner.

Critical Work Function: Provide Facilitation and Customer Service

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B1. Gather and analyze customer input	• Questions to users are relevant and clearly defined. • Input is analyzed for important and underlying issues. • Input is organized and summarized in an effective manner. • Recommendations based on customer input are developed and presented to key personnel.	• Ability to determine relevant sources of information. • Ability to analyze and interpret customer input for expressed and implied issues. • Knowledge of information gathering methods and techniques. • Knowledge of applicable documentation procedures.	• Ability to analyze information. • Ability to probe for underlying issues and pose critical questions. • Ability to contribute to an open communication environment. • Ability to identify the need for data and select/obtain information appropriate to the task.
B2. Manage working relationships with customers	• Relationships are managed so that customers are satisfied with current level of service. • Relationships are managed so that customers would voluntarily return for additional service. • Interactions with customers reflect an understanding of their key satisfaction criteria. • Internal, external and global customer expectations are met in a timely manner.	• Knowledge of escalation procedures. • Knowledge of support boundaries. • Knowledge of operating environments, office suite applications, networks, hardware tools and online resources. • Knowledge of interfacing systems. • Knowledge of practices of internal, external and global customers.	• Ability to accept responsibility for own actions and impact on others. • Ability to demonstrate commitment to personal improvement. • Ability to recognize and analyze customer needs and resolve conflicts to customer satisfaction. • Ability to resolve technical issues and obtain customer approval. • Ability to respond appropriately to others and modify behavior to the situation.
B3. Perform negotiated services	• Current resources are balanced against internal, external and global customer needs. • Negotiated agreement stays within budget and time constraints. • Acceptable options are consistently presented and negotiated.	• Knowledge of available resources and customer needs. • Knowledge of negotiation variables. • Knowledge of negotiated agreement parameters.	• Ability to detect underlying issues. • Ability to apply creative thinking to new situations. • Ability to distinguish between facts and inferences. • Ability to redirect customer to appropriate resources for solutions to needs outside the bounds of assigned responsibilities. • Ability to recognize and analyze customer needs and resolve conflicts to customer satisfaction.

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Critical Work Function: Provide Facilitation and Customer Service

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B4. Act as liaison between groups	• Liaison communication includes updating all stakeholder groups. • Groups agree on decision-making process. • Consensus is established between groups. • All involved groups are fairly represented.	• Knowledge of each group's functions and responsibilities. • Knowledge of ultimate goal. • Knowledge of organizational communication processes. • Knowledge of interrelations between different organizational groups. • Ability to analyze group responses.	• Ability to detect underlying issues. • Ability to compare multiple viewpoints. • Ability to summarize/paraphrase information. • Ability to encourage cooperation/ negotiation.
B5. Provide training to customers	• Internal, external and global customer requirements for training are correctly identified, interpreted and evaluated. • Scope of work is correctly defined to meet customer learning requirements. • Resources are accurately and completely identified. • Customer requirements, scope of work, resources required, content and evaluations are appropriately and completely documented. • Content developed contains appropriate amount of information and is consistent with learning objectives. • Training is effectively presented. • Effectiveness of service delivered is evaluated.	• Ability to identify key sources of information. • Knowledge of information gathering methods and company procedures and processes. • Knowledge of available resources. • Knowledge of required technical information and ability to organize technical material for ease of learning. • Ability to create appropriate presentation visuals for technical material.	• Ability to recognize and analyze customer needs and resolve conflicts to customer satisfaction. • Ability to visualize task sequentially and identify interdependencies. • Ability to document "lessons learned" succinctly and accurately and create detailed supporting documents. • Ability to speak clearly and concisely, and to compose and present well-organized presentations. • Ability to analyze and manipulate learning tools, formulate and adapt learning strategies and synthesize multiple learning techniques. • Ability to perform appropriate learning needs assessments and write learning objectives. • Ability to plan resource needs and constraints.

Critical Work Function: Provide Facilitation and Customer Service

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B6. Manage demands from multiple customers	• All internal, external and global customers are serviced in timely manner. • Size and age of queue are within departmental and company guidelines. • Assignment of priorities follows departmental guidelines.	• Knowledge of departmental and company guidelines. • Knowledge of availability of company and customer resources, and ability to access them. • Knowledge of practices of internal, external and global customers.	• Ability to prioritize daily tasks, prepare schedule and monitor/adjust task sequence. • Ability to set and adjust well defined/ realistic goals. • Ability to resolve conflicts to customer satisfaction. • Ability to communicate appropriate verbal/nonverbal messages. • Ability to define and communicate workload limits. • Ability to apply self-management skills and analyze and adjust goals.
B7. Solicit customer feedback and apply input to improve quality of service	• Customers are surveyed on a regular basis on important technical issues. • Input is analyzed for important and underlying concerns. • Service delivery procedures are analyzed in light of customer input. • Recommendations for quality improvement are developed and presented to key personnel.	• Knowledge of customer contact and survey processes regarding technical support. • Ability to analyze and interpret expressed and implied needs. • Knowledge of service delivery methods and practices. • Knowledge of customer quality issues.	• Ability to evaluate quality and effectiveness of processes. • Ability to develop recommendations based on information. • Ability to summarize/integrate and present information. • Ability to actively participate in discussions and present complex technical information. • Ability to select/obtain data/information relevant to the task and analyze the data.
B8. Document and communicate customer feedback and requests	• Documentation includes customer-oriented problem solution summary. • Documentation is clear, concise and published/distributed appropriately. • Customer feedback and requests are communicated effectively to appropriate personnel in a timely manner.	• Knowledge of communication procedures for customer feedback and requests. • Knowledge of organization chart and roles/ responsibilities of company personnel/ departments.	• Ability to summarize/paraphrase information. • Ability to create original documents. • Ability to explain concepts and present technical information. • Ability to use word processing, database tools and presentation software. • Ability to be an advocate for customer within the organization.

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Critical Work Function: Perform Hardware and Software Installation, Configuration and Upgrades

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C1. Identify and interpret customer requirements	• Requirements are complete and accurate. • Requirements reflect current customer expectations. • Information is effectively gathered, organized and analyzed. • Internal, external and global customers are consulted.	• Knowledge of installation processes. • Ability to query existing knowledge base. • Knowledge of hardware, software, operating system and networking principles. • Knowledge of technologies and cultural variables of internal, external and global customers.	• Ability to pose critical questions. • Ability to compile multiple viewpoints. • Ability to identify and prioritize need for data. • Ability to analyze data and contrast conflicting data.
C2. Evaluate present data and system configuration	• Accurate and complete description of data and system configuration is obtained. • Gathered data is verified against standard configuration. • Deficiencies in configuration are clearly and concisely identified. • Information is effectively and correctly gathered, organized and analyzed.	• Ability to identify system components. • Knowledge of multiple operating systems, applications and hardware. • Knowledge of networks and online resources, both internal and external. • Knowledge of system configuration.	• Ability to examine information/data for relevance and accuracy. • Ability to pose specific technical questions. • Ability to understand, interpret and recognize the accuracy of information.

Critical Work Function: Perform Hardware and Software Installation, Configuration and Upgrades

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C3. Develop installation plan	• Installation plan is appropriate and timely and documentation is complete and accurate. • Installation plan includes input from customer, key individuals and groups and is designed for minimal impact on process flow and productivity. • Installation plan includes tracking system or methods for tracking solutions and procedures and processes for final delivery and/or handoff. • Installation plan includes adequate beta testing and limited production testing phases. • Disaster recovery plan is designed and in place. • Internal, external and global customers are consulted, and plan is reviewed by appropriate people. • Information is effectively gathered, organized and analyzed, and documentation is complete and accurate.	• Knowledge of the impact of the installation plan on whole system. • Knowledge of solution tracking systems and methods. • Ability to identify installation-related tasks and sequence them accordingly. • Ability to reference knowledge base and online and other information resources. • Ability to utilize technical documentation. • Knowledge of practices of internal, external and global customers. • Ability to conceive, implement and track technological solutions.	• Ability to generate solutions and devise a plan of action. • Ability to create detailed supporting documents. • Ability to interpret, synthesize and summarize information. • Ability to respond to customer needs and concerns and demonstrate commitment to customer. • Ability to interpret and clarify communication.
C4. Install, configure and test system hardware and peripherals	• System hardware and peripherals are installed and configured according to specifications. • System configuration is refined to meet user needs. • System hardware is configured for optimum system and user efficiency. • System and peripherals are tested for performance and compatibility.	• Knowledge of hardware and peripheral installation and configuration. • Knowledge of technical specifications. • Ability to use test equipment to analyze system operation. • Knowledge of hardware and software troubleshooting and adjustment techniques and practices.	• Ability to read and follow written instructions. • Ability to interpret pictures and diagrams. • Ability to examine the situation, analyze possible causes/reasons and recommend action plan. • Ability to apply rules/principles to process/ procedure and use logic to draw conclusions.

Critical Work Function: Perform Hardware and Software Installation, Configuration and Upgrades

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C5. Install, configure and test new operating and application software, and software upgrades	• Operating and application software, and upgrades are installed and configured according to specifications. • Software configuration is refined to meet user needs. • Software is configured for optimum system and user efficiency. • System is tested for performance and compatibility.	• Knowledge of software installation and configuration practices. • Ability to use test programs and other aids to analyze system operation. • Knowledge of hardware and software troubleshooting and adjustment techniques and practices. • Knowledge of applications programs.	• Ability to read and follow written instructions. • Ability to interpret pictures and diagrams. • Ability to examine the situation, analyze possible causes/reasons and recommend action plan. • Ability to apply rules/principles to process/ procedure and use logic to draw conclusions.
C6. Optimize system performance through software and hardware configuration	• Impacts of different system configurations on system performance are evaluated. • Input from users is used in making system configuration decisions. • Changes in performance caused by changes in configuration are tracked and documented.	• Knowledge of hardware and software interaction and compatibility. • Ability to detect and resolve hardware and software conflicts. • Ability to identify operational and performance issues.	• Ability to compare information and identify deviations. • Ability to analyze situations and formulate task sequence. • Ability to identify and isolate problems and develop theory on possible cause. • Ability to create detailed supporting documentation.
C7. Perform quality checks on outcomes of work performed	• Quality checks and metrics are defined and applied during installation and configuration processes. • Outcomes are analyzed and problems are identified. • Recommendations for improvement in processes are developed and communicated.	• Knowledge of operational and performance specifications. • Knowledge of performance checking tools and procedures. • Knowledge of acceptable quality and performance standards.	• Ability to read and follow written instructions. • Ability to recognize patterns/relationships and visually analyze relationship between parts/whole and process/procedure. • Ability to interpret, analyze and summarize/integrate information. • Ability to prioritize tasks, prepare schedule and monitor task sequence. • Ability to apply rules/principles to process/ procedure and use logic to draw conclusions.

Critical Work Function: Perform Hardware and Software Installation, Configuration and Upgrades

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C8. Document system installation, configuration procedures and current configuration	• Documentation is clear and accurate. • Documentation follows organization format and standards. • Documentation has appropriate level of detail. • Documentation clearly identifies changes and impact of changes.	• Knowledge of technical documentation tools, procedures and practices. • Knowledge of document control procedures and practices. • Knowledge of configuration standards and terminology. • Knowledge of appropriate levels of detail for procedures and configuration.	• Ability to create detailed supporting documentation. • Ability to interpret information, prepare basic summaries and reports and select methods of communication. • Ability to present complex ideas/ information. • Ability to analyze data, integrate multiple items of data and contrast conflicting data. • Ability to use logic to draw conclusions and examine information for relevance and accuracy.

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Critical Work Function: Perform System Operations, Monitoring and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D1. Operate computer system and run system applications	• System is started and shut down following procedures. • Problems during operations are identified and resolved. • System backup is implemented according to plan and schedule. • Optimization applications are run according to schedule and need.	• Knowledge of applicable startup and shut down procedures. • Knowledge of applicable backup procedures. • Knowledge of system optimization and diagnostic routines.	• Ability to read and follow written instructions. • Ability to identify problems and develop theory on possible cause.
D2. Perform system diagnostics	• Diagnostics are completed in a timely manner. • Diagnosis is complete and accurate. • Diagnostics follow a logical process.	• Knowledge of diagnostic procedures and processes. • Ability to use diagnostic tools. • Knowledge of operating environments, online resources and standard computing and troubleshooting methodologies.	• Ability to select information appropriate to the task. • Ability to pose critical questions. • Ability to apply rules and principles to diagnostics and use logic to draw conclusions. • Ability to analyze information.
D3. Monitor and analyze system performance	• System performance is monitored according to procedures. • Problems are identified and resolved or reported in a timely manner. • System performance is compared to baseline performance for discrepancies.	• Knowledge of system monitoring and diagnostic tools and procedures. • Ability to detect, evaluate and appropriately escalate problems. • Knowledge of performance measurement tools and procedures.	• Ability to read and follow written instructions. • Ability to identify problems and develop theory on possible cause.

Critical Work Function: Perform System Operations, Monitoring and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D4. Develop and implement preventative maintenance plan	• Plan includes appropriate level of detail. • Plan development includes key people. • Plan is documented and communicated effectively to internal, external and global customers and appropriate personnel in a timely manner. • Plan is consistent with strategic and tactical organizational objectives.	• Knowledge of preventative maintenance procedures and processes. • Knowledge of company practices for maintenance. • Knowledge of practices of internal, external and global customers. • Knowledge of roles and responsibilities of company personnel and departments.	• Ability to organize information. • Ability to create detailed supporting documents. • Ability to use word processing, database tools and spreadsheet software. • Ability to present complex information. • Ability to analyze customer needs and demonstrate commitment to customer. • Ability to recognize patterns/relationships and visually analyze relationship between parts/whole and process/procedure. • Ability to examine the situation, analyze possible causes/reasons, and recommend plan of action. • Ability to apply rules/principles to process/ procedure and use logic to draw conclusions.
D5. Evaluate maintenance processes and outcomes	• Evaluation includes all relevant internal, external and global customers. • Evaluation reflects strengths and weaknesses of the maintenance processes and outcomes. • Evaluation includes appropriate follow-up action and new plan/solution based on reassessed needs. • Evaluation is documented clearly and concisely. • Evaluation information is effectively gathered, organized and analyzed. • Outcomes are analyzed and compared with goals.	• Knowledge of preventative maintenance procedures and processes. • Knowledge of company practices for maintenance. • Knowledge of practices of internal, external and global customers. • Knowledge of evaluation documentation procedures. • Knowledge of relevant sources for evaluation input.	• Ability to analyze and summarize information and identify interdependencies. • Ability to compare multiple viewpoints. • Ability to pose critical questions. • Ability to identify own strengths/ limitations and accept constructive criticism. • Ability to evaluate installation processes and suggest modifications.

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Critical Work Function: Perform System Operations, Monitoring and Maintenance

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D6. Communicate and document maintenance procedures and system status	• Documentation includes customer-oriented problem solution summary. • Documentation is clear, concise, and published/distributed appropriately. • Status is communicated effectively to internal, external and global customers and appropriate personnel in a timely manner.	• Knowledge of internal and external communication procedures. • Knowledge of organization chart and roles and responsibilities of company personnel and departments. • Knowledge of practices of internal, external and global customers.	• Ability to summarize/paraphrase information. • Ability to create original documents. • Ability to explain concepts and present technical information. • Ability to use word processing, database tools and presentation software.

Technical Writing

As a technical writer, you make technical information easily understood. Technical manuals, detailed specifications, online help, web content and training materials are just a few examples of the documents you create. You define the audience and purpose of your document; determine the technical level, tone and organization; and choose your document's delivery method (print or electronic). You are accurate. You thoroughly research your subject by interviewing experts and users, and testing the product you're writing about. You use page layout or word processing programs to create your documents and design graphics. Your creativity, communication skills and ability to understand and simplify complex material are valuable assets to your readers and to your future.

SAMPLE TITLES

- Desktop Publisher
- Document Specialist
- Documentation Specialist
- Editor
- Electronic Publications Specialist
- Electronic Publisher
- Instructional Designer
- Online Publisher
- Technical Communicator
- Technical Editor
- Technical Publications Manager
- Technical Writer

"As a technical writer, if I understand how programmers and system administrators and system engineers think and can speak to them in their own language, I gain respect and am able to synthesize the information they give me more easily. Then I am able to put it into lay language for the final document."

A Technical Writer Discussing the Importance of Math and Science Skills

The Iterative Nature of IT Work

The development of skill standards necessarily requires an analytical approach that results in the classification of functions and tasks in a discrete, linear and sequential form. When using skill standards data, it should always be remembered that the actual nature of this work is iterative, with ongoing cycles that build over time to a completed task. It should not be inferred that the skill standards set forth unalterable steps of procedure for the accomplishment of a task.

As with all professions, the nature of information technology jobs is precise yet flexible, with processes and tasks subjected to continuous feedback, improvement and refinement, based on available resources and customer/client needs. The ability to respond to the iterative nature of information technology work should be considered a key employability skill.

Summary of Critical Work Functions

A. Analyze Project Requirements	B. Perform Research	C. Design Document	D. Develop and Write Document	E. Publish and Package
A1 Gather data to identify customer requirements	B1 Define research questions	C1 Select design and publication tools	D1 Select, synthesize, and organize pertinent information to meet user needs	E1 Collaborate with graphics specialists
A2 Interpret, evaluate and confirm requirements	B2 Identify and evaluate sources of information	C2 Plan layout and document design	D2 Create content of document	E2 Coordinate with printer and/or media production house
A3 Define scope of work	B3 Gather background information	C3 Select style and tone	D3 Develop feedback/ validation vehicles	E3 Provide advice regarding delivery media and methodology
A4 Identify time, technology and resource constraints, and delivery options	B4 Interview subject matter experts	C4 Determine information flow and level of detail	D4 Obtain feedback on information and technical accuracy	E4 Tailor composition and layout for delivery media
A5 Review and refine document plan	B5 Interview and/or observe target audience	C5 Identify appropriate visuals	D5 Edit for readability, grammar and usage	
A6 Define purpose, standards and use of documentation	B6 Interpret and report research results	C6 Provide feedback to development team/ individuals	D6 Test, validate and verify for usability	

"I personally think you need an outside life as well. If you want to communicate well with others, people with diverse ways of thinking help you.... Today you need an eclectic approach, varied skills to perform well."

A Technical Writer

Technical Writing

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The Scene

The field of technical writing is growing so rapidly and in so many directions that you will have to decide where to focus your energy. You may want to become a human interface design engineer, designing screens, web pages or delivery documentation. Or you may want to specialize in developing online technical help for software tools. Developing training manuals is another opportunity for technical writers. As a technical writer you will also need to develop a thorough understanding of the technical jargon and documentation constraints used in specific industries. For example, documenting technical procedures in the airline industry requires a different knowledge base than the same type of documentation in the medical electronics industry. Terminology as well as standards can vary significantly between industry sectors.

As a beginning technical writer you will be part of a team responsible for discrete elements of writing. As you become more experienced you will have more input on the overall style and organization of the document. You will get involved in issues dealing with production and delivery. As part of a large organization, you will probably work in a team where each member specializes in one specific aspect of the production process. On the other hand, if you are a contractor or working for a small company, you may have to take on wider responsibilities. Often you are working under difficult time constraints and with requirements that are not fully defined or change several times during the project. You need to interface not only with customers and users, but also with printers or media producers. Organizational skills are critical to your success.

Sometimes you'll get into a project where you're fixing problems caused by others. A company may have contracted someone to create a document which, upon delivery, is found to be unusable. You are now asked to "fix" it. You need to call upon strong analytical skills to define what is worthy or valuable in the original document, interview the development leader, and reorganize, research and rewrite the document.

Even though creativity of style and presentation are valuable skills, you are often constrained in your development by technical constraints and publication standards. Understanding and working with the organization procedures and culture are important to the effectiveness of your product. Often you will be working on a small part of a document with other writers writing other pieces. You will have to learn to adapt your style so that the end product "speaks with a uniform voice." Working with highly technical topics and staff will push you to the edge of your technical expertise and require that you acquire quite a bit of technology knowledge on the way.

A typical day as an entry-level technical writer may include attending a team meeting to evaluate the status of current projects and reassess task distribution. You may spend time interviewing users or testing a software tool to understand its capabilities and "feel." You probably will spend some of your day doing actual writing or reviewing and editing others' work. Your day will probably be broken up with meetings and interruptions and you will have to learn to concentrate your writing effort into small time periods.

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Scenarios

Entry Level

- Help write training manuals in collaboration with other writers.
- Participate in status report meetings.
- Interview users and assess effectiveness of training manuals.
- Take charge of small projects, such as an employee technology newsletter.
- Support senior editors with various writing and editing projects.

You're one of a group of ten technical communicators in a very large grocery distribution company. Your job is to work with programmers who develop and maintain a complex software system that tracks product inventory. The software package is used at branch distribution sites where warehouse personnel enter data relating to inventory, distribution and orders. You help write training modules to teach the branch personnel how to use the software (quick reference guides, troubleshooting guides and material for the field service personnel who install the software). Because there's a lot of turnover in the company branches, your group must be certain that the documentation is clear.

You support the senior members of the technical communications team, and sometimes you take over the status reporting when senior members are not available. You also contribute to the planning activities, reporting on schedule issues and unexpected delays.

You sometimes visit the sites to see how well the training is working and help conduct a user interface evaluation at the site.

In addition to the software materials, you are the main writer for the employee technology newsletter. You interview employees to write personal interest pieces on the use of technology within the company and technology articles of general interest to the employees. The senior members also assign you various writing and editing tasks as the need arises, such as writing short technical briefs for the annual report to the stockholders.

"Project management is necessary for a technical writer. At a previous company, our team created training materials. I served as a project manager to identify milestones, audience, key participants, roles and responsibilities. Even in doing a very small project, you still need project management skills to work with all the variables you must manage during a project."

A Technical Writer During a Focus Group

"The question should be: 'How does what I do reflect an addition to and demonstrated value to the product/service?'"

An Electronic Publications Specialist

Proficiency Level

- Evaluate audience needs and make decisions for content and design.
- Develop overall concept, navigational structure and visual concept for web site.
- Work with the web design and production teams and the art director.
- Research and develop content.
- Organize and conduct user focus groups.
- Adapt content and organization to audience needs and interests.

Your software development company is developing an online career IT resource center to be offered on the web. You are charged with evaluating the audience needs with the goal of posting the resource center on the web site. You'll need to come up with the overall concept, navigational structure and visual concept that best meet the audience needs and the technology constraints. You will then work with the web design and production teams and the art director to come up with final design and layout.

Your primary responsibility is the development of the content for this online resource. To offer a complete source of information to the users, you will need to research and evaluate all the training and certification options offered through your company. The audience will rely on your recommendations based on their perceived needs, so you must be thorough in your evaluation process and present your findings in ways that make it easy to select the best training solution. Once the resource center has been produced, you will organize and conduct focus groups to determine possible enhancements. Your audience includes a wide range of users: new entrants to the IT field, potential hires for the company and employees who want career advancement. As a result the web site needs to be flexible to serve the interests of a variety of users.

Expert Level

- Develop production schedule, and assign tasks and responsibilities.
- Prioritize tasks and plan for contingencies.
- Contribute to the writing and editing of documents.
- Interface with programmers and production engineers.
- Handle recruiting, hiring and personnel issues.
- Develop overall concept and organization of documents.
- Review all phases of project and assume overall responsibility for project.

You're working for a company that writes software for hospital billing. You are the project manager for the development of a set of online technical documents for a new software product to be released in two months. You develop a production schedule and review it with customers and your team. The software development schedule has been running behind and the development of the software product is not complete. You need to stay informed of changes made by the software team and to accurately reflect these back to your document, while seeing to it that the other document sections are completed on time.

You assign tasks to conduct the research, develop the writing and conduct testing. You try to identify which parts of the document are less likely to be affected by potential software design changes, and get your team started on these first. As the project is short on time and money you get involved in parts of the writing and editing.

In order to complete the project you need to hire a graphic artist to replace the one you just lost to a competitor. You're considering hiring a contractor in the interim. You deal with human resources personnel to try to expedite the advertising and selection process.

You start interacting early in the process with the production and delivery team to make sure that your product meets their specifications. You create the page design and the organization for the manual and work with the programmers to create the graphic design for the screen shots or other aspects of the user interface.

Several times during the project, you need to reassess the schedule and reassign priorities to accommodate problems and task delays. You spend many long days and some weekends working on the document to see it to completion by the scheduled date. Your ability to interact with and motivate your team members is a critical element of the success of the project. You enjoy the pace of the work and the feeling of accomplishment that comes with developing a quality product within the challenges of tight deadlines and budgets.

"A good technical writer must be self-motivated to cover a lot of continued education outside the job definition of staff writer. An independent must be even more up to date to relate to multiple clients' cutting edge projects."

A Freelance Technical Writer

"The Internet/Web is THE new technology for technical writing, and has tremendous impact on the whole field. User expectations are changing daily with the explosion of the web. The ocean of information that's available must be sorted out and technical writers will play a big role in doing that."

An Online Publisher

Technical Writing

Critical Work Function: Analyze Project Requirements

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A1. Gather data to identify customer requirements	• Sources and methods for gathering requirements are affordable and relevant. • Information is accurate and complete. • Information gathering interviews follow standard company practices. • Sources are reliable, available and current. • Target audience/user groups are identified and used as key information sources.	• Ability to identify key sources of information. • Knowledge of interview techniques with respect to customer requirements and delivery options. • Knowledge of information gathering methods and quantity of information required. • Knowledge of workplace and industry vocabulary. • Knowledge of industry standards.	• Ability to pose critical questions. • Ability to compile and analyze multiple viewpoints. • Ability to respond appropriately to others. • Ability to identify and prioritize the need for data. • Ability to encourage cooperation and keep an open mind to new data and opinions. • Ability to consolidate and summarize a variety of options. • Ability to apply creative solutions to new situations.
A2. Interpret, evaluate and confirm requirements	• Customer needs are clearly defined and prioritized. • Conflicting requirements are identified and resolved. • Gaps in information are identified and addressed. • Complete set of requirements is communicated to and approved by customer. • Final requirements are clearly documented and acceptable to customer. • Mechanism for signing off on requirements is developed and followed. • Requirements are properly interpreted, evaluated and confirmed.	• Ability to define requirements in appropriate business terms. • Ability to present and refine requirements as necessary with customer approval. • Knowledge of outlining and conceptualizing tools.	• Ability to select/obtain information relevant to task. • Ability to relate intent to desired results. • Ability to analyze information for accuracy, consistency and relevance. • Ability to use word processing, desktop publishing and graphics software. • Ability to organize information into outlines. • Ability to obtain customer approval of requirements.

Critical Work Function: Analyze Project Requirements

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A3. Define scope of work	• Project objectives, including size, format, and other specifics of the proposed deliverables, are correctly identified and agreed upon. • Criteria for successful completion of the work are accurately identified. • Major project tasks and interdependencies are correctly identified. • Estimate of time, materials and capabilities needed to meet customer requirements is accurate. • Schedule is based on resource availability and project timeline. • Scope of work is documented, approved and accurately meets customer requirements.	• Ability to identify technical and human resource interdependencies. • Ability to evaluate work procedures for effectiveness and efficiency. • Knowledge of hardware and software capabilities/constraints. • Knowledge of project management tools.	• Ability to create detailed supporting documents. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to negotiate alternatives. • Ability to prioritize conflicting work demands. • Ability to identify the theme, purpose and scope of the assignment. • Ability to visualize sequence of events/ activities. • Ability to estimate required resources and schedule.
A4. Identify time, technology and resource constraints, and delivery options	• Constraints are accurately identified and documented. • Constraints are communicated to appropriate personnel and customers effectively and in a timely manner. • Contingency plans are developed with plausible alternatives. • Delivery options meet customer needs and project specifications.	• Delivery options are appropriately applied to specifications. • Ability to identify appropriate resources. • Knowledge of key sources of information. • Knowledge of technology and resource constraints. • Knowledge of various delivery options and industry standards. • Knowledge of operating systems, application software and Internet capabilities.	• Ability to create detailed supporting documents. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to apply creative solutions to new situations. • Ability to understand constraints, generate alternatives, consider risks, evaluate options and formulate action plans. • Ability to present complex information and recommendations.

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Critical Work Function: Analyze Project Requirements

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A5. Review and refine document plan	• Information needs are identified and communicated to appropriate people in a timely manner. • Necessary and sufficient information is gathered to meet project goals. • Inconsistencies, contradictions and discrepancies between the information given and information needed are identified. • Document plan is accurate and complete.	• Knowledge of location of subject matter experts and interview techniques to obtain technical and non-technical information. • Knowledge of appropriate workplace vocabulary and concepts. • Knowledge of quantity and characteristics of information required. • Ability to evaluate relevance and consistency of written material.	• Ability to verify data accuracy. • Ability to summarize information and requirements. • Ability to select and evaluate appropriateness of existing information. • Ability to pose critical questions. • Ability to listen attentively and interpret and clarify communication.
A6. Define purpose, standards and use of documentation	• Definition of purpose meets customer requirements for delivering useful content to end-users. • Audience for document is clearly identified. • Document meets acceptable industry standards for readability and presentation.	• Knowledge of customer requirements. • Knowledge of documentation standards. • Ability to identify audience and purpose of document.	• Ability to compare and analyze multiple viewpoints. • Ability to pose critical questions. • Ability to demonstrate sensitivity to customer concerns and interests. • Knowledge of word processing and online tools. • Ability to present complex ideas/ information. • Ability to create agreement and/or consensus on document use and purpose.

Critical Work Function: Perform Research

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B1. Define research questions	• Research questions are clearly focused and succinctly defined. • Research questions are relevant to project and customer requirements and goals.	• Ability to synthesize information into clear research questions which are relevant to project goals. • Knowledge of research interview questionnaire development. • Knowledge of project and customer requirements and goals.	• Ability to interpret information. • Ability to compare multiple viewpoints. • Ability to pose critical questions. • Ability to apply rules/principles to process/ procedure and use logic to draw conclusions.
B2. Identify and evaluate sources of information	• Sources of information are credible and can provide relevant information. • Sources of information include subject matter experts, the target audience and appropriate documents. • Sources of information are evaluated based on project requirements.	• Knowledge of copyright issues and laws. • Knowledge of research methods. • Knowledge of online and other sources of information.	• Ability to pose critical questions. • Ability to identify and prioritize the need for information. • Ability to evaluate relevancy of sources of information. • Ability to be creative in identifying and locating sources of information.
B3. Gather background information	• Priorities regarding what information should be gathered are correctly determined. • Information gathered is relevant, accurate and complete. • Information provides the contextual background needed. • Information gathering processes follow appropriate company practices.	• Knowledge of a variety of research tools and technologies. • Ability to integrate various information technologies. • Knowledge of company policies and procedures. • Knowledge of online resources.	• Ability to pose critical questions, and to understand and interpret both verbal and nonverbal responses. • Ability to identify and prioritize the need for information. • Ability to analyze and synthesize information.

Critical Work Function: Perform Research

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B4. Interview subject matter experts	• Interview questions are relevant, succinct and directed to appropriate contacts. • Information interviews are conducted in a cost-effective manner. • Information gathering interviews follow appropriate company practices. • The purpose, processes and expectations of the interview are effectively explained to interviewees.	• Knowledge of key sources of information for subject matter experts. • Knowledge of research interview methods. • Knowledge of workplace and industry vocabulary. • Knowledge of group interview facilitation techniques for information technology subject matter experts.	• Ability to identify and prioritize the need for data. • Ability to summarize information. • Ability to encourage cooperation. • Ability to pose critical questions and analyze responses. • Ability to listen, interpret and respond to communication appropriately. • Ability to interview a diverse population. • Ability to apply rules/principles to process/ procedure and use logic to draw conclusions.
B5. Interview and/or observe target audience	• Interview questions are relevant, succinct and directed to appropriate contacts. • Information interviews are conducted in a cost-effective manner. • Information gathering interviews follow appropriate company practices. • The purpose, processes and expectations of the interview are effectively explained to interviewees. • Target audience is consulted or observed to obtain required information.	• Knowledge of research interview methods. • Knowledge of workplace and industry vocabulary. • Knowledge of company and departmental practices and procedures.	• Ability to identify and prioritize the need for data. • Ability to summarize information. • Ability to encourage cooperation. • Ability to pose critical questions and analyze responses. • Ability to apply rules/principles to process/ procedure and use logic to draw conclusions. • Ability to listen, interpret and respond to communication appropriately. • Ability to interview a diverse population.
B6. Interpret and report research results	• Research reports are concise and timely. • Research reports are relevant. • Research reports communicate results clearly and accurately. • Research reports contribute to refinement of document plan. • Research reports are prepared and communicated in accordance with company procedures.	• Ability to relate research results to purpose of the project. • Knowledge of company procedures regarding research reporting techniques.	• Ability to probe for meaning. • Ability to present results clearly and concisely. • Ability to interpret information, prepare basic summaries/reports and select method of communication. • Ability to analyze and integrate multiple data items. • Ability to create original documents and detailed supporting documentation.

Critical Work Function: Design Document

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C1. Select design and publication tools	• Tools meet task purpose. • Tools are cost-effective and readily available. • Tools selected are in accordance with company practices and standards.	• Knowledge of design and publication tools. • Knowledge of company practices and standards.	• Ability to resolve technical issues. • Ability to understand organizational hierarchy and follow procedures. • Ability to utilize word processing, desktop publishing and online tools.
C2. Plan layout and document design	• Appropriate information is presented in a logical sequence. • Layout is formatted and document is designed to meet customer requirements. • Principles of effective design are applied.	• Knowledge of subject matter. • Knowledge of the psychological impacts of layout. • Knowledge of company documentation guidelines. • Knowledge of principles of design. • Ability to select and technical information to meet user needs.	• Ability to visually analyze relationship between parts/whole. • Ability to demonstrate creative thinking. • Ability to simplify, summarize and paraphrase complex material. • Ability to use advanced word processing and publishing tools.
C3. Select style and tone	• Style and tone are appropriate for purpose, medium and audience. • Style and tone conform to customer requirements.	• Knowledge of different writing styles. • Knowledge of audience characteristics. • Knowledge of strengths/limitations of media options.	• Ability to demonstrate sensitivity to diversity issues. • Ability to communicate appropriate verbal and nonverbal messages. • Ability to present information persuasively and objectively.
C4. Determine information flow and level of detail	• Appropriate level of detail is determined for purpose. • Level of detail meets customer expectations. • All stakeholders are included in design process. • Information flow is logical and supports purpose of document.	• Knowledge of customer expectations. • Ability to adjust level of detail to meet customer/user needs. • Knowledge of document design tools. • Knowledge of effective flow of information in technical documents.	• Ability to use logic to draw conclusions. • Ability to use previous training/experience to predict outcomes. • Ability to organize information logically.

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Critical Work Function: Design Document

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C5. Identify appropriate visuals	• Visuals conform to customer requirements. • Visuals enhance message. • Visuals are appropriate in style and tone. • Visuals are cost-effective. • Visuals are appropriate for delivery option.	• Knowledge of media choices. • Ability to match visuals to style and tone. • Ability to select and use visuals to communicate effectively. • Knowledge of document size constraints when using visuals.	• Ability to use imagination to visualize events and activities. • Ability to adhere to goals and constraints. • Ability to use presentation and graphics software.
C6. Provide feedback to development team/individuals	• Feedback is clear, concise and timely. • Feedback includes recommendations for improvement. • Feedback is documented clearly and accurately. • Feedback is disseminated to appropriate parties, including project sponsors, development team and decision makers.	• Knowledge of company documentation procedures. • Knowledge of design process and principles.	• Ability to understand continuous improvement processes. • Ability to relate intent to desired results. • Ability to value differences of opinion. • Ability to assess performance of others and provide constructive feedback. • Ability to make clear, concise and compelling presentations.

Critical Work Function: Develop and Write Document

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D1. Select, synthesize and organize pertinent information to meet user needs	• Information is selected for relevance and appropriateness. • Information is accurate. • Information meets user needs. • Information is synthesized and well organized.	• Knowledge of user requirements. • Knowledge of company standards and practices.	• Ability to recognize and organize information most relevant and important to the situation. • Ability to compile and analyze multiple viewpoints and items. • Ability to use computers to process information. • Ability to simplify complex information. • Ability to use inferential knowledge and to synthesize information based on past experience and industry knowledge.
D2. Create content of document	• Content is presented clearly and concisely to the intended audience. • Technical terminology is redefined for lay readers where appropriate. • Appropriate presentation tools are used. • Style and tone are consistent. • Content is presented in proper media and communicates necessary information. • Content meets stated specifications and standards in a timely fashion as set forth in the document plan.	• Knowledge of the principles of technical writing and presentation. • Knowledge of company standards and specifications. • Knowledge of technical writing tools, methods and delivery options. • Ability to translate technical terminology and concepts. • Ability to create templates for information technology content.	• Ability to use word processing, desktop publishing and graphics tools. • Ability to interpret and summarize research information. • Ability to create clear, concise original documents. • Ability to analyze and synthesize information. • Ability to use appropriate language, style, organization and format.
D3. Develop feedback/ validation vehicles	• Document is distributed and feedback is actively solicited. • Review process and timelines are identified and followed. • Steering committees, advisory groups or panels are consulted as appropriate. • Opportunities for user input are provided.	• Knowledge of group communication aids and tools for obtaining feedback. • Knowledge of company guidelines for obtaining feedback.	• Ability to use word processing, desktop publishing, email, net conferencing, telephone, video and graphics tools. • Ability to gather, analyze and categorize information. • Ability to present complex ideas/ information and analyze responses. • Ability to listen attentively and compare multiple viewpoints. • Ability to respond assertively while understanding impact on others.

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Critical Work Function: Develop and Write Document

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D4. Obtain feedback on information and technical accuracy	• Available information resources are identified and confirmed. • Feedback is requested in a timely manner. • Appropriate feedback is collected from subject matter experts. • Review/revision process follows company procedures. • Appropriate feedback is incorporated into the final document.	• Knowledge of location of subject matter experts. • Knowledge of company and departmental review processes and procedures.	• Ability to solicit and accept constructive feedback. • Ability to demonstrate composure. • Ability to listen attentively. • Ability to respond appropriately to others. • Ability to evaluate feedback for accuracy and relevance. • Ability to create data gathering processes. • Ability to recognize job tasks, distribute work assignments and monitor performance.
D5. Edit for readability, grammar and usage	• Document is free of grammatical errors. • Document meets customer expectations for readability, usage and usability. • Document meets standards of style identified in the document plan.	• Knowledge of grammar, readability and usability standards consistent with design. • Knowledge of advanced word processing and editing tools. • Ability to apply professional editing principles.	• Ability to evaluate consistency of written material. • Ability to judge the accuracy, appropriateness and style of document.
D6. Test, validate and verify for usability	• Document is pertinent, accurate and usable. • Document contains appropriate information and is organized conveniently for the user. • Inappropriate style or tone is identified and eliminated. • Missing elements required to meet user and business needs are identified and addressed. • Validation is performed by the subject matter experts and usability is confirmed by the target audience. • Document meets technical standards and customer expectations.	• Knowledge of basic research reporting for information technology. • Knowledge of interview, observation and other data gathering techniques for information technology. • Ability to plan and conduct usability tests. • Ability to interpret test results correctly. • Ability to ask appropriate questions, identify appropriate test subjects, and employ the comments made to improve the document.	• Ability to gather, evaluate and categorize information. • Ability to synthesize appropriate solutions. • Ability to respond appropriately to others and demonstrate empathy. • Ability to interpret and clarify communication.

Critical Work Function: Publish and Package

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E1. Collaborate with graphics specialists	• Document meets mechanical specifications. • Document meets graphics standards. • Document is usable, readable and meets standards of production and layout as stated in the document plan.	• Knowledge of graphics terminology and standards. • Knowledge of printing and production concepts. • Knowledge of desktop publishing concepts and tools.	• Ability to effectively interpret, clarify and influence communication. • Ability to present complex ideas/ information and analyze group/individual responses. • Ability to use computer networks and email.
E2. Coordinate with printer and/or media production house	• Scope of work is developed, documented and approved. • Production schedule is developed, updated and communicated to stakeholders. • Costs and benefits of various production alternatives are analyzed and presented. • Production decisions are made and communicated in a timely manner.	• Knowledge of printing and graphics production terminology. • Knowledge of project planning techniques and tools. • Knowledge of vendor strengths and weaknesses.	• Ability to present complex ideas/ information. • Ability to prioritize tasks, prepare schedule and monitor/adjust task sequences.
E3. Provide advice regarding delivery media and methodology	• Proposals presenting delivery alternatives are developed. • Technical impact of media and methodology alternatives are determined, analyzed and communicated. • Costs and benefits of media and methodology alternatives are analyzed and presented. • Recommendations are clearly documented and distributed to appropriate personnel.	• Knowledge of proposal development techniques. • Knowledge of technical advantages and limitations of media and methodologies.	• Ability to analyze situation/information, consider risks/implications and compile multiple viewpoints. • Ability to synthesize and summarize information. • Ability to present alternatives and recommendations with adequate supporting data. • Ability to present complex information/ ideas and analyze responses.

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Critical Work Function: Publish and Package

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E4. Tailor composition and layout for delivery media	• Technical specifications and scope of work are developed based on the delivery media selected. • Critical project steps, specifications and deliverables are approved. • Specifications and project requirements are effectively communicated to all stakeholders.	• Knowledge of technical advantages and limitations of media and methodologies. • Knowledge of project analysis and presentation techniques.	• Ability to present complex data/ information to internal and external customers and vendors. • Ability to listen attentively and interpret communication. • Ability to organize information for specific audience, purpose and media. • Ability to use writing, publishing, graphics and design tools.

Web Development and Administration

You will play a vital role in your company's presence on the world wide web. You may use web page development software to create or change web pages, inserting text content, graphics and interactive modules that are often supplied by others in your organizational team. Before you start, you will probably talk to the many stakeholders in your company who depend on the organization's web presence. You'll also look at successful models and research software tools to help design the look, feel and navigation. In some organizations you may be responsible for making sure the web pages and updates get installed, and work with the hardware associated with the web pages.

SAMPLE TITLES

- Web Administrator
- Web Architect
- Web Designer
- Web Page Developer
- Web Producer
- Web Site Developer
- Web Specialist
- Webmaster

The Iterative Nature of IT Work

"Since no one person seems capable of knowing everything and being the expert, we have to rely on each other and in the team's ability to solve problems."

A Web Developer

The development of skill standards necessarily requires an analytical approach that results in the classification of functions and tasks in a discrete, linear and sequential form. When using skill standards data, it should always be remembered that the actual nature of this work is iterative, with ongoing cycles that build over time to a completed task. It should not be inferred that the skill standards set forth unalterable steps of procedure for the accomplishment of a task.

As with all professions, the nature of information technology jobs is precise yet flexible, with processes and tasks subjected to continuous feedback, improvement and refinement, based on available resources and customer/client needs. The ability to respond to the iterative nature of information technology work should be considered a key employability skill.

WEB DEVELOPMENT AND ADMINISTRATION

Summary of Critical Work Functions

KEY ACTIVITIES

A. Perform Content and Technical Analysis	B. Develop Web Applications/Sites	C. Implement Application/Site Design	D. Maintain Applications	E. Manage Web Environment	F. Manage Enterprise-wide Web Activities
A1 Gather data to identify customer requirements	B1 Develop site map and application models	C1 Develop and implement usability testing	D1 Update content	E1 Evaluate and recommend web hardware, software and third-party solutions	F1 Define and manage development standards
A2 Research content	B2 Select design tools and programming language	C2 Plan and coordinate customer acceptance testing	D2 Integrate customer feedback	E2 Set up server software and hardware	F2 Train designers and developers
A3 Define scope of work	B3 Produce graphics and layout elements	C3 Plan rollout	D3 Perform application maintenance	E3 Manage server	F3 Evaluate web technologies and standards
A4 Prepare and present functional and technical specifications	B4 Create or adapt content	C4 Facilitate move to production system	D4 Recommend application/site improvements	E4 Support disaster recovery	F4 Provide quality customer service
A5 Develop and present concept alternatives	B5 Write supporting code	C5 Hand off to customer/ user	D5 Document application/site changes		
A6 Prepare preliminary application	B6 Develop supporting databases				
A7 Create and refine preliminary design/ mockup	B7 Perform unit and integration testing				
A8 Review technical considerations and constraints					
A9 Design site security measures					
A10 Develop project plan					

"I look for the 'digger,' the person who is technically aggressive, persistent and who will dig until the problem is solved forever."

A Human Resources Professional

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The Scene

Web pages have evolved from simple documents with text and a few graphics to sophisticated multimedia vehicles. Streaming audio and video are becoming more and more common on web sites and the complexity of their interactivity with users is increasing continuously. Despite increasing popularity, the capability of the Internet in displaying multimedia elements is still limited when compared to other media platforms. Web developers must create designs that take into account the bandwidth of the network and Internet connections and the speed of the user platform. Web design is made even more difficult by the fact that user Internet technology varies widely—from Internet access through standard phone lines to high-speed/high-bandwidth Internet connections. If a web page takes ten minutes to download to a user workstation, its success and appeal are very limited. On the other hand, if developers design consistently for only the lowest technology available, limiting the page to text and graphics, the experience will be very boring and the web pages will lack the ability to attract visitors. Web development is often a balance between what the developers would like to create and what the medium allows them to accomplish. The development of web sites is a highly creative process supported by strong technical expertise. As the Internet moves more and more to supporting electronic commerce, developing web sites will require increasing levels of business and marketing skills.

At the beginning of your career in web, you may spend more time maintaining existing web sites than creating new ones—implementing content and design changes and identifying and resolving functionality problems. You may work as part of a development team to create new sites and be given responsibilities for the building of simple web pages. You will probably be involved in the testing of existing and prototype sites, verifying link functionality and measuring download efficiencies.

After a few years, as your talents and experience develop, you will be given responsibilities for development projects with increasing complexity. You may be placed in charge of a development team. You may also be asked to analyze web site effectiveness from the company and user perspectives. At this point in your career you may choose to develop a stronger expertise in specific web technologies, such as specific media types or web server technologies. Or you may choose to focus on the applicability of web throughout the organization and on web standards and procedures. As you demonstrate stronger business skills, you will be involved in contributing to strategic decisions regarding web usage and to the management of enterprise-wide web activities.

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Scenarios

Entry Level

- Review information and ask questions of key persons to identify relevant content and preferred presentation.
- Become familiar with key individuals and adapt to their knowledge of technology and communication style.
- Develop concepts for web design and organization.
- Validate, refine with and obtain approval from key persons.
- Design, build and test web pages and links.
- Update contents and maintain web site.

You were recently hired by a small specialty retail company whose management decided it was time to catch the information technology wave and get their message on the Net. Much of the company's business is through catalog phone- or mail-order transactions. The company recently completed a survey that showed that even though the majority of their customers did not make their purchase through the Internet, most of them conducted product research and selection online. The company purchased web space from an Internet provider—now all they need is a web site.

Your task is to develop the company's web site and transfer product and ordering information onto the web format. This seems like a challenging assignment for your first job. However, you have assembled an impressive portfolio of web projects completed during internships while you were in school, and that portfolio, along with good communication skills, got you the job. The emphasis in the project is primarily on designing an easy-to-use and attractive site, rather than on using sophisticated technology. Most of the customers are home Internet users and want information quickly without having to jump through many technology hoops. As a result, your writing, organization and visual design skills will be more heavily challenged than your technical skills.

You will be working closely with the marketing and catalog development staff, as they will help you identify how and what information should be presented online. However, they will rely on you to decide the organization of that information. After getting familiar with the company's product lines, you create a design concept that you present to the marketing and catalog development group. You discover rapidly that technical web terminology is mostly foreign to them. It is difficult for them to envision the product from only a rough concept, as their experience with the Internet, even as users, is limited. Struggling with the communication gap, you develop a series of mockups as are often used in the presentation of advertising concepts, and which prove quite effective in this situation. After refining the idea to a point where everyone involved can approve it, you start building and testing the actual web pages and links. You work mostly alone through the development phase, using the other staff to validate prototypes and give feedback on design and usability.

Once the development is complete, you will spend most of your time updating content, improving design and adding features to the site. At a later time, you may design and conduct a user survey regarding the web site features to improve its effectiveness. You hope that as the site proves successful more funding will be allocated to Internet marketing, allowing more creative and sophisticated web techniques to be developed and implemented.

"Absolutely, we like to get balanced people on our team, people who can work on and contribute to a team. We have to be able to talk with clients and customers, as well as technical specialists and developers. If we are all working together, the products are better."

An Independent Web Architect

"Quality and continuous improvement: always build on what you did before. Sometimes it's better to get a product out the door rather than waiting a year. To get it out, you sometimes have to let go of perfection."

A Web Developer

Proficiency Level

- Define requirements with client.
- Develop, negotiate and refine proposals with client.
- Develop design concepts and validate with client.
- Build prototypes and test with representative user group.
- Finalize web content, design and structure.
- Build database and web site and test for functionality.
- Conduct usability testing, analyze results and implement design changes as needed.
- Track tasks, milestones and budgets.
- Manage development team and keep development in line with requirements.
- Report status to management from your firm and from the client organization.

You have been working as a web developer for several years in different companies. Two years ago you were hired by a consulting firm that develops web sites for companies in a wide range of industries. Typically the client companies do not have in-house web developers. This often means that the clients have only limited knowledge and understanding of the technology constraints. In selected cases, however, high-technology companies will hire the services of your firm as their staff is already overloaded with existing projects. This sometimes means that the client knows the technology in great depth and will try to micro-manage the development process.

Your current project is for a large company that organizes projects by creating expert work teams of individuals drawn from throughout the organization. To select teams best suited for a specific project, management needs to have access to current employee profiles and skills information. You and your development team are charged to create a secure intranet site that allows each member of the organization to update and maintain their personal information while providing a common look, feel and structure to the overall site. Since the information is of a common structure, it makes sense to utilize a database to access and maintain the data. This further allows management to sort through a large number of profiles to select employees with specific skills.

After meeting with client management to define the requirements and the technology constraints, you start developing a proposal including scope of work, required resources, timeline and cost of service. You lead the discussion and negotiation sessions with the client to arrive at a proposal that satisfies all parties. The first task of your team is to work with the client organization's employees and managers assigned to your project to identify what information should be included and how it will be sorted and retrieved. Confidentiality and security issues are key concerns expressed by the employees. After requirements have been agreed upon, your team starts developing the structure for the database and the web site. Prototypes are created and tested with a group of selected employees and managers. Their feedback is analyzed and site and user interface designs are modified accordingly. After several reviews, and redesign and testing iterations, a final design is approved. Your team now moves on to production and implementation. Members of your team do most of the detailed technical work; you help by solving difficult technical problems as they arise. You also act as a gatekeeper in making sure that your creative web developers do not go overboard with jazzy features and technology. A large part of your role during the development phase is to track tasks, milestones and budgets, and report the project status on a regular basis to the management of both your firm and the client organization.

Expert Level

- Research and analyze relevant information.
- Lead the discussion process with the team.
- Develop a set of standards that is approved by every member of the team.
- Identify underlying issues and next steps for the project.
- Develop and deliver presentations to upper management.

Your expertise as a web developer has been recognized throughout the company. Over the years, you have shown to management that your decisions are reliable and based on solid data. Peers and managers enjoy working with you, as you are dependable and communicate effectively in a wide range of contexts. In many instances, colleagues come to you for advice or to brainstorm new concepts, and you are recognized internally as a mentor.

The style of your company has traditionally been very nonstructured and somewhat reluctant to use prescriptive standards. However, in the area of web development this lack of standards has undermined the company's ability to present a consistent image to their customers. A need for standardization of content, style and design and development procedures is becoming increasingly apparent. Management has decided to form a cross-functional, cross-departmental task force to study the issue and make recommendations. You have been asked to lead this effort as your knowledge of web practices throughout the company and your demonstrated ability to work with diverse teams will be extremely valuable.

The team is composed of managers, users and developers bringing to the table a wide range of perspectives and concerns. Your task is to gather information on current practices and on current and future requirements for web development and usage. Your facilitation and negotiation skills will be called upon many times throughout this process. You will be asked to sort through a lot of information—sometimes incomplete, often conflicting—and lead the team through a consensus process to a set of recommendations to be presented to upper management. This task is made even more challenging because of the increased use of intranet web pages by company departments. You must balance security and remote access needs of these "eyes-only" sites, with the need to provide free access to appropriate information to employees, vendors, customers and the public.

After several months of research, debate and development of possible solutions, your team creates a proposed set of standards and procedures that could be applied across the organization. You also have assessed the costs and benefits of implementing these standards so that upper management can make an informed decision. During the research phase, it became apparent that some of the groups felt strongly about their current way of developing web sites and were not readily open to changing. Your team realizes for the new web strategy to be successful a thorough implementation plan needs to be developed. You are now ready to go to upper management with your findings and recommendations. Your ability to summarize complex information into a comprehensive plan, clearly present relevant issues and answer difficult questions strongly impresses management. Your company's management approves your team proposal and you are placed in charge of developing the implementation plan for the new standards and leading the implementation effort.

"With technology constantly changing, you need to stay abreast and not only in your area of expertise. It's myopic if you are not keeping up in other areas as well."

A Web Site Administrator

Critical Work Function: Perform Content and Technical Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A1. Gather data to identify customer requirements	• Audience and mission of project/product are well defined. • Sources and methods for gathering requirements are affordable and relevant. • Information is accurate and complete. • Information gathering interviews follow appropriate company practices. • Sources of requirements are reliable and current. • Information is gathered continuously and cost-effectively.	• Knowledge of customer interview techniques regarding requirements. • Ability to identify key sources of information. • Knowledge of the subject matter.	• Ability to identify and prioritize the need for data. • Ability to pose critical questions. • Ability to analyze group/individual responses. • Ability to summarize information and requirements. • Ability to encourage cooperation.
A2. Research content	• Content is properly indexed and weighted by importance. • Content is mapped to customer requirements. • Missing content is completely identified. • All sources of information are identified and accessed. • Content is reviewed for relevance to the mission.	• Knowledge of indexing and weighting techniques. • Knowledge of mapping techniques. • Knowledge of sources for content. • Ability to relate content to mission.	• Ability to interpret communication and compare multiple viewpoints. • Ability to apply creative thinking to new situations. • Ability to examine task and technology relationship. • Ability to implement new technologies and applications. • Ability to visualize integrated media product. • Ability to select/obtain information relevant to the task and integrate multiple items of data.

Critical Work Function: Perform Content and Technical Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A3. Define scope of work	• Features and functions of the product are properly prioritized. • Project objectives are identified and agreed upon in accordance with company procedures. • Size and specifics of the work involved are identified accurately. • Criteria for successful completion of the work are identified. • Scope of work is documented in an accurate, complete and succinct form.	• Knowledge of the types of features and functions and their implementation. • Ability to define measurable criteria for completion of work. • Ability to identify key sources of information. • Ability to assess skill sets. • Ability to assess resources required for scope of work.	• Ability to create detailed supporting documents and summarize information and requirements. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to analyze information for accuracy and consistency. • Ability to compile multiple viewpoints. • Ability to visualize task sequentially and identify interdependencies. • Ability to negotiate success criteria.
A4. Prepare and present functional and technical specifications	• Functional and technical specifications are presented in a clear and concise manner. • Functional and technical specifications are complete and include functional and technical conclusions. • Functional and technical specifications are published and updated regularly. • Functional specifications detail all product features and activities. • Technical specifications fully and properly describe the operating system software and hardware, client side support and server side software.	• Knowledge of the role of functional and technical specifications and conclusions. • Ability to analyze functional and technical data and specifications. • Ability to translate features and activities into functional specifications. • Knowledge of the basics of operating system hardware, client side support and server side software. • Knowledge of methods and tools to present functional and technical specifications.	• Ability to summarize, integrate and analyze information. • Ability to present complex ideas and information. • Ability to apply rules and principles to process/procedure and use logic to draw conclusions. • Ability to interpret information, prepare basic summaries and select methods of communication.
A5. Develop and present concept alternatives	• An appropriate number of concepts are presented to all appropriate stakeholders. • Concepts incorporate the organization of information and look and feel as determined by stakeholders. • Conflicts among stakeholders are effectively resolved.	• Knowledge of concept development options and methodologies. • Ability to translate features and functions into look and feel. • Knowledge of various ways to structure content. • Knowledge of web technology. • Knowledge of web-safe palettes and colors. • Knowledge of graphic design and layout principles.	• Ability to demonstrate creative thinking while problem solving and apply creative solutions to new situations. • Ability to evaluate alternative solutions and formulate a plan of action. • Ability to present complex ideas and information. • Ability to summarize/paraphrase issues and resolve technical conflicts.

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Critical Work Function: Perform Content and Technical Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A6. Prepare preliminary application	• Content information is organized to meet application objectives. • Consensus is developed among all stakeholders regarding the organization of information. • Consensus is developed among all stakeholders regarding look and feel of the product. • Preliminary application follows company guidelines and practices.	• Ability to design content structure. • Knowledge of tools and techniques to create look and feel of an application/site. • Knowledge of site mapping and information mapping techniques. • Knowledge of graphical user interface design. • Knowledge of data modeling tools. • Knowledge of basic database management techniques. • Knowledge of basic programming techniques.	• Ability to analyze organization of information and transfer information between formats. • Ability to summarize/paraphrase issues and resolve technical conflicts. • Ability to summarize and interpret mathematical data. • Ability to convert numerical data and predict arithmetic results. • Ability to demonstrate creative thinking while problem solving and apply creative solutions to new situations.
A7. Create and refine preliminary design/ mockup	• Mockup is representative of all required design features. • Mockup is completed in a timely manner. • Mockup includes representative functional features. • Mockup is reviewed and refined based on customer feedback.	• Knowledge of mockup development options and methodologies. • Knowledge of mockup testing procedures. • Ability to synthesize information from different tests. • Ability to translate functional features into application/site design.	• Ability to analyze task/technology relationship. • Ability to consider risks/implications and compile multiple viewpoints. • Ability to generate/evaluate solutions and devise/implement plan of action. • Ability to recognize system strengths/ limitations. • Ability to demonstrate creative thinking while problem solving.
A8. Review technical considerations and constraints	• All technical environmental factors are considered. • All technological relationships are reviewed. • Technical considerations and constraints are properly documented. • Feasibility and usability issues are appropriately addressed. • Budget and equipment constraints are accurately assessed.	• Knowledge of technical environmental factors and technological relationships. • Knowledge of selected technologies and their limitations and constraints. • Ability to assess budget and equipment constraints.	• Ability to select/obtain data relevant to the task, integrate multiple items of data and contrast conflicting data. • Ability to apply rules and principles to process/procedure and use logic to draw conclusions. • Ability to examine information and recommend action plan. • Ability to willingly help others and establish rapport with coworkers and customers.

Critical Work Function: Perform Content and Technical Analysis

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
A9. Design site security measures	• All appropriate departments and personnel are consulted to gather security concerns. • Both internal and external security concerns are addressed. • Database integrity issues are completely addressed. • Access levels and priorities are properly set. • Information integrity is protected in accordance with company standards.	• Knowledge of roles of enterprise departments and personnel. • Knowledge of internal and external security concerns. • Ability to address database integrity issues. • Knowledge of access levels and priorities. • Knowledge of information integrity protection techniques.	• Ability to apply rules and principles to process/procedure and use logic to draw conclusions. • Ability to set well-defined, realistic goals and apply self-management skills. • Ability to work well with minimal supervision and pay attention to detail. • Ability to willingly help others and establish rapport with coworkers and customers. • Ability to recommend ethical course of action.
A10. Develop project plan	• Plan accurately identifies stakeholder requirements. • Plan includes project schedules and resource allocations, dependencies and milestones. • Plan includes functional and technical specifications, all data models, site maps, assumptions, constraints and risks. • Plan is accurately documented and updated throughout the project life cycle.	• Knowledge of risk analysis techniques. • Knowledge of project management tools. • Knowledge of basic computer systems, programming, database and web technologies. • Knowledge of functional and technical specifications, all data models, site maps, assumptions, constraints and risks.	• Ability to analyze organization of information. • Ability to summarize/integrate information. • Ability to work with minimal supervision and pay attention to detail. • Ability to prepare and organize multiple schedules. • Ability to assess individual knowledge/ skills and analyze work assignments.

Critical Work Function: Develop Web Applications/Sites

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B1. Develop site map and application models	• Site map and application models are developed to meet project goals and application objectives. • Site map and application models are developed according to company standards and practices. • Consensus is developed among all stakeholders regarding the organization of information. • Consensus is developed among all stakeholders regarding look and feel of the product.	• Ability to design content structure. • Knowledge of tools and techniques to create look and feel of an application/site. • Knowledge of site mapping and information mapping techniques. • Knowledge of graphical user interface design. • Knowledge of data modeling tools. • Knowledge of basic database management techniques. • Knowledge of basic programming techniques.	• Ability to analyze organization of information and transfer information between formats. • Ability to summarize/paraphrase issues and resolve technical conflicts. • Ability to demonstrate creative thinking process while problem solving and apply creative solutions to new situations.
B2. Select design tools and programming language	• Tools and languages are selected based on functional requirements and technical specifications. • Third-party applications are properly assessed and evaluated for applicability. • Tools and language meet ease-of-use requirements.	• Knowledge of design tools and tradeoffs. • Knowledge of company tool selection procedures. • Knowledge of third-party applications. • Ability to locate information on tools, languages and third-party applications. • Knowledge of programming languages and databases.	• Ability to evaluate options and make decisions. • Ability to project timeline and budget requirements. • Ability to integrate multiple items of data and reconcile conflicting information. • Ability to develop creative solutions and demonstrate resourcefulness. • Ability to predict outcomes and results of selection of tools.

Critical Work Function: Develop Web Applications/Sites

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B3. Produce graphics and layout elements	• Graphical user interface meets technical specifications. • Information is presented clearly and in the context of how users interact with the system. • Process to access information is simple and logical. • Artistic elements are aesthetically pleasing. • Graphics meet customer requirements and company standards. • Sources of graphic images are researched and make-or-buy decisions are made appropriately.	• Knowledge of various graphical applications and sources of graphic images. • Knowledge of principles of layout and graphics. • Ability to design user-friendly sites and applications. • Knowledge of company requirements and standards. • Knowledge of make-or-buy considerations and decision-making process. • Ability to develop aesthetically pleasing elements.	• Ability to mentally picture outcomes. • Ability to think creatively while solving problems. • Ability to judge effectiveness of graphics, animation, audio and video content. • Ability to judge content and form and reconcile to overall project image. • Ability to compile multiple viewpoints and formulate plan of action. • Ability to generate and evaluate alternative solutions.
B4. Create or adapt content	• Content sources are thoroughly researched. • Subject matter experts are consulted where applicable. • Drafts are produced in a timely manner. • Content is reviewed in accordance with company procedures. • Content meets customer requirements. • Content is clear, concise, consistent and grammatically correct.	• Knowledge of sources for content. • Knowledge of company procedures for content review. • Knowledge of interview techniques for subject matter experts regarding content. • Knowledge of information mapping techniques. • Knowledge of web technology and its capabilities.	• Ability to create original documents and synthesize information. • Ability to follow policies/procedures and work with minimal supervision. • Ability to interpret and clarify communication. • Ability to paraphrase, summarize and generalize existing ideas and demonstrate creative thinking process while problem solving. • Ability to prioritize daily tasks and monitor/adjust task sequences.

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Critical Work Function: Develop Web Applications/Sites

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B5. Write supporting code	• Code meets project objectives and functional specifications. • Code is designed so the application performs efficiently. • Code is properly documented to ensure maintainability.	• Knowledge of code development procedures. • Knowledge of programming language required for application. • Knowledge of reusable component programming process. • Knowledge of code documentation process. • Ability to evaluate alternatives in code implementation and make decisions. • Ability to develop code that meets coding standards.	• Ability to write clear documents. • Ability to generate and evaluate alternative solutions and formulate a plan of action. • Ability to apply rules/principles to process/procedure and use logic to draw conclusions. • Ability to manipulate technology for desired results. • Ability to understand system organization/hierarchy. • Ability to demonstrate honesty and trustworthiness.
B6. Develop supporting databases	• Links between web application and associated databases are properly established. • Fundamental database concepts are followed.	• Knowledge of database design concepts. • Knowledge of relational database management systems. • Knowledge of connectivity software for database and web.	• Ability to apply rules and principles to process/procedure and use logic to draw conclusions. • Ability to examine information/data, analyze possible causes/reasons and recommend action plan. • Ability to analyze customer needs and demonstrate commitment to customer. • Ability to analyze system configuration/stability and recognize system strengths/limitations. • Ability to analyze technology output and examine task/technology relationship.

Critical Work Function: Develop Web Applications/Sites

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
B7. Perform unit and integration testing	• Testing plan is developed in collaboration with all appropriate members of project team. • Test scripts accurately test the functions the module is designed to perform. • Tests validate product performance within specifications and assess the efficiency of the code. • Units are tested using standard and appropriate testing procedures. • Testing on each unit is repeated until the unit is free of errors. • Errors are correctly analyzed and resolved. • Errors and solutions are documented in a complete and concise form.	• Knowledge of unit testing procedures. • Knowledge of regression testing techniques. • Knowledge of error analysis and resolution processes. • Ability to develop test scripts. • Knowledge of documentation procedures for errors and code modifications.	• Ability to analyze system configuration/ stability. • Ability to recognize system strengths/ limitations. • Ability to use logic to draw conclusions. • Ability to analyze possible causes/reasons. • Ability to recommend action plan. • Ability to identify and correct and troubleshoot malfunctions/failures.

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Critical Work Function: Implement Application/Site Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C1. Develop and implement usability testing	• Individuals from user community are given opportunities to interact with product. • User reactions to the product are accurately documented. • Where applicable, users are observed while using product. • Information from usability testing is clearly conveyed to development team. • Modifications are made to product based on usability test results.	• Knowledge of client support capabilities. • Knowledge of test procedures for usability. • Knowledge of application environment and user requirements. • Knowledge of user level of expertise. • Ability to translate usability issues into application/site modifications. • Knowledge of error analysis and resolution processes.	• Ability to understand system organization/ hierarchy. • Ability to follow processes/procedures. • Ability to analyze technology output. • Ability to examine task/technology relationship. • Ability to appropriately refer complaint/ discrepancy. • Ability to identify and evaluate system performance.
C2. Plan and coordinate customer acceptance testing	• Performance criteria and procedures are validated to ensure they meet customer requirements. • Load testing is properly performed to ensure performance meets customer requirements. • Test procedure is prepared and documented for user. • System performance is tested according to plan and schedule. • Test results are documented in a complete form. • Issues and recommendations are communicated to design team.	• Knowledge of load testing techniques. • Knowledge of test procedures for customer acceptance. • Knowledge of application environment and user requirements. • Knowledge of user level of expertise.	• Ability to summarize and interpret mathematical data. • Ability to accept constructive criticism, apply self-management skills and analyze and adjust goals. • Ability to present complex ideas and information and analyze group/individual response. • Ability to summarize, integrate and analyze information.

Critical Work Function: Implement Application/Site Design

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
C3. Plan rollout	• Rollout plans are communicated to stakeholders in a timely manner. • Final reviews and approvals are conducted according to company standards. • Resources for a successful rollout are clearly identified. • Rollout is planned to meet overall project goals and timelines. • Contingency plans are outlined. • Support staff training needs are identified and accommodated within the plan.	• Knowledge of customer and company communication requirements. • Knowledge of review and approval practices and procedures. • Knowledge of support staff training needs and requirements.	• Ability to analyze technology output and examine task/technology relationship. • Ability to apply rules and principles to process/procedure and use logic to draw conclusions. • Ability to suggest and examine system modifications/improvements. • Ability to willingly help others and establish rapport with coworkers and customers. • Ability to identify and project resource needs.
C4. Facilitate move to production system	• Product is release-tested in the production environment. • Support staff is properly trained to respond to customer calls. • The application is moved from the development server to the production environment.	• Knowledge of release test procedures. • Knowledge of support staff training requirements and techniques. • Ability to move application from development server to production environment.	• Ability to identify training needs and conduct task-specific training. • Ability to apply rules and principles to process/procedure and use logic to draw conclusions. • Ability to suggest and examine system modifications/improvements. • Ability to accept responsibility for own actions and accept feedback.
C5. Hand off to customer/user	• Documentation is completed and updated. • Application meets customer/user requirements. • Application is fully functional for the customer/user. • Appropriate final approvals and signatures are secured. • User support and training materials are finalized and delivered. • Procedures for gathering user feedback are put into place.	• Knowledge of company documentation procedures and standards. • Knowledge of user support and training needs. • Knowledge of organizational practices for securing final approvals and signatures. • Knowledge of instructional design principles.	• Ability to identify training needs and provide appropriate support materials. • Ability to organize and present technical information. • Ability to gather and analyze customer/user feedback. • Ability to willingly help others and establish rapport with coworkers and customers.

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Critical Work Function: Maintain Applications

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D1. Update content	• Site/application is tested after content is updated to ensure integrity. • Updates are performed in a timely manner. • Updates are performed in accordance with application requirements. • Content is updated only on appropriate pages. • Updated content is accurate. • Links are reviewed and updated.	• Knowledge of link checking tools. • Ability to fix broken links and eliminate orphaned images. • Knowledge of work flow. • Knowledge of application requirements.	• Ability to follow rules/policies/procedures and work with minimal supervision. • Ability to efficiently manage time and prioritize daily tasks. • Ability to follow specified maintenance procedures and correct malfunctions/ failures. • Ability to identify and recommend system modifications/improvements. • Ability to set well defined, realistic goals and apply self-management skills.
D2. Integrate customer feedback	• Customer feedback is gathered on a continuous basis. • Feedback is organized, analyzed, prioritized and acted upon. • Changes are clearly and thoroughly documented. • Customers are kept informed of application changes and updates.	• Knowledge of data gathering techniques. • Knowledge of practices of internal, external and global customers. • Knowledge of the application or server being supported. • Knowledge of user level of expertise.	• Ability to accept responsibility for own actions and impact on others. • Ability to demonstrate commitment to personal/social improvement. • Ability to be flexible and cooperative. • Ability to recognize and analyze customer needs and resolve conflicts. • Ability to resolve technical issues and obtain customer approval.
D3. Perform application maintenance	• Problems are properly identified and resolved in a timely manner. • Application is modified to correct errors. • Enhancements to application are made effectively. • Internal, external and global customer expectations are met in a timely manner. • Problems are correctly identified and referred to appropriate personnel in a timely manner.	• Knowledge of support boundaries. • Knowledge of code development and issue resolution procedures. • Ability to evaluate alternatives and make decisions in code implementation. • Knowledge of programming techniques and database management systems.	• Ability to devise/implement plan of action. • Ability to visually analyze relationship between parts/whole, process/procedure. • Ability to identify the problem, analyze possible causes and recommend action plan. • Ability to understand the requirements of the task and propose technological solutions. • Ability to perform specified maintenance, identify problems and correct malfunctions/failures.

Critical Work Function: Maintain Applications

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
D4. Recommend application/site improvements	• Customer input and feedback are gathered and documented based on use. • Feedback and input are evaluated for feasibility. • Recommendations on site improvements are developed with associated budget considerations. • Recommendations are made to appropriate stakeholders in accordance with company procedures. • Risk assessments are appropriately considered.	• Knowledge of risk assessment analysis techniques. • Knowledge of business plan and strategic goals. • Ability to perform feasibility evaluations. • Knowledge of budget considerations and evaluation techniques.	• Ability to implement technological improvements and generate technological solutions. • Ability to analyze operational problems. • Ability to develop new/alternative system designs. • Ability to compose well-organized presentations and debate issues. • Ability to develop formal and informal relationships with leaders in the enterprise.
D5. Document application/ site changes	• Changes are completely and accurately documented. • Change documentation is distributed in a timely manner to appropriate personnel and/or departments. • Documentation procedures and standards are followed.	• Knowledge of change documentation and its importance. • Knowledge of change documentation procedures and standards.	• Ability to create detailed supporting documents. • Ability to select/obtain data relevant to the task, integrate multiple data items and contrast conflicting data. • Ability to set realistic goals and apply self-management skills. • Ability to follow rules and policies and work with minimal supervision. • Ability to efficiently manage time.

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Critical Work Function: Manage Web Environment

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
E1. Evaluate and recommend web hardware, software and third-party solutions	• All relevant sources are completely reviewed. • Evaluation criteria are thoroughly developed. • Evaluation criteria are prioritized and agreed to by customer. • Recommendations meet company and customer requirements. • Evaluation and recommendation processes are completed in accordance with company procedures and guidelines. • Recommendations are communicated appropriately. • Risk assessments are appropriately considered.	• Knowledge of risk assessment methods. • Knowledge of sources of information regarding web server hardware, software and third-party solutions. • Knowledge of company web objectives. • Knowledge of and ability to use programming tools, web server software and content management software. • Knowledge of and ability to use search engines, web server statistics packages and authoring tools. • Knowledge of and ability to use digital commerce applications and data conversion tools. • Knowledge of application of evaluation criteria.	• Ability to evaluate effectiveness of solutions for customer and forecast future customer needs. • Ability to adapt principles to new applications and judge logical consistency. • Ability to stay current on cutting edge technologies and processes. • Ability to implement technological improvements and generate technological solutions. • Ability to compose well-organized presentations and debate issues. • Ability to analyze, interpret, summarize and integrate data/information.
E2. Set up server software and hardware	• Software and hardware are properly installed and configured. • Directory structure is logical and includes security requirements. • Directory file names adhere to naming conventions. • Server is properly configured for security. • Third-party software/extensions are properly loaded and tested. • Installation plan includes input from customers and is designed for minimal impact on process flow and productivity.	• Knowledge of the impact of the installation plan on whole system. • Ability to use technical documentation. • Knowledge of practices of internal, external and global customers. • Knowledge of installation obstacles and procedures to resolve them. • Knowledge of directory structures and naming conventions. • Ability to load and test third-party software/ extensions.	• Ability to predict outcomes/results based on experience or prior knowledge. • Ability to implement plan of action. • Ability to present complex ideas and information. • Ability to integrate system technology and follow proper procedures. • Ability to respond appropriately to others.

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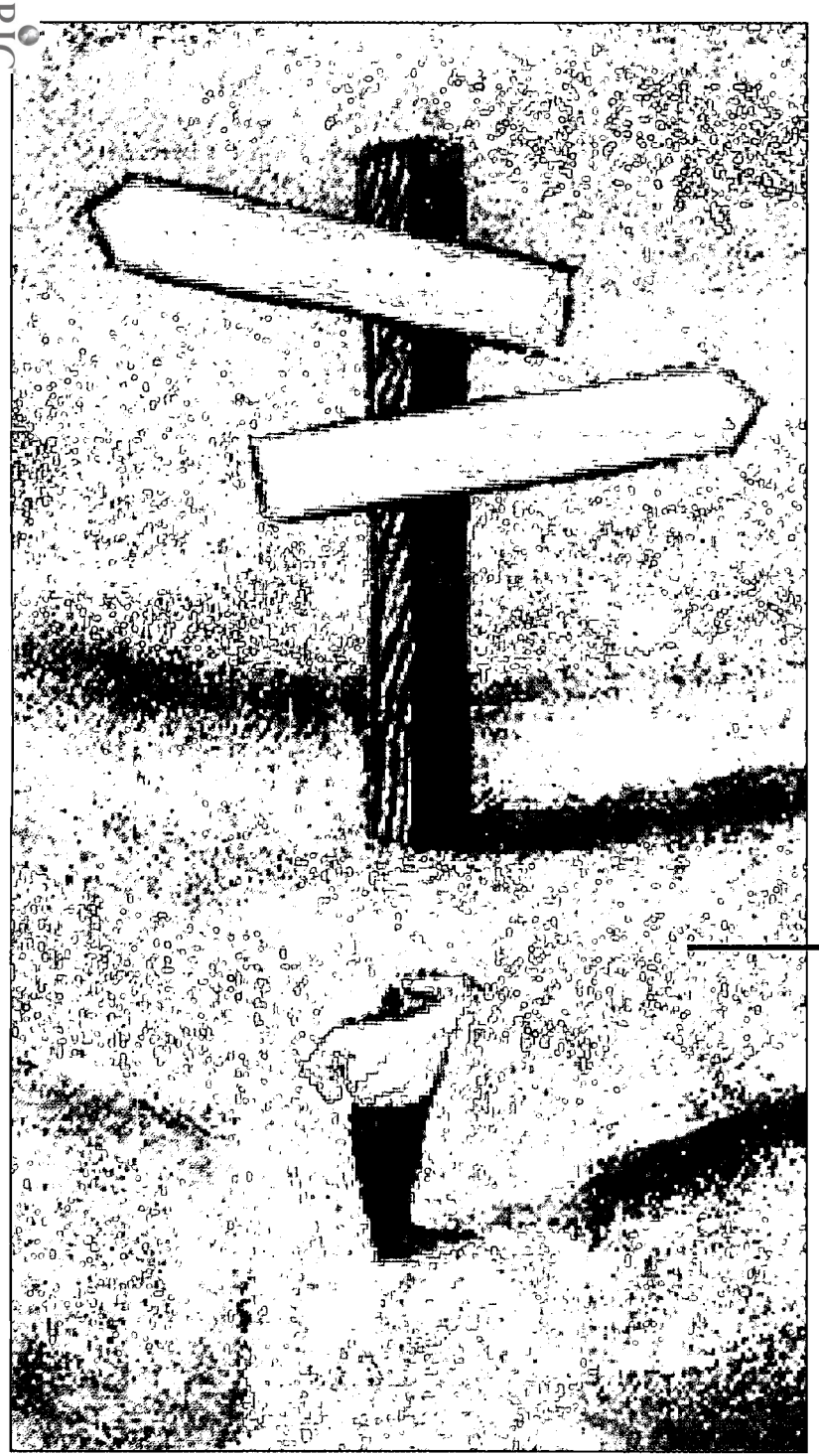
E3. Manage server	• Performance problems are identified and resolved in a timely manner. • User data input issues are properly managed. • Server activity is properly monitored, analyzed and communicated in accordance with company guidelines. • Upgrades and patches are effectively implemented when appropriate. • System down time is minimized.	• Ability to use system administration tools. • Ability to analyze hardware and software problems. • Ability to tune the server to maximum performance. • Knowledge of resources available to resolve defects. • Knowledge of system error resolution procedures. • Knowledge of user data input conventions. • Knowledge of monitoring procedures and ability to design and generate reports.	• Ability to identify and prioritize the need for data. • Ability to organize and analyze information. • Ability to apply rules and principles to diagnostics and use logic to draw conclusions. • Knowledge of monitor system performance and analyze system operation. • Ability to create detailed supporting documents. • Ability to use word processing and spreadsheet software. • Knowledge of systems performance monitoring tools.
E4. Support disaster recovery	• Backups and restores are properly performed and escalation procedures are followed. • Criticality of applications is properly determined. • Restore times meet company requirements and backup schedules are defined to meet application requirements. • Problems are assessed for criticality and reported to relevant personnel in a timely manner. • Backup and recovery plans are identified and agreed upon by technical support group and user. • Backup and recovery plans are documented completely and accurately. • Unforeseen outages and data loss are effectively resolved.	• Knowledge of backup/recovery procedures and their planning and implementation processes. • Ability to identify user needs in terms of backup and recovery. • Knowledge of operating systems. • Ability to project resources required to implement backup and recovery plans. • Knowledge of system operations.	• Ability to analyze information/data and recommend action plan. • Ability to identify system problems and evaluate for criticality. • Ability to apply rules and principles to process/procedure and use logic to draw conclusions. • Ability to follow specified maintenance, evaluate performance of technology and analyze failures. • Ability to respond appropriately to others and demonstrate empathy for their concerns. • Ability to adhere to standards and lead by example.

Critical Work Function: Manage Enterprise-wide Web Activities

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
F1. Define and manage development standards	• Style guides are written to meet enterprise objectives. • Coding standards are written to meet enterprise objectives. • Standards are followed in accordance with company policies.	• Knowledge of style guides and coding standards. • Knowledge of company policies regarding standards. • Knowledge of server and client side capabilities and limitations. • Knowledge of user characteristics and practices. • Knowledge of company usage standards and branding.	• Ability to create detailed supporting documents and write clearly and succinctly. • Ability to adhere to standards and encourage others to adopt new concepts. • Ability to follow rules/policies and procedures. • Ability to recognize ethical issues and recommend appropriate course of action.
F2. Train designers and developers	• Training plan is developed for designers and developers. • Designer and developer requirements for training are correctly identified, interpreted and evaluated. • Resources are accurately and completely identified. • Training, resource and evaluation requirements are documented. • Content contains the appropriate amount of information and is consistent with learning objectives. • Training is effectively presented and clearly communicates information in a logical flow. • Effectiveness of training is properly evaluated to determine how well customer expectations were met.	• Knowledge of information gathering methods and company procedures and processes. • Knowledge of instructional design principles. • Knowledge of available resources and ability to plan according to needs and constraints. • Knowledge of required technical information and ability to organize technical material for ease of learning. • Knowledge of online resources.	• Ability to visualize task sequentially and identify interdependencies. • Ability to create detailed supporting documents. • Ability to speak clearly and present well-organized presentations. • Ability to analyze and manipulate learning tools, and formulate and adapt learning strategies. • Ability to summarize, analyze and integrate information. • Ability to create and deliver multimedia presentations. • Ability to identify training needs and conduct task-specific training.

Critical Work Function: Manage Enterprise-wide Web Activities

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
F3. Evaluate web technologies and standards	• Appropriate information sources for off-the-shelf applications, tools and resources are considered. • Alternative technologies are evaluated against customer requirements. • Research is conducted regarding technologies and standards. • Make-or-buy decisions are made in collaboration with appropriate personnel/ departments. • New technologies and standards are communicated to appropriate personnel effectively in a timely manner. • Consultation with management/personnel is provided as requested and in accordance with company mission and goals. • Security issues are effectively addressed.	• Knowledge of sources of information for emerging and current technologies. • Knowledge of customer requirements. • Knowledge of new and emerging tools and technologies, programming languages, distributed computing and computing platforms. • Knowledge of security issues and protocols.	• Ability to research additional information sources and create data gathering processes. • Ability to analyze operational problems, evaluate computer utilization and judge information accuracy. • Ability to evaluate effectiveness of solutions for customer and forecast future customer needs. • Ability to adapt principles to new applications. • Ability to stay current on cutting edge technologies and processes.
F4. Provide quality customer service	• Relationships are managed so that customers are satisfied with current level of service. • Internal, external and global customer expectations are met in a timely manner. • Problems are correctly identified and referred to appropriate personnel in a timely manner.	• Knowledge of escalation procedures. • Knowledge of support boundaries. • Knowledge of operating environments, office suite applications, networks, hardware tools and online resources. • Knowledge of practices of internal, external and global customers.	• Ability to analyze customer needs and demonstrate commitment to customers. • Ability to resolve conflicts to customer satisfaction. • Ability to identify the problem, analyze possible causes and recommend action plan. • Ability to recognize differences/biases and respect the rights of others. • Ability to accept constructive criticism and accept responsibility for own actions.



APPENDICES

Appendices

Project Management, Task Management and Problem-Solving/Troubleshooting

The following functions and tasks are reproduced from Version 1 of *Building a Foundation for Tomorrow: Skill Standards for Information Technology*. These elements represent core skill areas and may be applied to all career clusters.

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
1. Define scope of project	• The project's contribution to overall business needs is explicit. • Criteria for satisfying customer needs are identified. • The size and the specifics of the project are documented accurately and completely. • Applicable standards, regulations, and laws are identified.	• Ability to use appropriate project management planning tools. • Ability to create project scenarios. • Knowledge of applicable standards, regulations, and laws.	• Ability to analyze situation and formulate plan of action. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to visually analyze relationship between parts/whole and integrate processes.
2. Identify stakeholders, decision-makers and escalation procedures	• Appropriate people are identified in a timely manner. • Escalation procedures are clearly identified and agreed upon.	• Knowledge of company policy and procedures. • Knowledge of system's hierarchy.	• Ability to consider risks and implications. • Ability to use logic to draw conclusions from available information. • Ability to demonstrate sensitivity to stakeholder's concerns and interests.
3. Develop detailed task list (work breakdown structures)	• The size and specifics of the project are identified and documented. • Each task is sized appropriately. • Environment is documented accurately and completely.	• Ability to use appropriate project management planning tools. • Knowledge of work processes.	• Ability to formulate plan of action. • Ability to create comprehensive model. • Ability to identify important aspects of the situation.
4. Estimate time requirements	• Time requirements are realistic. • Time estimates accommodate the management approved level. • Contingency plans are included in the time estimates.	• Ability to create project scenarios. • Ability to visualize project time requirements at the task level. • Knowledge of spreadsheet and project management software.	• Ability to analyze situation and formulate a schedule. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to visually analyze relationship between parts/whole and integrate processes.

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5. Develop initial project management flow chart	• Activities contingent on other activities are sequenced appropriately. • Approval points, milestones, and go/no go decision points are defined to allow for project review, evaluation, postponement, and cancellation. • Tasks requiring long lead times are identified to avoid project delays. • Task priorities are assigned.	• Ability to use appropriate project management flow charting tools. • Ability to create project scenarios. • Ability to visualize tasks sequentially. • Knowledge of spreadsheet and project management software.	• Ability to analyze situation and formulate a plan of action. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to visually analyze relationship between parts/whole and integrate processes.
6. Identify required resources and budget	• Resource and budget estimates are supported with data. • Rationale for recommending specific resources is defined. • Recommendations are thoroughly documented.	• Ability to project resource and budgetary needs. • Ability to visualize project resource requirements at the task level. • Knowledge of company operating procedures regarding resource allocations. • Knowledge of spreadsheet software.	• Ability to analyze situations and forecast conclusions regarding resource needs. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to create detailed supporting documents.
7. Evaluate project requirements	• Conflicting or overlapping requirements are identified. • Evaluation includes feedback from key customers, management and peers. • Evaluation is well documented.	• Ability to non-defensively critique project plan. • Knowledge of company operating procedures regarding project plan evaluations. • Knowledge of spreadsheet and project management software.	• Ability to request feedback, both written and oral. • Ability to judge project effectiveness/ efficiency. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to create detailed supporting documents.
8. Identify and evaluate risks	• Risk identification is complete and considers impact on whole system. • Risk evaluation includes feedback from key customers, management and peers. • Risks are well documented.	• Ability to project potential risk scenarios. • Ability to non-defensively evaluate risks. • Knowledge of potential impact on whole system. • Knowledge of word processing software.	• Ability to determine system components to be modified or improved. • Ability to predict potential risks based on experience or prior knowledge. • Ability to create detailed supporting documents. • Ability to compare multiple viewpoints.

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9. Prepare contingency plan	• Alternative ways to accomplish the goals are identified. • Limitations and tradeoffs are explicit. • Attention is directed to areas of concern and risk. • Contingency plan is well documented.	• Ability to create alternatives. • Ability to forecast potential pitfalls. • Knowledge of potential impact on whole system. • Knowledge of word processing, spreadsheet and project management software.	• Ability to pose critical questions. • Ability to identify contingencies based on experience or prior knowledge. • Ability to create detailed supporting documents.
10. Identify interdependencies	• Interdependencies are completely and accurately identified. • Appropriate information is gathered from other parts of the system. • Interdependencies are clearly documented and communicated to those impacted by the project.	• Ability to see the "big picture". • Ability to diagram or document interdependencies. • Knowledge of potential impact on whole system. • Knowledge of word processing and project management software.	• Ability to identify interdependencies based on experience or prior knowledge. • Ability to evaluate information for accuracy. • Ability to integrate multiple items of data and reconcile conflicting information.
11. Identify and track critical milestones	• Milestones and schedules are clearly understood and communicated. • Appropriate information is gathered from other parts of the system. • Milestones are adjusted appropriately. • Documentation provides comprehensive and understandable information.	• Ability to use appropriate tracking and milestone tools. • Ability to evaluate project progress. • Knowledge of potential impact on whole system. • Ability and willingness to adjust plans and milestones to changing priorities or customer requirements. • Knowledge of word processing, spreadsheet and project management software.	• Ability to formulate and organize processes. • Ability to identify milestones based on experience or prior knowledge. • Ability to evaluate information for accuracy.
12. Participate in project phase review	• Project reviews are timely and include the appropriate team members. • Appropriate information is gathered from other parts of the system. • Review is complete and follows operating procedures.	• Ability to participate in a group review process. • Ability to evaluate project progress. • Knowledge of potential impact on whole system.	• Ability to examine information for relevance and accuracy. • Ability to actively participate based on experience or prior knowledge. • Ability to interpret and clarify communication.

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13. Secure needed resources	• The use of the resources is optimized. • Resources are obtained so that tasks and activities occur as planned. • People, equipment, supplies, and services are available when needed. • The need for substitutions is identified and arranged.	• Ability to request resources, both written and oral. • Knowledge of company operating procedures regarding resource availability. • Knowledge of industry standards and constraints. • Knowledge of word processing and spreadsheet software.	• Ability to integrate systems technology resources. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to create detailed supporting documents.
14. Manage the change control process	• Necessary changes are identified and evaluated. • Appropriate information is gathered from other parts of the system. • The impact of the change is factored into project schedule and budget. • Appropriate parties are notified of the impact of the changes. • Changes are contemplated and approved in a timely manner. • Required changes are documented and implemented.	• Ability to evaluate impact of changes on project plan. • Knowledge of the standard operating procedures regarding project changes. • Knowledge of potential impact on whole system. • Knowledge of word processing, spreadsheet and project management software.	• Ability to examine changes for relevancy and appropriateness. • Ability to actively participate based on experience or prior knowledge. • Ability to interpret and clarify communication. • Ability to adapt to changes.
15. Report project status	• Project outcomes are evaluated against project goals. • Complete project phase results are documented and clearly communicated. • Lessons learned are clearly documented and communicated. • Performance metrics associated with the process are captured and documented. • Significant problems are immediately reported. • The style and format of the project status document conforms to company requirements.	• Ability to evaluate project status and outcomes non-defensively. • Knowledge of the standard operating procedures regarding project reviews. • Knowledge of the potential impact on whole system. • Knowledge of word processing, spreadsheet and project management software.	• Ability to accept responsibility for own outcomes. • Ability to actively participate based on experience or prior knowledge. • Ability to interpret and clarify communication. • Ability to present information in a clear, concise and objective manner.

TASK MANAGEMENT

KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
1. Define scope of work to achieve individual and group goals	• The task's contribution to overall business needs is explicit. • The size and the specifics of the task are identified accurately. • Criteria for successful completion of the tasks are identified. • Multiple tasks are planned simultaneously. • Potential problems are identified and contingency plans developed.	• Ability to visualize project time requirements at the task level. • Ability to use appropriate time management methods. • Knowledge of applicable standards, regulations, and laws.	• Ability to analyze situation and formulate a task sequence. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to visually analyze relationship between parts/whole and integrate processes.
2. Develop time and activity plan to achieve objectives	• Plan is coordinated with team, cross-functional groups, or individuals. • Plan changes are communicated promptly to all those affected. • Tasks are prioritized according to business needs. • Multiple tasks are managed simultaneously. • Contingency plan is developed.	• Ability to visualize project time requirements at the task level. • Ability to use appropriate time and resource management methods. • Knowledge of system procedures and constraints. • Knowledge of word processing and spreadsheet software.	• Ability to analyze situation and formulate a task strategy. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to visually analyze relationship between parts/whole and integrate processes. • Ability to devise and implement plan of action.
3. Design and develop work processes and procedures	• Work processes or procedures reflect customer needs and cost specifications. • Work processes or procedures are developed on time. • Work processes or procedures are documented clearly and concisely. • Work processes or procedures reflect potential risks and dependencies.	• Ability to design and develop work flow. • Ability to identify impacts on work processes. • Ability to see the "whole picture." • Knowledge of standard company work processes and procedures. • Knowledge of word processing and spreadsheet software.	• Ability to analyze situation and create work plan. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to analyze work assignments. • Ability to document work processes.

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KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
4. Identify and obtain tools and resources to do the job	• Necessary supplies and tools are available when needed. • Budget guidelines for tools and resources are followed. • Documentation for use and maintenance of hardware and software is secured, current and accessible. • Material request procedures are followed.	• Ability to forecast tools and resources. • Ability to access needed tools and resources. • Knowledge of material request procedures. • Ability to analyze cost and benefit of various tools and resources. • Knowledge of word processing and spreadsheet software.	• Ability to analyze situation and create a list of required tools and resources. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to coordinate acquisition, storage and distribution of software and hardware.
5. Coordinate and implement work processes and procedures	• All affected parties are informed and updated. • Implementation is in accord with all relevant policies and procedures. • Implementation conforms to business decision processes. • Implementation is completed within established time frame. • Technical issues are resolved.	• Ability to coordinate with others to meet deadlines. • Knowledge of task-related work processes and procedures. • Knowledge of business decision processes. • Knowledge of word processing and e-mail software.	• Ability to stay focused on desired outcomes. • Ability to actively participate in team tasks. • Ability to implement process plan. • Ability to resolve and negotiate issues with others.
6. Monitor, analyze, and evaluate work processes and procedures	• Appropriate monitoring and evaluation systems are utilized. • Processes and procedures are reviewed by appropriate customers and manager. • Recommendations for improvements in process and procedures are made to customers and management on a continuous basis.	• Ability to use standard monitoring and evaluation systems. • Ability to schedule process reviews following company standard practices. • Knowledge of word processing software.	• Ability to determine quality and quantity of workload. • Ability to continually improve processes. • Ability to assess individual development and improvement needs. • Ability to monitor efficient and effective utilization of materials and tools.
7. Generate and maintain task status report	• Documentation/information is accurate, clear, and concise. • Document/information is available on time. • The style and format of the documentation conforms to customer and management requirements. • Information/documents are stored in a timely manner. • Storage systems are easily accessible.	• Ability to evaluate task outcomes non-defensively. • Knowledge of documentation requirements of customer and management. • Knowledge of document storage and retrieval tools. • Knowledge of word processing software.	• Ability to accept responsibility for own outcomes. • Ability to make process improvements based on report outcomes. • Ability to evaluate relevance of data needed in report. • Ability to create concise report.

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1. Define the problem	• The problem definition is oriented and focused toward facts and data. • The existing human and system resources are used effectively to determine the problem. • The problem definition defines a gap in expectations. • Symptoms and background of the problem are identified. • Problem definition is documented clearly and concisely.	• Knowledge of system norms and operations. • Knowledge of problem isolation tools and procedures. • Ability to document abnormal events in detail.	• Ability to summarize/generalize information. • Ability to understand system discrepancies. • Ability to examine information/data for relevance and accuracy. • Ability to distinguish between problem symptoms and causes. • Ability to clarify and frame problems.
2. Perform appropriate analysis to identify problem cause	• Determine appropriate analysis technique. • Analysis is complete and documented. • Cause(s) of the problem and ramifications are identified and documented. • Scope of impacts are identified and documented.	• Ability to create and test a theory. • Ability to perform causal analysis. • Ability to identify the impact of the problem on the whole system. • Ability to break down the problem.	• Ability to think creatively while analyzing problem. • Ability to apply appropriate principles/ laws/theories to situation. • Ability to analyze information and identify interdependencies.
3. Identify/test possible solutions	• Solutions reflect concern for cost, schedule, and long-term implications. • Measured criteria for evaluation is established. • Tests are in compliance with legal requirements, company policy, operating procedure and customer specifications. • The appropriate solution is identified and the appropriate action is determined (escalate, fix, or resolve).	• Ability to develop experiments to test a theory. • Ability to develop and test alternative solutions (fix the fix). • Knowledge of company operating procedures regarding testing procedures.	• Ability to apply reasoning skills to identifying potential solutions. • Ability to research additional sources of information. • Ability to generate/evaluate solutions with others. • Ability to assess the feasibility and relevance of a solution.

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KEY ACTIVITY	PERFORMANCE INDICATORS *How do we know when the key activity is performed well?*	TECHNICAL KNOWLEDGE *Skills, Abilities, Tools*	EMPLOYABILITY SKILLS *SCANS Skills and Foundation Abilities*
4. Develop resolution plan	• Resolution plan is developed, documented and accepted by all impacted parties. • Resolution plan is designed for minimal impact of process flow and productivity. • Resolution plan includes appropriate input from customer, key individuals, departments, and outside providers. • Contingency plans are developed and made available. • Internal and external obstacles are identified and potential resolutions are identified and documented.	• Ability to facilitate solution selection. • Ability to organize and manage complex processes. • Knowledge of the impact of solutions on whole system.	• Ability to analyze system configuration. • Ability to gather data, analyze, and reach decisions and agreements. • Ability to resolve technical issues. • Ability to propose options/solutions based on research.
5. Implement solution	• Resolution plan is implemented in an efficient and timely manner. • Any changes to the plan are communicated promptly to key individuals. • Appropriate change requests are completed according to company requirements. • Solution to the problem (including operational adjustments) is documented and communicated to appropriate individuals and groups. • Problem solution is written into knowledge base and/or communicated appropriately.	• Ability to assess resolution plan on a continuous basis. • Knowledge of company change management procedures. • Ability to deal with implementation obstacles.	• Ability to organize new processes/ procedures. • Ability to predict outcomes/results based on experience or prior knowledge. • Ability to implement plan of action. • Ability to write and edit technical documents. • Ability to communicate with a variety of audiences.
6. Evaluate problem solving processes and outcomes	• Evaluation determines whether the outcomes solved the problem in accord with what was intended (and did not cause any unintended or unexpected results). • Evaluation determines whether the process was used efficiently and responsibly. • The validity and usefulness of the outcomes is assessed. • Any appropriate follow-up action is determined.	• Ability to evaluate technical solutions. • Knowledge of company procedures for follow-up actions.	• Ability to summarize/generalize information. • Ability to compare multiple viewpoints. • Ability to analyze information and identify interdependencies. • Ability to evaluate problem solving processes and suggest continuous improvement.

Bibliography

Bailey, T. and Merritt, D. (1995). *Making Sense of Industry-Based Skill Standards*. Berkeley: National Center for Research in Vocational Education.

Barnett, L. and Mahoney, J., ed. (1998). *Developing Technicians: Successful International Systems*. Washington, DC: The Community College Press.

Blank, W. (1982). *Handbook for Developing Competency-Based Training Programs*. Englewood Cliffs, NJ: Prentice Hall.

Bloom, B. (1956). *Taxonomy of Educational Objectives*. New York: David McKay Co.

Bridges, W. (1993). *Job Shift*. Reading, MA: Addison-Wesley.

Brooks, J. and Brooks, M. (1993). *In Search of Understanding: The Case for Constructivist Classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Davis, G. et. al, ed. (1997). *IS '97. Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems*. New York: Association for Computing Machinery.

Dick, W. and Carey, L. (1996). *The Systematic Design of Instruction*. New York: Harper Collins.

Dolence, M. and Norris, D. (1995). *Transforming Higher Education: A Vision for Learning in the 21st Century*. Ann Arbor, MI: Society for College and University Planning.

Driscoll, M. (1994). *Psychology of Learning for Instruction*. Boston: Allyn and Bacon.

Eisenberg, D. and Risley, R. (1998). *Improving Science and Technology Education at Community Colleges (Round 1)*. Jackson, MS: Mississippi Education and Research Center, Phi Theta Kappa.

Harris, R. et. al. (1995). *Competency-Based Education and Training*. South Melbourne, Australia: McMillan Education Australia, PTY.

Hull, D. and Grevelle, J. (1998). *Tech Prep: The Next Generation*. Waco, TX: CORD Communications, Inc.

Johnston, W. and Packer, A. (1987). *Workforce 2000: Work and Workers for the 21st Century*. Indianapolis, IN: The Hudson Institute.

Keirsey, D. and Bates, M. (1984). *Please Understand Me: Character and Temperament Types*. Del Mar, CA: Prometheus Nemesis Book Company.

Leff, J. and Malyn-Smith, J. (1998). *Making Skill Standards Work*. Boston: Educational Development Center, Inc.

Miles, Curtis. (1994). *The Mindful Worker*. Clearwater, FL: H and H Publishing Co.

National Alliance of Business. (1995). *Skill Standards: Benchmarks of Excellence*. Washington, DC: National Alliance of Business.

Packer, A. "The SCANS Challenge: Preparing Your Workforce for High Performance." *Employment Relations Today*, Winter, 1992-1993.

Regan, M. (1998). *E-Careers: Connection to Opportunities in Interactive Digital Media*. San Francisco: Bay Area Multimedia Partnership.

Stevenson, R. (1996). *Skill Standards Guidebook I*. Olympia, WA: Washington State Board for Community and Technical Colleges.

Sylwester, R. (1995). *A Celebration of Neurons: An Educator's Guide to the Human Brain*. Alexandria, VA: Association for Supervision and Curriculum Development.

U.S. Department of Labor. (1992). *Learning a Living: A Blueprint for High Performance*. Washington, DC: U.S. Department of Labor.

U.S. Department of Labor. "Secretary's Commission on Achieving Necessary Skills." *Executive Summary*, April, 1992, U.S. Department of Labor.

Wheatley, M. (1994). *Leadership and the New Science*. San Francisco: Barrett-Koehler.

Wills, J. "Voluntary Skill Standards and Certification." *Center for Workforce Development Institute for Educational Leadership*, 1995, U.S. Department of Labor.

Internet Resources

Advanced High Performance Manufacturing Skill Standards
National Skill Standards Project for Advanced Manufacturing.
http://www.bmpcoe.org/bestpractices/internal/sdcc/sdcc_6.html

Documents About Standards
http://ed.gov/G2K/doc-stan.html

Goals 2000: Increasing Student Achievement through State and Local Initiatives
http://ed.gov/G2K/goalsrpt/title.html

Making Sense of Industry-Based Skill Standards
http://vocserve.berkeley.edu/Summaries/777sum.html

NCRVE's Skill Standards Page
http://vocserve.berkeley.edu/SkillsPage.html

O*NET - The Occupational Information Network
http://www.doleta.gov/programs/onet

Gateway: Bioscience Industry Skill Standards
http://www.edc.org/CEEC/projects.html

Information Technology Association of America
http://itaa.org/

National Skill Standards Board
http://www.nssb.org/

NHCSSP Part 1: Why Skill Standards?
http://www.fwl.org/nhcssp/nhcss01.htm

ScansLink: A product of the Texas Skills Standards and Certification Project
http://www.dcccd.edu/nlc/misc/scans/slink.htm

Sites Offering Academic and Skill Standards
http://ed.gov/G2K/standard.html

NWCET Partners

American Association of Community Colleges
http://www.aacc.nche.edu/

American Electronics Association
http://www.aeanet.org/

The Boeing Company
www.boeing.com

The Chauncey Group International
http://www.chauncey.com/

Colorado Electronic Community College
http://www.cecc.cccoes.edu/

Department of Commerce
http://www.doc.gov/default.htm

Department of Labor
http://www.dol.gov/

Digital Creators
http://www.digitalcreators.com/index_ie4.html

The Education Development Center
http://www.edc.org/

Florida CC Distance Learning Consortium
http://www.distancelearn.org/

Gartner Institute
http://www.gartnerinstitute.com

Harcourt Brace: The Dryden Press
http://www.dryden.com/

IEEE
http://www.ieee.org/

Maryland State Department of Education
http://www.msde.state.md.us/

Microsoft
http://www.microsoft.com

National Science Foundation
www.nsf.org

Northwest Regional Educational Laboratory
http://www.nwrel.org/

Society for Information Management
http://www.nwlink.com/~seasim/

University of Phoenix
http://www.phoenix.edu

University of Washington
http://www.washington.edu

UW, Bothell
http://bothell.washington.edu

Washington Software Alliance
http://www.wsa1.org/

Washington State Board for Community and Technical Colleges
http://www.perkins.ctc.edu/

Western Governor's University
http://www.wgu.edu/wgu/index.html

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The following organizations have provided representatives to industry expert panels, focus groups and in-depth interviews conducted in the development of the information technology skill standards.

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Adaptec
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The NWCET gratefully acknowledges the technical guidance and financial support of these strategic partners and sponsors.

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