Development of occupational taxonomies for computer specialists

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EXECUTIVE SUMMARY

Background

Rapid progress in the field of computers and high technology during recent years has resulted in corresponding changes in computer specialties occupations. These changes have created new and unprecedented positions lacking common job titles and well established job descriptions. Although several taxonomies such as the Dictionary of Occupational Titles (U.S. Department of Labor), the Standard Occupational Classification Manual (U.S. Department of Commerce) and the Taxonomy of Computer Science and Engineering (AFIPS Taxonomy Committee) provide relevant information, none include sufficiently detailed classifications of computer specialists. This lack of detail has created problems for those in government, industry, and academia who are involved with occupational surveys and personnel functions. Perceiving a need to improve the quality of information on occupations within the computer field, the American Federation of Information Processing Societies (AFIPS) developed, under a grant from the National Science Foundation, an expanded taxonomy of computer specialist occupations which provides a contemporary, standardized set of easily understood and acceptable classifications.

Purpose

The following report is the result of a study conducted for the National Science Foundation (NSF) by AFIPS which produced such an occupational taxonomy for the computer specialists field. The term “occupational taxonomy” refers to a job classification list that specifies by title a series of related job functions. The main purpose of the study was to develop a new taxonomy which is easy to understand and use, functional in producing accurate data on actual jobs in the economy, flexible to allow for future modifications, more complete than existing taxonomies, and consistent in design with other taxonomies currently used by the NSF.

Scope

The new taxonomy consists of ten major occupational categories, representing a significant expansion of the computer specialties taxonomies currently available. Each of the general major categories includes a detailed list of specific computer specialties jobs and functional titles. These subcategories serve to clarify the general categories and provide the detail necessary for finer screening of personnel functions.

Procedures

To produce the type of taxonomy described above, the following tasks were performed:

—Researched existing sources of occupational information
—Developed an initial taxonomy
—Established an expanded taxonomy and survey questionnaire
—Evaluated the expanded taxonomy through survey pretest
—Distributed, collected and conducted statistical analysis of questionnaire based on expanded taxonomy

Two surveys of selected representatives from industry, academia, federal laboratories, and individual computer professionals provided the data on which the findings of the study were based. The pretest and survey samples consisted mainly of individual members of AFIPS’ constituent organizations. The questionnaire, which includes questions about job responsibilities and titles, was filled out by 107 respondents. Further information on the statistics is shown in Appendix D of the final report.

Participants

As noted earlier, the study, launched in the Spring of 1985, was conducted for the National Science Foundation (NSF) by the American Federation of Information Processing Societies
Methodology

The key tasks involved in conducting the study were as follows:

I. Research of Existing Sources
   A. Identified relevant taxonomies, job descriptions, and personnel surveys from government, industry, and other organizations
   B. Identified the target population, (i.e., organizations employing computer specialists), for the survey sample
   C. Presented initial research to AFIPS panel

II. Development of Initial Taxonomy
   A. Established list of primary computer specialties occupational areas with descriptive statements
   B. Developed and implemented survey sampling procedures
   C. Solicited and incorporated panel responses/reactions/additions to initial taxonomy and proposed sampling methods

III. Established Initial Expanded Taxonomy and Survey Questionnaire
   A. Established occupational sub-categories and selected characteristics/requirements to differentiate among sub-category levels
   B. Listed a representative sample of organizations employing computer specialists
   C. Requested, evaluated, and incorporated panel recommendations on survey questionnaire

IV. Taxonomy Evaluation Pretest
   A. Surveyed small sample of pretest respondents by mail and gathered responses
   B. Met with respondents and validated accuracy of responses
   C. Analyzed accuracy/reliability of responses and fine-tuned questionnaire and reporting requirements

V. Taxonomy Evaluation Survey and Analysis
   A. Mailed questionnaire to and gathered responses from appropriate representatives of the organizations selected for the sample
   B. Met with respondents and reviewed collected data
   C. Evaluated the results statistically for accuracy/reliability

Findings

The information obtained by carrying out the tasks provided the following taxonomy of the computer specialist occupational workforce:

718 **Computer Scientist**—An individual, usually with an advanced degree, who is engaged as a theorist, researcher, designer or inventor (or any combination of these roles) in the fields of computer hardware or software. The computer scientist most often specializes in one of the following areas:
   A. Theory of Automata
   B. Computer Architecture/Networks
   C. Number/Information Theory
   D. Computer Logic
   E. Computer Languages
   F. Fundamental Algorithms
   G. Software Structures/Operating Systems
   H. Artificial Intelligence
   I. Theory of Complexity
   J. Graphics
   K. Other

719 **Computer Hardware Engineer**—A highly trained specialist, usually with an engineering degree, who applies state-of-the-art knowledge to the design, installation, adaptation or interfacing of computer or computer-related equipment.

720 **Computer Software Engineer**—A highly trained specialist, usually with a degree in either engineering or computer science, who applies state-of-the-art knowledge to the design of overall software systems, to the setting of operational specifications, quality standards and testing procedures, and to the definition of user needs.

721 **Telecommunications Specialist**—A highly trained specialist, usually with a degree in engineering, computer science and/or information theory who deals with the devices and techniques employed for transmission of signs, signals, writing, images, sounds or data of any nature by wire, radio, or other electromagnetic equipment, or in the interfacing of computer and communications equipment.

722 **Systems Programmer**—A high level programmer, usually with a college degree, who creates, maintains, and controls the use of computer systems software with the aim of optimizing operational efficiency.

723 **Systems Analyst**—A specialist, usually with a college degree, who gathers information about the operation of a given physical system, analyzes this information and then formulates a logical plan to achieve desired objectives for improving the system usually through the use of computer, or computer-related equipment and software.

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*The numbering system used here directly corresponds to the numbered computer specialties categories included in the current NSF taxonomy.*
Conclusions

I. The taxonomy meets the research needs of the NSF by achieving the pre-study goals of being easy to understand and use, functional in producing accurate data on actual jobs in the economy, flexible to allow for future modifications, more complete than existing taxonomies, and consistent in design with other taxonomies currently used by the NSF. These goals are reflected in the following characteristics of the final taxonomy:

A. Very few survey responses fell into the “other” category indicating that the taxonomy is complete and inclusive for the computer specialist field.

B. Panel review showed that the occupational titles are consonant with those used by computer professionals working in the field, thus permitting easy association between actual tasks and the nomenclature incorporated in the taxonomy.

C. The taxonomy spans the computer specialties in depth as well as range, facilitating detailed studies of labor market factors in a leading-edge technological area.

D. The classifications can be readily cross-referenced and aggregated to meet the requirements of public sector statistical groups.

II. The taxonomy is a summation of the computer specialties field as it is today. Continuing change in the industry will necessitate updates at appropriate intervals, perhaps every three to five years.

III. The problem of obsolescence already plagues existing government taxonomies dealing with the computer specialties field, with the notable exception being the Department's MOTD and those used by other agencies for internal operations. The need to keep basic government taxonomies current is vital.

IV. Existing taxonomies miss relatively small, but significant groups of critical high-technology skills. Therefore, strong efforts should be made to combine existing taxonomies into a single listing which would address both the public and private sectors' needs. This would facilitate the process of planning for the future of the computer industry through an analysis of current personnel resources.

Recommendations

The following actions are recommended to the National Science Foundation:

1. The taxonomy should be incorporated as quickly as possible into all NSF surveys and studies.

2. Additional in-depth statistical analyses are needed to establish base line demographic profiles of the various computer specialist fields.

3. A dissemination plan should be developed as soon as possible to ensure the adoption of the taxonomy by other agencies and organizations. Use of the taxonomy by all federal agencies and the computer industry would establish a much needed element of consistency among studies and reports produced by each of the various groups.

4. The need to keep basic government taxonomies current is critical. The taxonomy should therefore be updated at appropriate intervals (perhaps every 3–5 years) to reflect continuing changes in the computer specialties field.

5. Small but significant groups of people employed in the computer specialties field are often not large enough to be identified in current taxonomies. A mechanism to ensure that federal agencies, educational institutions, and private sector organizations involved in personnel analysis are able to identify these critical skills should be created.

6. To simplify the use of this taxonomy, the development of
A document which would crossfoot with the DOT, SOC, OES, and MOTD classifications is highly recommended. Adoption of these recommendations will ensure that accurate and informative data on the computer specialties field will be obtained by the National Science Foundation and other governmental agencies. The expanded taxonomy will broaden the scope of knowledge of the current characteristics of the computer specialties workforce and enable accurate projections to be made of future personnel and resource needs by the United States government.