Skills possessed and skills useful for MIS practitioners—A research report*

by ROBERT M. HENRY

University of Minnesota
Minneapolis, Minnesota

The major report setting forth major curricular recommendations for graduate professional programs in information systems appeared in 1972.** The context of the report was an information systems environment and developmental process distinguishing between two analyst activities: information analysis and design analysis. Figure 1 seeks to draw the ACM distinction. And that distinction is carried forth into skill sets identified as desirable for graduates. Six clusters or groupings of skills are offered (people, models, systems, computers, organizations, and society) and thirteen courses are proposed to impart those skills. The thirteen courses are set forth as a two-year graduate core curriculum for both information and design analysts.

The Management Information Systems Research Center at the University of Minnesota has taken the liberty of amending the chart (Figure 2) from its form in the ACM report. Course titles and sequencing are unchanged. The rows in the chart represent the four semesters of core courses in the recommended two-year curriculum. Vertical or downward sloping arrows indicate prerequisite relationships. Horizontal arrows represent co-requisite course offerings. The chart shows the names of skill clusters identified by the committee nearest the courses which most directly address those clusters. Thus “people” skills are seen to be communicated through courses entitled “Organizational Functions” and “Human and Organizational Behavior.” At the bottom of the exhibit, the Management Information Systems Research Center has added the words “Information Analyst” and “Design Analyst,” each with an arrow. The arrow indicates the opposing poles of the curriculum at which either analyst might take additional elective courses. Six of the courses are shown to be more representative of generalist information analyst skills and seven of the courses are seen to be more representative of the design analyst’s specialty area. The words “generalist” and “specialist” are MISRC additions.

The ACM report isolated six skill clusters in proposing thirteen graduate courses spread over two years. While opinion was solicited by the ACM committee from many areas, no formal research underlay the ACM report. The University of Minnesota sought to validate the ACM assumption and recommendations. The ACM committee assumed sufficient demand for Information Systems graduate students to justify their proposed curriculum and recommended specific skills to be stressed by that proposed curriculum. To test the ACM assumption and recommendations, the MISRC researchers determined to survey DP/IS practitioners in an empirical fashion. Relevant questions included the following: What skills do practitioners presently possess? What skills are useful for each position? How do employees, supervisors and users vary in their perceptions? What then are the implications for education?

The MISRC research objectives were three in number:

1. Survey projected demand quantity for MIS graduates
2. Specify skills required
3. Develop curricular implications

The procedure in attacking these research objectives was first to build a subject sample. Seventeen relatively autonomous organizations were approached in fourteen Twin Cities firms. In concert with the Corporate Director of Information Systems or his equivalent, a manning table was developed for twelve positions representing the managerial and software development positional levels within information system. A descriptive paragraph attempted to set the bounds for each position so that, regardless of job titles, like functions and personnel could be compared across organizational boundaries.

In the next step skills were selected, clustered, and processed into research instruments. After pilot testing, 111 skills were eventually selected to be researched. The skills were grouped into seven clusters and then reclustered into three. The total skill set appears in Appendix A. An asterisk

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* Sustaining MISRC Associates for the research period included Burlington Northern, Inc.; Dayton Hudson Corporation; CENEX, Inc.; Federal Reserve Bank; General Mills, Inc.; Honeywell, Inc.; International Multifoods; Minneapolis Gas Company; 3M Company; Northern States Power Company; Northwest Bancorporation; Pillsbury Company; St. Paul Companies, Inc.; and Soo Line Railroad Company.


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on any skill in the first six clusters represents a "generalist" skill or one more representative of the information analyst activity. Skills without asterisks in the first six clusters represent "specialist" skills more appropriate to the design analyst activity. The seventh cluster, "performance", cannot be divided into specialist or generalist skills.

The performance cluster is a part of each clustering scheme (see Figure 3), illustrated between the six rows and three columns.

Once the firms were selected and the skill sets were chosen, pilot tested, and clustered, separate instruments were designed for supervisors, users, and employees. Each participant supervisor and user rated a designated employee of his acquaintance at a level within the organization determined by the researchers and the information systems manager. Supervisors and users rated the employees as to skills actually possessed and skills deemed useful or non-useful for that employee's level of functioning, regardless of whether or not the employee actually possessed the skill. Rating scales were a four-point forced choice. A pilot attempt was begun with six points rather than four, but the four-point scale was found better to harmonize with the four-point scales presently being used by subjects in job review and evaluation. For every one of the 111 skills, then, supervisors and users rated a given employee as to the degree of skill possessed and the usefulness of that skill for the position. Where a rater was not familiar with one of the 111 skills, where a rater had not observed either the presence or absence of that skill in the employee being rated, or where the rater had no feel for the usefulness of that skill for the positional level within the organization, the rater was requested to refrain from making a judgment.

Each employee engaged in self rating as to skill levels possessed. Just as the supervisors and users, they rated the usefulness or non-usefulness of every skill for their positional level in the organization. Unlike supervisors, employees were asked to designate the source (or sources) of skills for each skill they possessed. Three weights could be assigned by employees as to the sources for any skill. In the illustration, shown by Figure 4, the employee has indicated he is superior or exceptional in his ability to write detailed program specifications. That skill is deemed by him to be extremely useful or significant for his position in the organization. The employee has indicated that primary sources of that skill for him were: (1) higher education; (2) on the job experience after data processing entry; and (3) in-house education. Firms were chosen, skills selected, and rating instruments designed. Data gathering was step four. The subject sample consisted of 981 persons, representing 475 employee raters, 375 supervisor raters, and 131 user raters distributed among twelve positional levels. (See Figure 5).
### Skills Possessed and Skills Useful for MIS Practitioners—A Research Report

The data base consisted of nine major files—two files each for employees, supervisors and users consisting of their 111 ratings both for (1) Skills Possessed and (2) Skills Useful. There were three additional employee files: (1) company demographic information (size of firm, monthly hardware expenditure, reporting structure, etc.); (2) individual demographic information (total DP experience, length of time per present position, immediate past ten-year work history, educational level, graduation data, major specialty area, age, etc.); and (3) skill sources for the 111 skills. Output at any data base entry includes (1) skill mean ratings, (2) skill sources, (3) a rank ordering of the entire skill set, and (4) individual and company demographic data. Inquiries may be addressed for any or all positions by any set or sub-set of either rated or rater subjects, for skills possessed and for skills useful, for each of the 111 skills and/or each of the skill clusters. T-test significance testing was at the .001 level.

### FINDINGS

#### Company demographic information

The firms have major hardware expenditures for DP/IS averaging slightly more than $75,000 per month for mainframes in Twin Cities locations alone. In all but five cases the director’s reporting channel is through the Vice President for Administration or Management Services (or his equivalent). Analysts and programmers are assigned about equally to applications areas and to project teams. The user’s role has become increasingly prominent. Essentially, they represent information systems as opposed to DP environments.

#### Individual demographic information

Subjects averaged 30 years 11 months in age, six years mean total DP experience plus an additional one and one-half years non DP-business experience. Average DP experience per current firm was slightly more than five years and the average length of time per present position was two and a half years. The data base consisted of nine major files—two files each for employees, supervisors and users consisting of their 111 ratings both for (1) Skills Possessed and (2) Skills Useful. There were three additional employee files: (1) company demographic information (size of firm, monthly hardware expenditure, reporting structure, etc.); (2) individual demographic information (total DP experience, length of time per present position, immediate past ten-year work history, educational level, graduation data, major specialty area, age, etc.); and (3) skill sources for the 111 skills. Output at any data base entry includes (1) skill mean ratings, (2) skill sources, (3) a rank ordering of the entire skill set, and (4) individual and company demographic data. Inquiries may be addressed for any or all positions by any set or sub-set of either rated or rater subjects, for skills possessed and for skills useful, for each of the 111 skills and/or each of the skill clusters. T-test significance testing was at the .001 level.

#### EMPLOYEE GRADUATION DATA

<table>
<thead>
<tr>
<th>Degree</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>89</td>
<td>18</td>
</tr>
<tr>
<td>Technical Institute</td>
<td>83</td>
<td>17</td>
</tr>
<tr>
<td>Undergraduate Degree</td>
<td>250</td>
<td>53</td>
</tr>
<tr>
<td>Graduate Degree</td>
<td>34</td>
<td>7</td>
</tr>
<tr>
<td>Undergraduate and Technical Institute</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Graduate and Technical Institute</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>TOTALS</td>
<td>475</td>
<td>100</td>
</tr>
</tbody>
</table>

### Major Field in College

<table>
<thead>
<tr>
<th>Field</th>
<th>9th</th>
<th>12th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Admin. (Non-Acct.)</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>Math</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td>Liberal Arts</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>No College</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>Accounting</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Corp. Science</td>
<td>1%</td>
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</tr>
</tbody>
</table>
by every comparison of the performance cluster with every other cluster, for any position, by all raters, on both skills possessed and skills useful, the performance cluster received a significantly higher mean rating. There was no surprise in terms of usefulness. The big surprise was that users (1) rated employees significantly higher than either employees or supervisors on performance skills presently possessed (Figure 8); and (2) rated performance skills significantly higher than any other cluster of skills presently possessed (Figure 9).

In Figure 9, the rank ordering of employee and supervisor mean ratings were consistent for levels of skills possessed and relative usefulness by cluster in both the seven cluster and the three cluster analysis. Users disagreed little as regards relative usefulness, reversing only the importance of the society and models clusters in the sixth and seventh rank order positions for the seven cluster comparison. Users disagreed drastically on the cluster mean values derived from their individual ratings on skills presently possessed. After surprising by elevating the performance cluster, users on both the seven cluster and three cluster groupings said that the twelve positions surveyed possess technical skills above all else. In short, the users confirmed the projected image of "computerniks" on the DP/IS personnel. And that image is the more strongly stated in contrast with their clear agreement with employees and supervisors as to rank orderings of useful skills.

The rank ordering varied but not substantially across positions. Specialist skills would be elevated, for example, over generalist skills both for senior and junior programmers. At all other positions generalist skills were deemed more useful. The marked trend to elevate the behavioral skills with systems over technical skills suggests something of the evolution of systems, the enhanced role of the user, and the viability of the ACM insight in suggesting an information analyst as a key developmental resource.

**Entry level positions**

The probability of entering each of the twelve positions is depicted in Figure 10. From "without" means either from outside the DP/IS organization or from outside the firm. Experience to acquire threshold organizational and specialty skills is predictably more determinative than graduate versus undergraduate levels of information analysis or design analysis education. With good DP/IS experience of 1-3 years, either design or information analysts may target for junior systems analyst/programmer or junior analyst, depending upon the job function within the organization. Additional experience will enhance opportunity for more rapid upward mobility. Rarely will graduates enter at senior levels of MIS environments until tested within the environment. Graduates recruited who have not yet acquired DP/IS work experience will enter, at least
presently, at the junior programmer or DP trainee level (regardless of degree level). If the programmer function continues to shift toward a coding function, entry level for the environments surveyed will be standardized at junior analyst or junior programmer analyst level. While the openings were not surveyed in the present research, the evaluation of MIS oriented systems suggests that increasingly information and design analysts with strong functional competence in an applications area, e.g., finance, marketing, etc., will have recruitment opportunity from the applications area of the firm. Although experience is key, the desired combination of experience and relevant education has implications for both recruitment areas—the firm and the educational institution. As the firm must select “mid-career” persons for additional education, so must higher education recruit them.

Demand

Of the environments surveyed an average of three new junior programmer lines, two new junior analyst/programmers, and one new junior analyst is projected each year for each of the next five. Private talk indicates the forecasted increase is at asking levels only. The curve of the increase for both senior and junior programmers is decreasing. The curve of the increase for both junior analysts and junior programmer/analysts is increasing. The net size of the organization has essentially stabilized. Information rather than design analysts appear the critical new resource required.

Sources of skill

Figure 11 shows the percentage of each of seven sources as contributor to a given skill cluster. The same analysis can be performed on each of the 111 skills, where possessed. The informal process of “on the job training after DP entry” was the major source cited. Higher education was the highest formal process cited, somewhat surprisingly given the mean seven and one-half years subject aggregate business experience and the newness of computer-related curricula. The source of tomorrow’s information analyst is predictably higher education.

Continuing education

Space does not permit the position-by-position profile which must be the address of another paper. On the basis of supervisor usefulness ratings for the ACM clusters significant continuing education needs by position were as follows:

1. People—all positions except senior and junior programmers
2. Systems—all positions except specialty managers, senior and junior programmers
3. Organizations—all positions except specialty managers, programming manager, senior and junior programmers
4. Computers—throughout the programmer/analyst and programmer functions
5. Society—for the director, junior analyst, and programmer manager
6. Models—for the assistant director and the specialty manager

SUMMARY

A large data bank has been constructed which may be queried on numerous parameters. Only gross findings have been reported to date.

Certain ACM assumptions and recommendations were tested. For the environments sampled, there is viability and greater demand for information analysts than for design analysts. If graduates could undergo the two-year
recommended curriculum “mid-career” with 1-3 years of specialty experience, a highly recruitable graduate could be produced. Experience will increase as a dominant recruitment criterion.

An interesting consideration for further research is to compare MISRC’s 1973 research profile with another for the same twelve positions obtained in 1975. Updated implications for education might again be produced.

APPENDIX A—GENERAL INDEX TO SKILL CLUSTERS

* Generalist or Information Analyst

* Specialist or Design Analyst

NOTE: All skills are preceded by the words “Ability to” or “Knowledge of.”

I. PEOPLE (10)

• communicate with others verbally (in general)
• describe and identify individual and group behavior (e.g., describe and identify working relationships among people in an organizational environment)
• predict alternate future behavior of individuals and groups (e.g., predict individuals’ reactions to operating changes)
• grasp the facts and feelings of what is spoken
• recognize, understand, and communicate the meaning a particular event has for you
• interview others
• effect change in work relationships
• communicate and interact with non-computer oriented people
• gain the confidence and support of others in work relationships
• recognize and remove personality problems which interfere with job completion

II. SYSTEMS (23)

• view, describe, and define any situation as a system
• analyze and evaluate different software applications packages
• perform economic analyses (cost/benefit studies) of proposed resource commitments for a project
• analyze and determine cost benefits of project (information system) to user
• design and use I/O layouts
• calculate cost/performance tradeoffs in a system
• present in writing a detailed description of part of a project
• evaluate system performance and make needed adjustments to system after implementation
• design and use decision tables
• design and use run and grid charts
• specify, given information needs and sources, several alternative sets of information to meet needs
• develop the major alternatives in specifying an information processing system, including data files and communications structures
• prepare clear and useful documentation (programs and procedures within programs, systems, etc.)
• analyze programs outlines by system analysts for detailed design and construction
• make “rough cut” feasibility evaluations of proposed new techniques or applications of current technology
• design software and hardware configurations
• design and use flowcharts (system and program)
• prepare effective user documentation for either a portion of a system or an entire system
• project planning and control tools (PERT, CPM, etc.)
• sources for updating knowledge of technology
• general systems theory (open/closed systems, system boundaries, feedback concept)
• the need for security in programs, data storage, and work flow design, as well as physical protection of programs and data “outside” computer services (information concerning consultants, software houses, application packages, etc.)

III. COMPUTERS (32)

• write detailed program specifications
• convert existing programs from one system to another (language to language, computer to computer)
• use program testing aids (special debugging packages, traces, and snapshots)
• program in file oriented languages (COBOL, RPG)
• program in scientific or algorithmic type languages (FORTRAN, PL/1)
• program in an assembly type language (BAL, COMPASS)
• program in simulation languages (GPSS, SIMULA)
• revise existing programs (including debugging and refinement)
• analyze communication systems (estimate line and terminal requirements, volume and message length, queues, etc.)
• use sort and utility packages
• use sequential and index sequential file techniques
• use direct or random file techniques
• create, maintain and interrogate files
• prepare sample data for programs and providing test runs
• analyze and evaluate programming languages for selecting most appropriate language for a given problem solution
• analyze and evaluate different hardware configurations
• use interactive debugging facilities (available through a time-sharing arrangement such as Text-Editor)
• existing communications facilities (line types, exchanges, utilities)
• multilinked data structures (trees, multilist, inverted list, networks, etc.)
• sorting techniques (radix, merge, bubble, tree)
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I. SKILLS (50)
• searching techniques (sequential, binary, directory)
• microprogramming
• performance evaluation techniques (simulation packages, hardware and software monitors)
• minicomputers
• characteristics of auxiliary storage devices (capacity access, storage): tape, disk, drum, etc.
• input-output devices (types available, general market)
• operating systems (including scheduling algorithms, memory and peripheral management, interrupt systems)
• multiprogramming and multiprocessing
• time-sharing operating system (concepts and facilities)
• job control languages (coding and techniques)
• "inner workings" of compilers, interpreters or other translators
• communication access methods and their general features to support terminal/teleprocessing applications

IV. ORGANIZATIONS (12)
• develop positive and negative impacts of a specified information system on specified parts of an organization
• identify in an on-going organizational situation the key issues and problems of a given functional area (production, finance, marketing, etc.)
• present in writing a summary of a project for management action (suitable to serve as a basis for decision)
• identify possible short term and long term effects of a specified action on organizational goals
• develop specifications for a major information system, addressing a given organizational need, and determine the breakdown into manual and computer-based parts
• gather information systematically within an organization, given specified information needs and/or specified information flows
• apply the "system viewpoint" in depth within the organization structure
• data gathering techniques (interviews, etc.)
• the function of purposeful organizational structure and the major alternatives for that structure
• specify elements and relationships of information in various functional segments of the organization
• accounting practices and procedures
• corporate policy and lines of authority and responsibility

V. SOCIETY (10)
• articulate and defend a personal position on some important issue of the impact of information technology and systems on society (important as defined by Congressional interest, public press, semitechnical press, etc.)
• public and private data banks
• computer impacts on industrial, clerical and managerial positions
• computer industry with regard to growth patterns, competition, and government regulations
• standardization practices in the computer industry
• professional data processing associations
• problems of providing training in data processing
• changes in employment patterns as a result of automation
• potential applications of automated processes for society
• evaluate the social consequences of a proposed system

VI. MODELS (10)
• formulate and solve simple management science type models, linear programming, dynamic programming, queueing, simulation
• recognize the appropriate management science (operations research) models for situations commonly encountered
• queueing structures
• inventory control models
• matrix algebra
• differential calculus for optimization
• elementary statistics
• fundamentals of probability theory
• set theory
• formulate and solve complex simulation models

VII. PERFORMANCE CLUSTER (14)
• accept responsibility and initiate action
• perform tasks accurately
• cooperate and work effectively with others
• plan and organize work assignments
• motivate self and others
• train and develop subordinates
• create in others an acceptance and willingness to discuss problems
• manage other people
• complete assignments on time
• work effectively under pressure
• work independently with limited supervision
• define a problem
• handle a number of assignments simultaneously
• delegate assignments and review the results of assignments directly under control