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Maine IT Workforce Skills Management : A study for the Maine State Department of Labor

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Executive summary

From August 2010 to February 2011 personnel from Information and Innovation at the University of Southern Maine have conducted a study of IT skills needed, possessed and taught in Maine. The goals of this study were to provide fine-grained information to the Maine state Department of Labor to facilitate their workforce development activities.

This study concerns the skills sought after by employers, possessed by unemployed and employed workers and taught in education and training establishments with a "bricks and mortar" presence in Maine. It relied on data created by third parties and by study personnel. Anecdotal evidence was gathered from meetings with local industry IT professionals as well.

This study does not attempt to estimate demand or supply of a given skill, but it does assess which skills are in greatest and least demand, which skills are in greatest and least supply, and which skills are taught more and less often. The results of data analysis are presented in a new measure, "skill rank disparity," which exposes skill and training gaps and gluts.

This study provides certain insights into its results, observing individual cases of skills high in demand and low in supply, for example. Insights are also provided in terms of groups of skills that are often taught, often asked for, and whether these groups of skills are well-represented in the Maine IT workforce.

This study also provides specific and actionable recommendations concerning IT in Maine. We recommend:

- The creation of a Web-based IT Workforce Marketplace Pilot.
- The creation of The Instant University for IT Skills.
- Actions to Tighten the Linkage between Curricula and the Marketplace.
- Actions to Address the Shadow IT Workforce.

Acknowledgements and disclaimers

Our sincere thanks go to David Klein, Division Director, Bureau of Employment Services of the Maine Department of Labor for his incisive observations, consistent patience and crucial guidance to us as we navigated a rather tortuous path to our final results. Leighton Cooney, Governor's Readjustment Liaison during the first part of our work, was a major factor in defining our goals, encouraging us to propose the work and asking key (and sometimes difficult) questions as the work progressed.

Bob Hansen, Associate Provost for University Outreach at USM helped shape the program from his experience with training. Susan Nevins of USM's Center for Continuing Education kept us from forgetting the vital role people and business skills play in the success of IT workers. Professors Bruce Andrews and Charles Colgan of USM's Muskie School of Business and its Center for Business and Economic Research discussed this project with us early in its inception and provided wise insights and sage guidance. Joe Kumiszca of TechMaine also played a crucial role in supplying us with the survey data that we used for skill data about a subset of Maine's IT workforce, and we would be remiss in not acknowledging the vital anecdotal input to our work from the world of employers, including Jim Smith and Andrea Roma of Unum, Chris Houle then of Quantrix, Don Kennel of IDEXX, Ed McKersie of ProSearch, Jerry Lessard of Fairchild Semiconductor, John Doxey of National Semiconductor and many others. Thanks to Pete Mitchell of IBM for making their projections of IT skills available. Discussions during the LodeStone project with Coastal Counties Workforce Inc. and Goodwill Industries helped us appreciate the value of a skill-based approach. And thanks to Nick Cheung, a student at USM, who captured the training establishment data.

This report was prepared by the University of Southern Maine for the Maine Department of Labor's Bureau of Employment Services with funding from the United States Department of Labor. Since contractors conducting research and evaluation projects under government sponsorship are encouraged to express their own judgment freely, this report does not necessarily represent official opinion or policy of the Maine Department of Labor.

Although the report mentions specific entities (employers, professional organizations and educational and training institutions) this does not imply any implicit or explicit endorsement of them. Similarly, the report mentions specific hardware and software products, and here too we do not mean to imply any endorsement of them.

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Introduction

From August 2010 to February 2011 personnel from the Information and Innovation at the University of Southern Maine conducted a study of IT skills needed, possessed and taught in Maine. The goals of this study were to provide fine-grained information to the Maine state Department of Labor to facilitate their workforce development activities.

This study concerns the skills sought after by employers, possessed by unemployed and employed workers and taught in education and training establishments with a "bricks and mortar" presence in Maine. It relied on data created by third parties and by study personnel. Anecdotal evidence was gathered from meetings with local industry IT professionals as well.

This study does not attempt to estimate demand or supply of a given skill, but it does assess which skills are in greatest and least demand, which skills are in greatest and least supply, and which skills are taught more and less often. The results of data analysis are presented in a new measure, "skill rank disparity," which exposes skill and training gaps and gluts.

This study provides certain insights into its results, observing individual cases of skills high in demand and low in supply, for example. Insights are also provided in terms of groups of skills that are often taught, often asked for, and whether these groups of skills are well-represented in the Maine IT workforce.

This report begins with a brief discussion of the context in which the report was written, the goals of the study and the methodology chosen for it. It continues with a brief literature review, followed by sections that address all of the study's deliverables. This report concludes with our conclusions, recommendations and suggestions for future work. Two appendices document the contractual deliverables and a computer literacy guide and checklist. Bibliographic citations are expressed in parentheses, as (Miller, 2010).

Background

During 2009 and 2010, two of the authors of this study (Bantz and Wilson) collaborated with the University of Southern Maine (USM) Center for Continuing Education, the Maine State Department of Labor, Coastal Counties Workforce Inc. and Goodwill Industries to provide IT training to individuals displaced by the closing of the Brunswick Naval Air Station. The project to define and deliver this training was called "LodeStone."

One of the issues encountered early in LodeStone was the choice of IT skills to train for. We made this choice on our best judgment, tempered by advice from experienced teachers. The skill choice was vetted by Goodwill and reviewed by the then Commissioner of the Maine State Department of Labor, Laura Fortman. At each step the selection of skills was made without reference to data concerning what skills Maine employers were looking for, because at that time there was little or no data to refer to. Subsequently, in meetings with Maine employers, we learned anecdotally what skills were needed but hard to find, but nowhere in our contacts or in our search of the literature did we find authoritative and quantitative answers.

From this experience, we conceived a view of IT in Maine as a system of stocks and flows (Fisher, 1896), suitable for modeling in the System Dynamics methodology (Forrester, 1961) (Sterman, 2001). The study began with this orientation but soon focused on acquiring, understanding and in some cases creating data. In September 2010 David Klein formalized this focus in a note that was to guide the study to its conclusion.

One of the authors (Bantz) was aware of work at IBM (Gresh, Connors, Fasano, & Wittrock, 2007) focusing on creating an inventory of employee skills, characterizing a consulting engagement in terms of specific skill needs, and automatically selecting personnel based on skill matching. This capability is of immense economic value to IBM – it helps increase the utilization of IBM workers and can serve as a valuable input into training needs. Early on in the project we had hoped to engage with IBM to get access to their skill definitions and algorithms, but these are considered proprietary and were ultimately not available to us. In retrospect this was not a serious disappointment – the characteristics of IBM's workforce planning are not well-matched to the open multi-employer multi-trainer situation of IT in Maine.

How the study was done

The study consisted of three main tasks, to which a fourth (computer literacy) was added in October, 2010. The three tasks were to discover the extent to which IT tasks are required from workers with non-IT jobs, to determine gaps and gluts in the skills of Maine's IT workforce with respect to job postings, and to determine whether Maine's educational and training institutions offer curricula relevant to the needs of Maine workers and employers. The workflow for these three tasks is illustrated in Figure 1 on page 8. The first task, to discover the extent to which IT tasks are required from workers with non-IT jobs, is shown in the upper left in a lilac color. The results of this task are discussed in the section "IT Skills needed in all Job Clusters" that begins on page 11. The second task, to determine gaps and gluts in the skills of Maine's IT workforce, is shown on the right in a yellow color and its results are discussed in "Skill Gaps and Gluts" on page 30. The third task, to determine curricula relevance, is shown at the bottom in a blue-green color and its results are discussed in "Training Capabilities" on page 51.

The figure shows data represented as a horizontal cylinder, and tasks shown as rectangles. Some of the tasks were automated: those that were manual have a figure at a desk superimposed on the rectangle.

For the first main task, that of discovering the extent to which IT tasks are required from workers with non-IT jobs, the figure is intended to be read as follows:

> *Data from O*NET's main database was manually classified into IT and non-IT tasks, and then searched to segregate the "soft" IT tasks (e.g., application usage) from "hard" IT tasks (e.g., infrastructure installation). Data from O*NET's supplemental Tools and Technology file were automatically selected into two datasets: software applications and hardware systems. And data from O*NET's supplemental Detailed Work Activities file were selected and searched to form a detailed work activities file, and also*

> *manually classified and keyword searched to form a second manual detailed work activities file.*

For the second main task, that of determining gaps and gluts in the skills of Maine's IT workforce with respect to job postings, the figure is intended to be read as follows:

> *Data on workers' skills from the TechMaine survey were compared to data on employers' skill needs from Burning Glass analysis with the help of a manually-created skills equivalence map, resulting in data concerning gaps and gluts.*

For the third main task, that of determining whether Maine's educational and training institutions offers curricula relevant to the needs of Maine workers and employers, the figure is intended to be read as follows:

> *Data from the World-Wide Web was manually extracted by reference to a manually-generated list of training institutions to form a course database. Keywords were manually added to the database. The database was then searched to provide summary data concerning course coverage of skills. That data was then compared with employers' skill needs to result in course coverage gaps and gluts.*

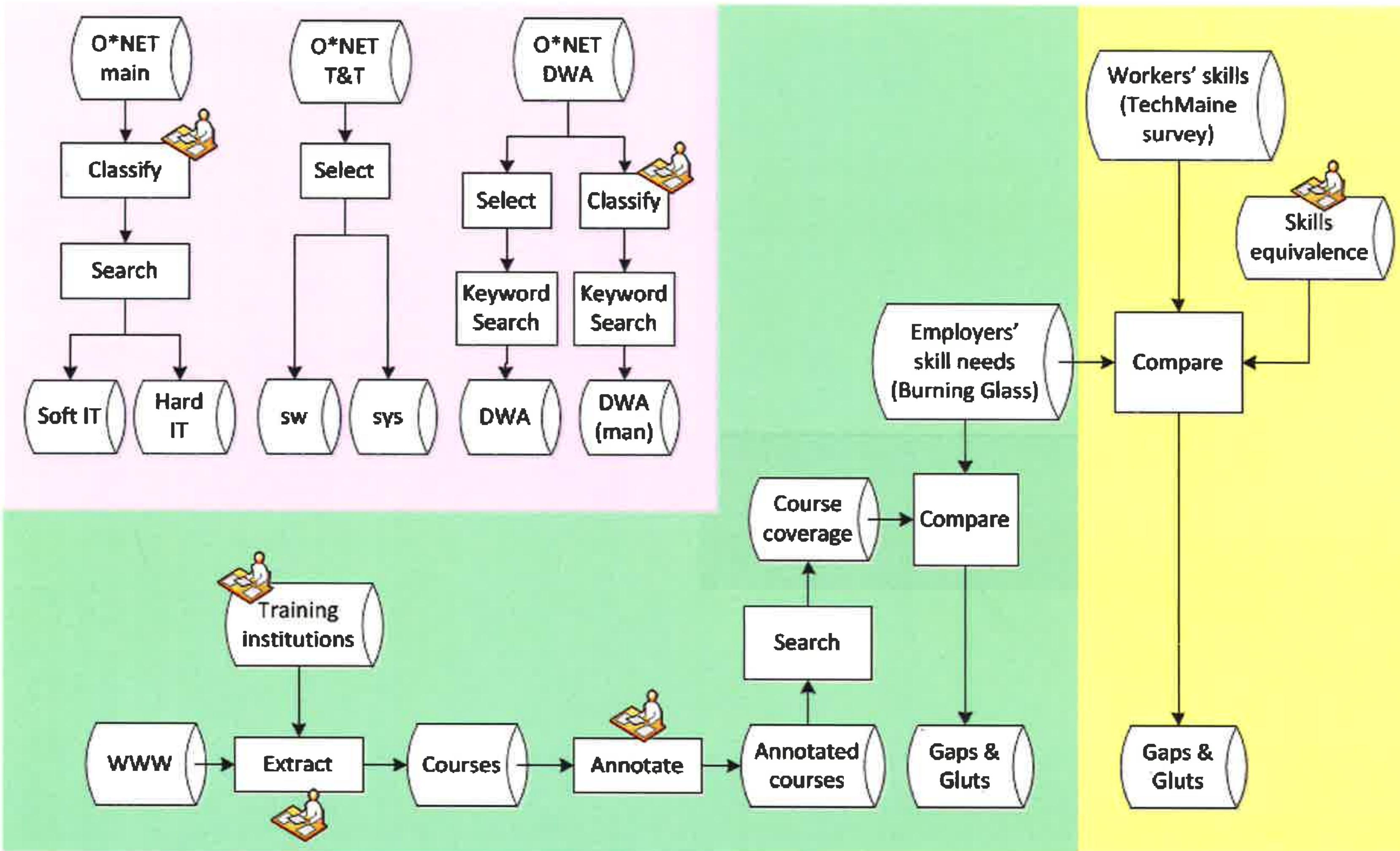

Figure 1. Study workflow

Relevant literature

In preparation for this project a brief literature search was done. The results were somewhat disappointing in that few skills-related references were found. Several common themes did emerge, however.

(National Workforce Center for Emerging Technologies, 2003) appears to have been an attempt to standardize (or at least document) IT skills. As this work appears not to have been updated, its currency is in question[1]. We note also that few citations have been made to this work.

(Gresh, Connors, Fasano, & Wittrock, 2007) is a fascinating description of how IBM manages its workforce, with a focus on skills. The emphasis is on computer algorithms capable of matching worker skills with job needs. The concept of "substitution" is introduced, where one skill can be applied in place of another, possibly with some incremental training. The internal IBM system is quite different from an open system, however, in that a managed set of skills exist, and both workers and job needs use only them.

(Ausink, Clemence, Howe, Murray, Horn, & Winkler, 2002), working for the Rand Corporation, studied the IT workforce at Fort Bragg, NC. Using linear programming to optimize the mix of staff and contractors, they found that use of contractors did not always optimize cost, and they identified the important role the "shadow[2]" workforce played. (Kaarst-Brown & Guzman, 2005) note that the "IT workforce" is ill-defined and also identified the important role played by the "shadow" workforce.

(Noll & Wilkins, 2002) studied curricula for IT training and concluded that overall business knowledge and "people skills" (teamwork, planning, communication) were important to employers. (Knyphausen-Aufsetz & Vormann, 2009) studied the hiring process for IT workers from a skill perspective and concluded that factors other than skills (the applicant's network of acquaintances, cultural fit with the potential employer) were important in the hiring process.

(Kuhn & Rayman, 2006) studied the IT workforce in Massachusetts and noted that the conditions of work (high degree of change, stress, insecurity) were important in employee retention and job satisfaction.

(Grant & Babin, 2006) provide a rudimentary model of the IT workforce in the US and in Canada and recommend that industry take a more active role in assuring a continued supply of workers. They observe that there is a well-documented mismatch between the needs of employers and the skills of the workforce.

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[1] IT skills evolve rapidly.

[2] The shadow workforce did not have job classifications consistent with the performance of IT tasks but performed them anyway.

Several “action research” papers (Trauth, Quesenberry, Huang, & McKnight, 2008) (Trauth, Reinert, & Zigner, A Regional IT Occupational Partnership for Economic Development, 2007) describe collaboration between university researchers, a local college, economic development professionals and the local business community. The term “action research” describes a style in which researchers intervene in the studied situation with deliberate consequences.

(Currid & Stolarick, 2010) studied the IT sector in Los Angeles and conclude that mixed skill populations (IT skills in non-IT industries) were vital to economic competitiveness.

(White, Rush, & Schaffer) is a study of principal investigators on National Institutes of Health grants, specifically of their age at the time of receiving the grant. A System Dynamics (Randers, 1980) model was constructed and was used to evaluate a proposed policy encouraging younger investigators.

Deliverables

The deliverables agreed to for this study are documented in "Appendix A. Contractual deliverables" on page 72. They consist, broadly, of data regarding cross-job-cluster IT skills, skill gaps and gluts with respect to employer needs, training capabilities of Maine institutions with gaps and gluts identified, and a discussion of computer literacy.

Important non-IT skills needed by IT workers

While not proscribed by our deliverables, we feel that it is important to mention certain non-IT skills and knowledge that are highly beneficial to IT workers. Past lack of emphasis on these skills and knowledge has led to a stereotypical view of IT workers as "basement dwellers."

(Noll & Wilkins, 2002) have identified the important role that interpersonal skills and business knowledge play in the effectiveness of IT workers, and we have confirmed this in our conversations with employers. The LodeStone project (see "Background" on page 5) included significant material on communications and collaboration, and on how business works, and we are indebted to our collaborators on that project from the USM Center for Continuing Education for insisting on this content. We feel strongly that without these skills and business awareness, IT workers will not be able to understand how their work relates to the needs of their employers and the customers they serve; they will be limited in their abilities to function in teams, so vital in modern enterprises, and they will not be able to use their creativity and independent judgment to design and operate systems that benefit their employers' real needs in a secure, ethical and long-lasting way.

IT Skills needed in all Job Clusters

The material in this section relates to contractual deliverables 2 and 3 (see "Appendix A. Contractual deliverables" on page 72).

Sources of data

The Occupational Information Network O*NET (O*NET Resource Center) is a comprehensive, national compilation of occupational data created for the U.S. Department of Labor, Employment and Training Administration by the National Center for O*NET Development. O*NET serves as a source of information for workers to explore occupational options and also as the basis for the development of applications requiring occupational information. The Resource Center makes the O*NET main database and supplemental database files available for download, without fee or restrictions.

O*NET data is organized under an occupation-based taxonomy derived from the US Department of Labor's Standard Occupational Classification or SOC (the 2009 Taxonomy was used). 1102 occupations are represented and grouped by family (first two digits of the SOC code) and Career Cluster, which only covers 1052 occupations. The Career Clusters are listed in Table 1 on page 13. Occupations are represented in the O*NET Content Model by several hundred statistical measures referred to as descriptors. These descriptors fall into one of the six categories in the Content Model: Worker Characteristics, Worker Requirements, Experience Requirements, Occupational Requirements, Workforce Characteristics and Occupation-Specific Information. Information found in O*NET descriptors were obtained from occupational analysts and surveys given to workers and occupation experts.

Three datasets were analyzed: the Main Database and two Supplemental Database Files, the Detailed Activities file and the Tools and Technology file.

1. The **Main Database** contains many types of descriptors, the majority of which are generic in nature, span all occupations and provide only an occupation coefficient specific to the generalized descriptor. Because our interest is occupation specific and qualitative few of the descriptors relate to our investigation. **Task statements** (found in the Taskstatements table) are qualitative descriptions of typical tasks preformed in a given occupation. The task statements table contains 18,464 task descriptions organized under 965 occupations (1,100 of these tasks are duplicates between occupations).

   We distinguish 'soft' IT skills, usually accomplished by application program usage, from 'hard' IT skills, typically requiring hardware and operating system interaction. Many of the task statements that do not explicitly mention the use of IT describe processes usually accomplished with the aid of soft IT skills. Fewer than 6% of the task descriptions are duplicated between occupations. Task statements describing the use of similar IT skills can be worded completely differently, and do not list specific technologies (e.g., C++, Oracle). For this reason we annotated the task descriptions manually to facilitate automatic search.

2. **Detailed Work Activities** are semi-generic descriptions of activities performed in 804 occupations. The Detailed Work Activities data contains 26,844 relationships between 2,164 Detailed Work Activities and the included occupations. Each Detailed Work Activity is also classified in relationship to a generic 'Work Activities' descriptor found in the Main O*NET Database.

3. The **Tools and Technology** data is a list of the typical tools and technologies used in 629 occupations including both specific examples and a broader classification referred to as Commodity Codes. The Tools and Technology data contains a total of 28,637 tool observations (with 16,342 shared between occupations) consisting of the relationships between the included occupations and 2,879 tool Commodity Codes and 12,057 example tools. The Tools and Technology data contains a total of 15,211 technology observations (with 8,210 shared between occupations) consisting of the relationships between the included occupations and 109 technology Commodity Codes and 6,933 example technologies.

number	Cluster name
1	Agriculture, Food and Natural Resources
2	Architecture and Construction
3	Arts, Audio/Video Technology and Communications
4	Business, Management and Administration
5	Education and Training
6	Finance
7	Government and Public Administration
8	Health Science
9	Hospitality and Tourism
10	Human Services
11	Information Technology
12	Law, Public Safety, Corrections and Security
13	Manufacturing
14	Marketing, Sales and Service
15	Science, Technology, Engineering and Mathematics
16	Transportation, Distribution and Logistics

Table 1. Occupational clusters

How the results were obtained

The data used in this part of the study all share a common trait: they are prose, created for human consumption. Further, as noted in "Skill equivalence" on page 31, they do not reflect a common or standard vocabulary for skills, much less a common set of skill definitions. For this part of the study our methodology was computer-based keyword search. That is, we selected a set of words ("keywords") and used a computer program to search for occurrences of those words in the prose. There are at least two major issues with this methodology. First, the same word can take on different meanings in differing contexts. For example, the word "network" is an IT term in some contexts and a human resources term in others. Second, prose may describe a concept with a number of words, none of which is a keyword. For example, the concept whose keyword is "debugging" may also be described as "remove errors."

For this reason, keyword search alone may give false positives (indicate the presence of a keyword that exists, but means something else in context) or false negatives (indicate the absence of a keyword that does not exist, but where a phrase in the prose has the same meaning). We used two strategies to control false negatives and false positives. The first is to sample the result by inspecting randomly selected prose for false positives or false negatives. The second is to manually tag prose with the keywords that are reflected by the meaning of the prose. This latter strategy is labor-intensive and subjective, but performs far better than straight keyword search.

We created two subsets of the Detailed Work Activities data. In the first, we identified all occupations with activities associated with the "Interacting with computers" Work Activities descriptor. This subset contains 292 occupations (36% of the total). The other subset was manually classified to determine IT-related activities. This subset contains 303 occupations (38%).

In dealing with the Tools and Technologies data, we selected occupations that made use of computer tools. Both the tools (e.g., computer types) and technologies (e.g., computer application programs) are of interest.

Results

Overall, the concentration of IT-related tasks in the task statement data was relatively low. 6% of the 18,464 task statements were manually classified as IT tasks. Of those, 36% were soft IT tasks and the remaining 64% were hard IT tasks. 31% of all occupations contained IT tasks, either explicitly or implicitly. Of those, 57% contained only soft IT tasks, 24% contained only hard IT tasks and 19% contained a mix. Surprisingly, hard IT tasks were more numerous than soft IT tasks.

The results of the Cluster Skills analysis are shown on pages 17-28. These results focus on IT skills in all clusters, including cluster 11, the IT cluster.

Insights

Figure 2 on page 17 resulted from an analysis of the task statements in the main database. It shows the prevalence of hard and soft IT tasks among the various clusters. As expected, the IT cluster had the highest number of IT tasks, but every cluster except Human Services had at least one. Note the dominance of hard IT tasks over soft IT tasks in all clusters except the IT and Human Services clusters.

Figure 3 on page 18 also resulted from an analysis of the task statements in the main database and represents the cluster breakdown of occupations containing IT tasks. The green area to the left of each bar in the figure shows the number of occupations containing both hard and soft IT tasks, while the blue bar represents the number of occupations with soft IT tasks (but not only soft IT tasks) and the red bar with hard IT tasks. Thus the total number of occupations in a cluster with at least one IT task is represented by the length of the blue bar plus the length of the red bar minus the length of the green bar. Interestingly, more occupations in the Science, Technology, Engineering and Mathematics cluster required IT tasks than in the Information Technology cluster! Even Health Science had more occupations requiring IT tasks. We suspect that this picture has changed dramatically in the last few decades as IT has become more relevant to the needs of specific occupations in virtually every cluster.

Figure 4 through Figure 7 were derived from the invaluable Detailed Work Activities data, from the supplemental files. Figure 4 on page 19 shows the number of occupations in each cluster that have IT-related work activities. The red bar shows occupations that only our manual classification identified as having such work activities, and thus the value of that classification. Note that the total number of occupations differs by cluster, so that this figure does not show the percentage of occupations in a cluster that have at least one IT-related work activity.

Figure 5 on page 20 shows the number of clusters that contain a specific detailed IT work activity. That is, the topmost bar shows that 16 of the clusters (all of them) contain occupations that use computers to enter, access or retrieve data. Fifteen of the clusters have occupations requiring the use of word processing or desktop publishing software, but only three of the clusters (including the information technology cluster) have occupations that require use of computer networking technology directly and explicitly (virtually all computer users use computer networking technology but few of them interact with that technology directly). This graph shows the most-commonly-found IT-related work activities and illustrates that many of them are found in many of the clusters.

Figure 6 on page 21 focuses on the 9 IT cluster occupations included in the Detailed Work Activities data. The most ubiquitous activities are testing, evaluation and security-related; the least ubiquitous are shown at the bottom of the figure. Note that the more-commonly-found activities are operational while the least-commonly-found activities include some involving design and implementation rather than operation.

Figure 7 on page 22 complements the preceding figure, listing IT-related activities in clusters other than Information Technologies. As might be expected, the soft IT activities (e.g., use computers to enter, access or retrieve data) are predominant, while more hard IT activities (e.g., use computer programming language, use computer application flow charts) are much less commonly found. The interesting observation is that these hard IT activities ARE found in non-IT cluster jobs.

Figure 8 on page 23 shows the number of occupations in each cluster with computer tools. As the number of occupations varies by cluster, this is not an indication of coverage but rather an enumeration. Interestingly, Health Science has the most occupations requiring computer tools.

Figure 9 on page 24 shows the number of clusters with at least one occupation that uses the given computer type. Personal computers, notebook computers and desktop computers are used in every cluster, while thin-client computers are used in only one. Figure 10 on page 25 and Figure 11 on page 26 break this down for the IT cluster and for the non-IT clusters. For the IT cluster, servers and mainframe computers are most-frequently referred to, while high-end computer servers are much less so, reflecting their limited use in larger enterprises. For the non-IT clusters, unsurprisingly, personal computers dominate.

Figure 12 on page 27 and Figure 13 on page 28 show the software used in the IT cluster and in the non-IT clusters, respectively. In the IT cluster the most-frequently-mentioned software supports development. High on the list are systems software like operating systems and databases. While Internet browser software is not frequently mentioned as a required activity, it is used by all occupations in the IT cluster. There are some surprises in the non-IT clusters, though. Many occupations call for occupation- or cluster-specific software (e.g., medical software, financial analysis software) as well as for cross-cluster software like data base user interface and query software, project management software and electronic mail software.

Summary

Our analysis supports the conclusion that IT activities now pervade the workforce. If we had historical data it would be likely that the trend of increasing use of computers in non-IT clusters would be most dramatic. Many occupations outside of the IT cluster also require hard IT activities, supporting the notion of a shadow IT workforce whose workers perform critical IT tasks in addition to their regular job requirements.

The importance of cluster- and occupation-specific software is probably new news (new as of the millennium!) as decades of investment in understanding job requirements pay off in targeted software.

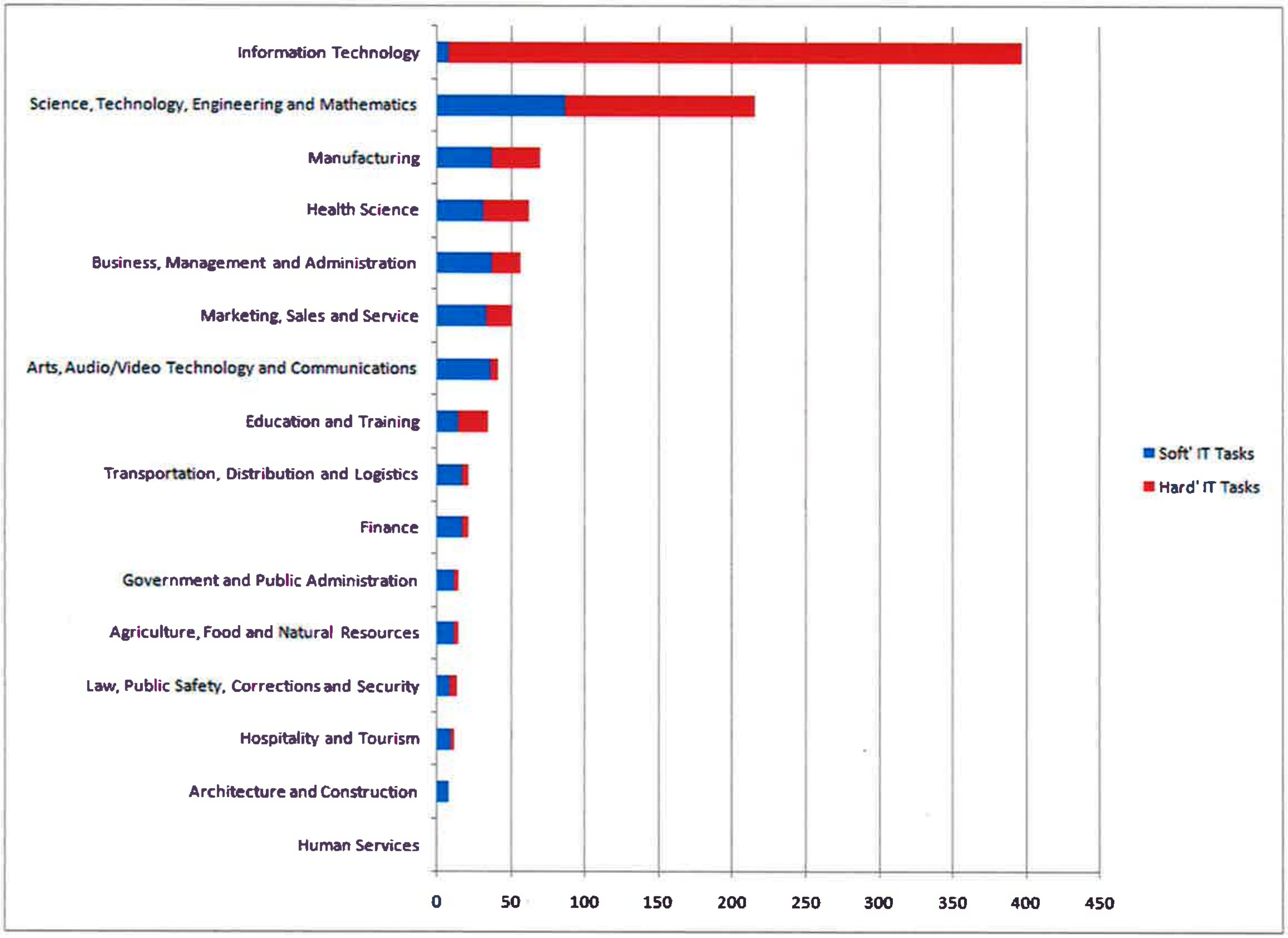

Figure 2. Hard and Soft IT Tasks by Cluster

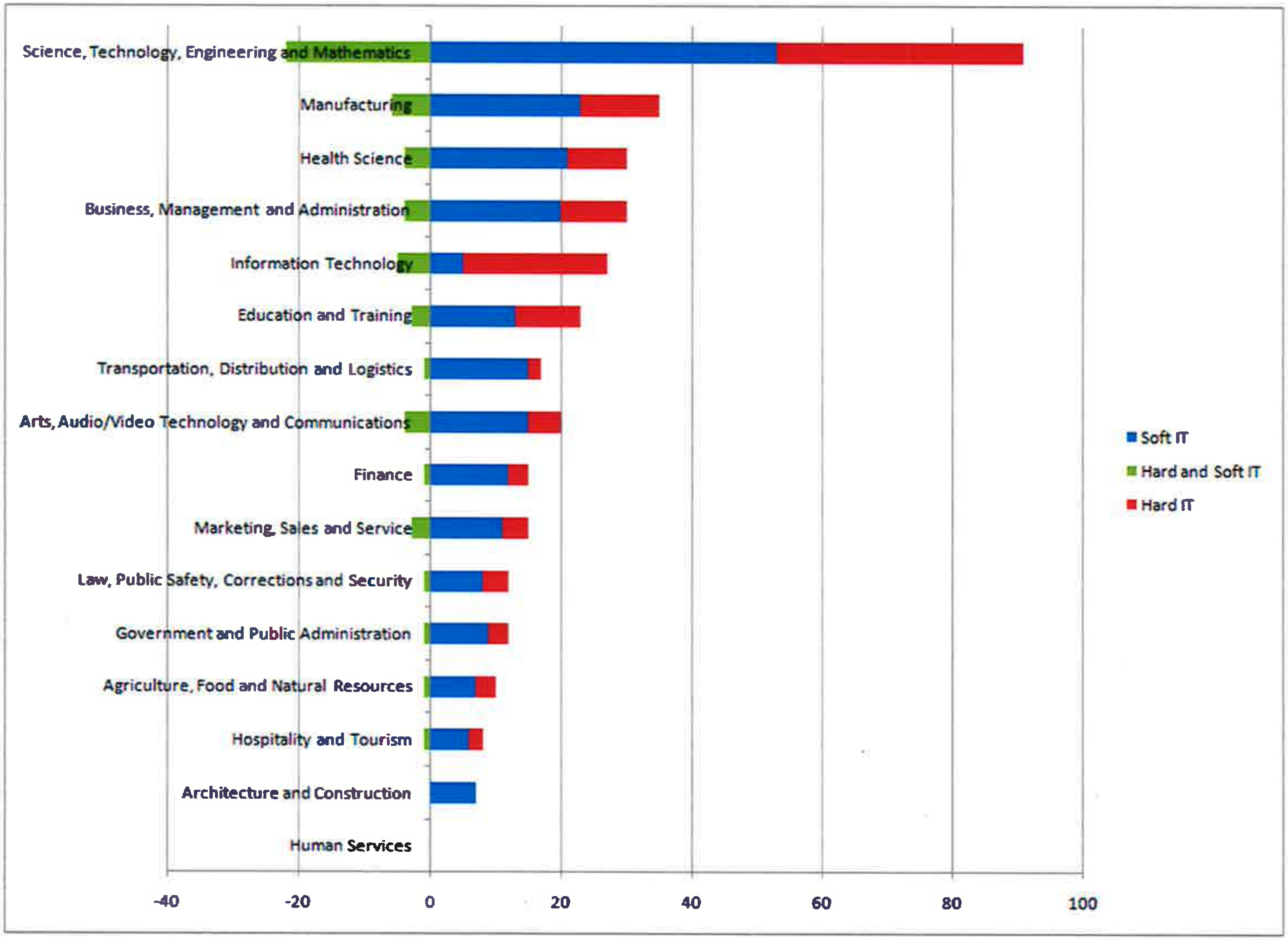

Figure 3. Hard and Soft IT by Occupation

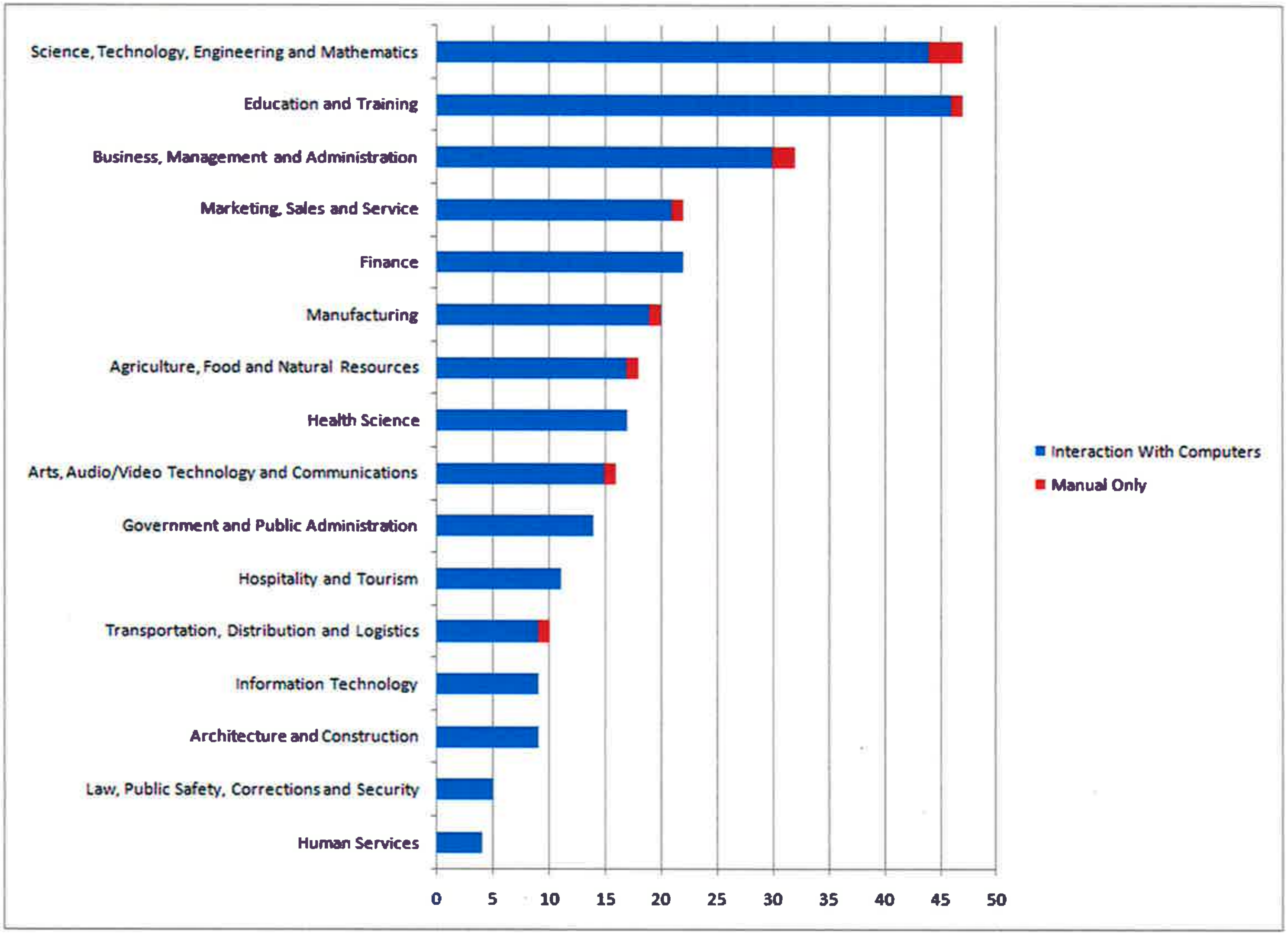

Figure 4. IT-related Detailed Work Activities -- Occupations by Cluster

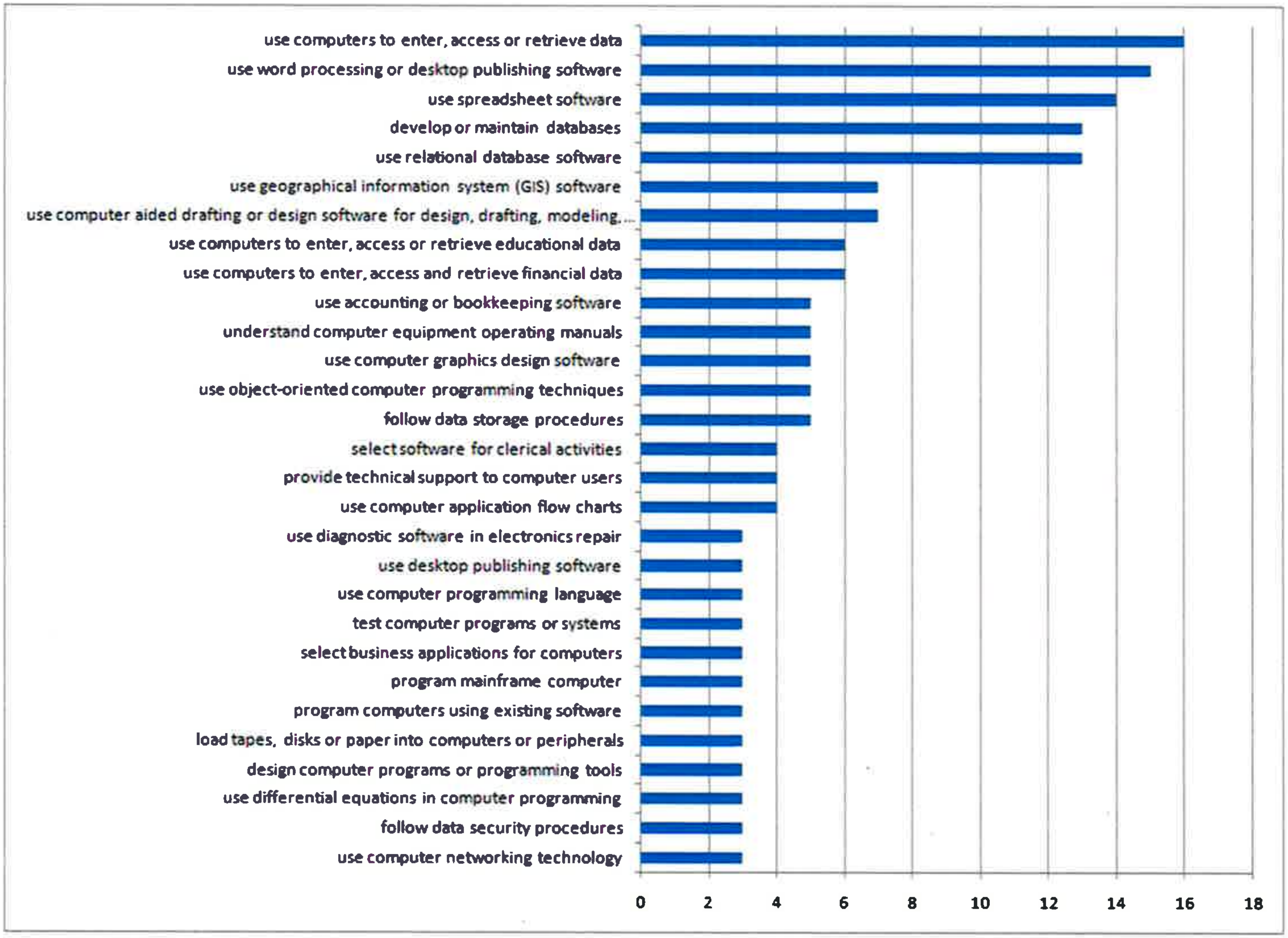

Figure 5. Top IT-related Detailed Work Activities by Cluster Count

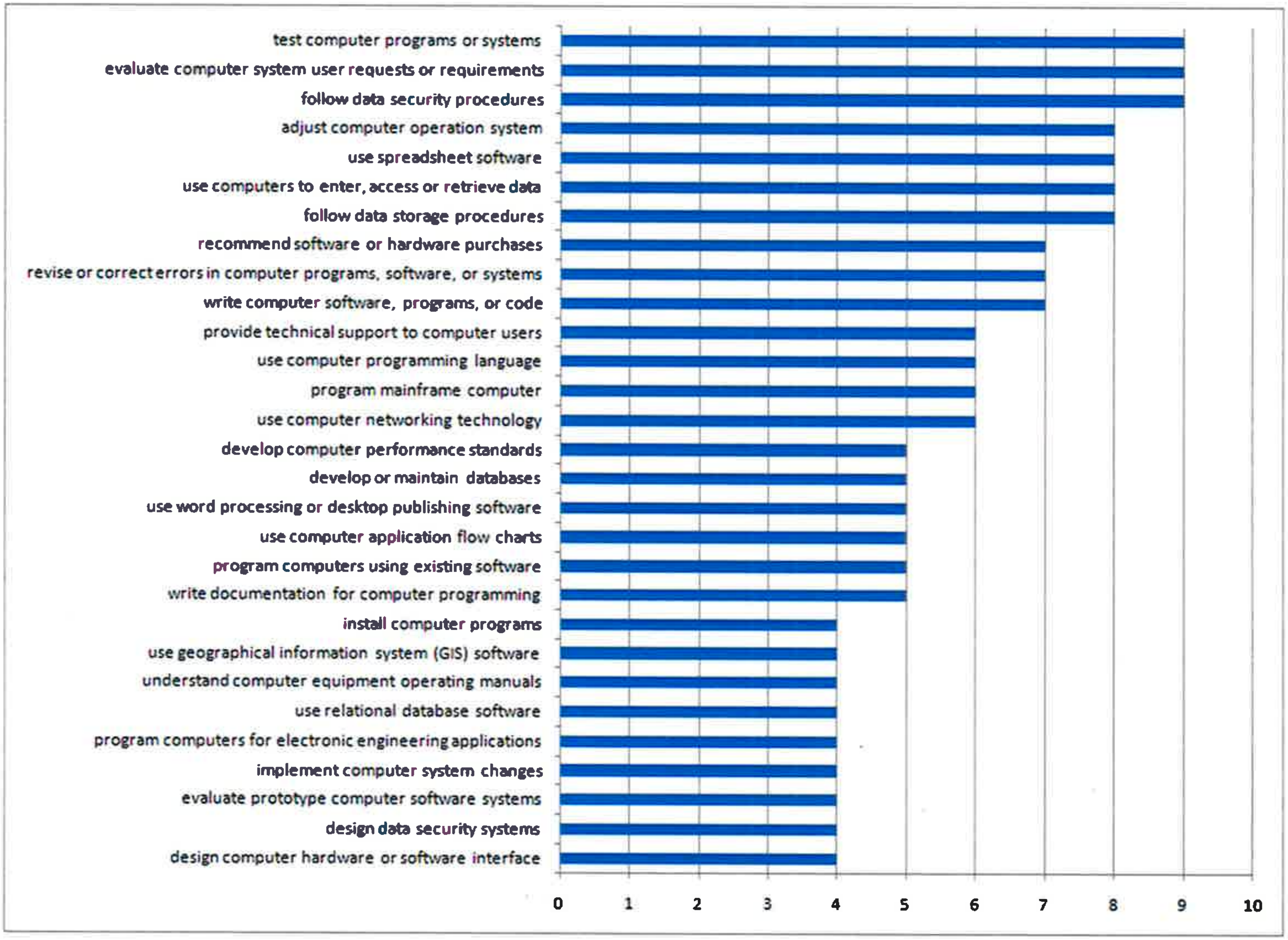

Figure 6. Top IT Cluster Detailed Work Activities

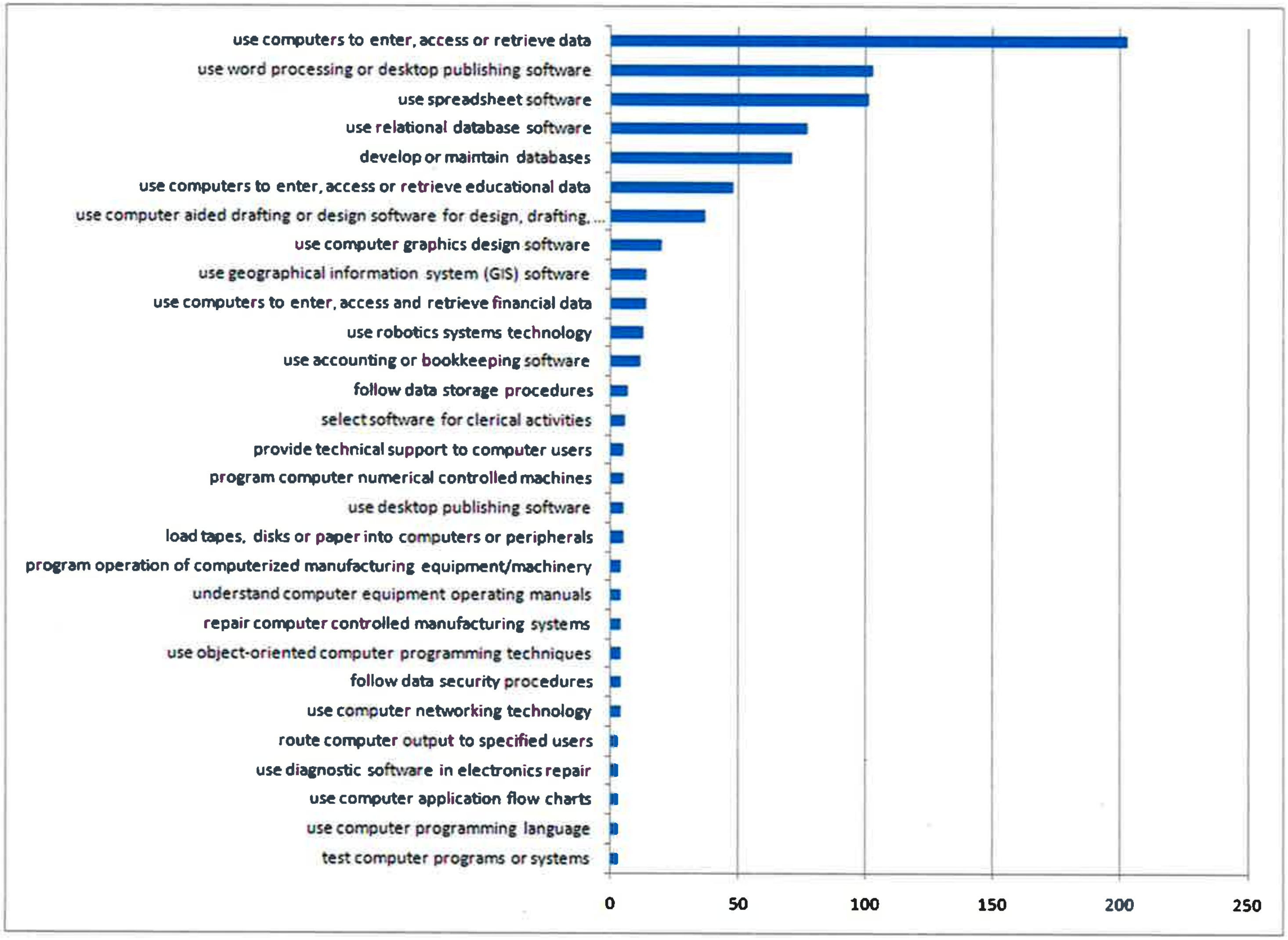

Figure 7. Top Non-IT Cluster Detailed Work Activities

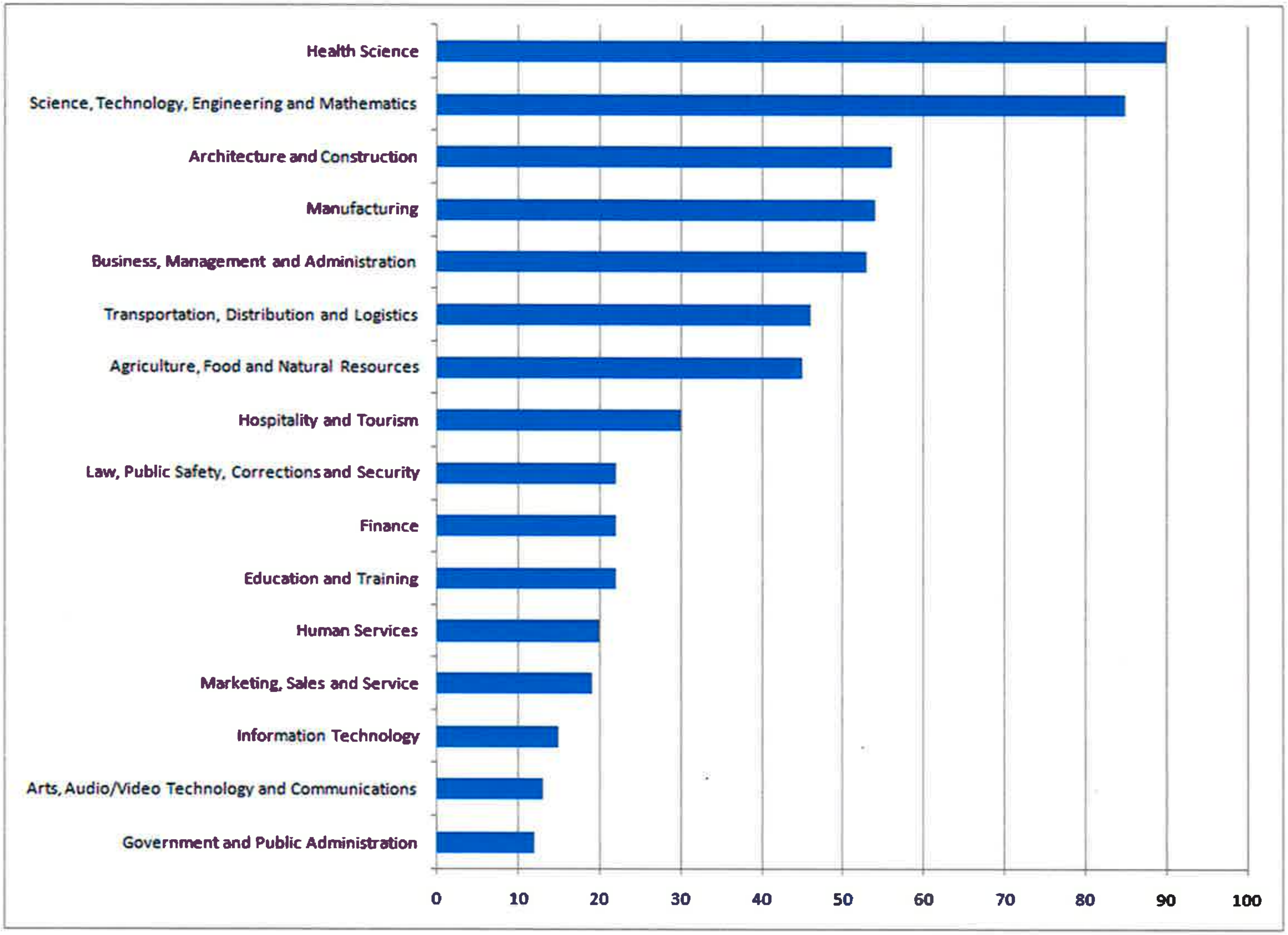

Figure 8. IT-related Tools and Technology -- Occupations by Cluster

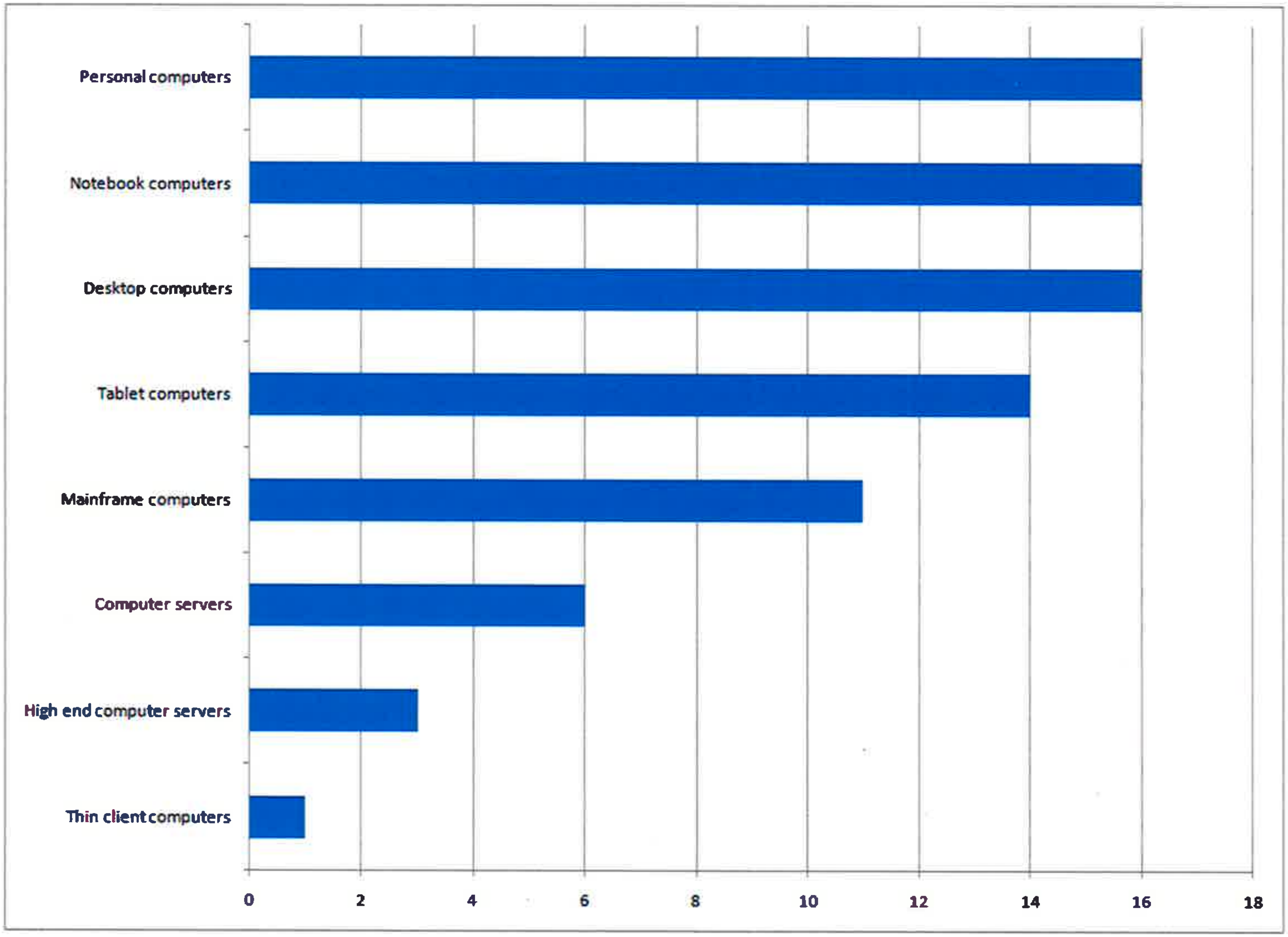

Figure 9. Computer Tools by Cluster Count

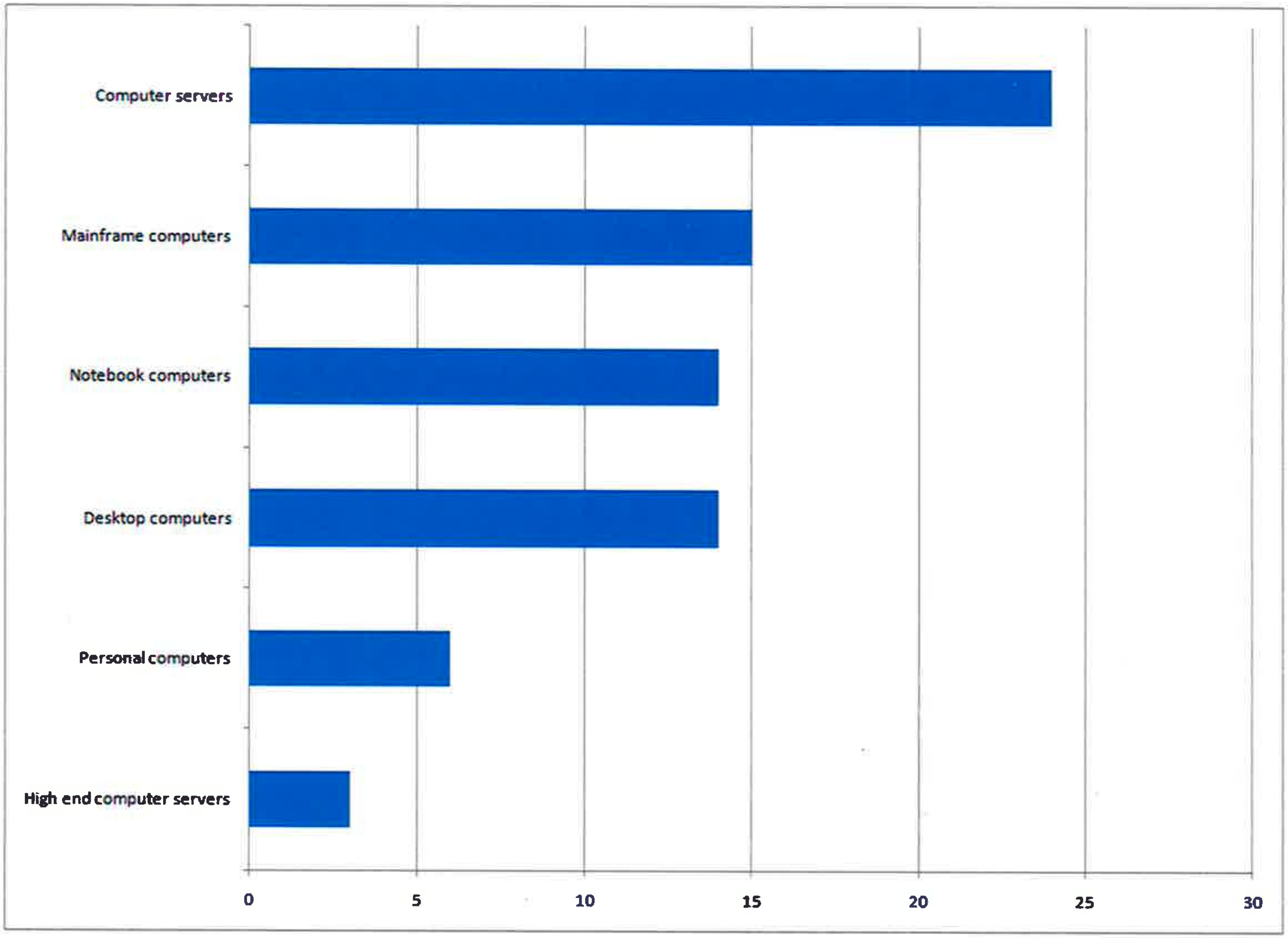

Figure 10. IT Cluster Computer Tools

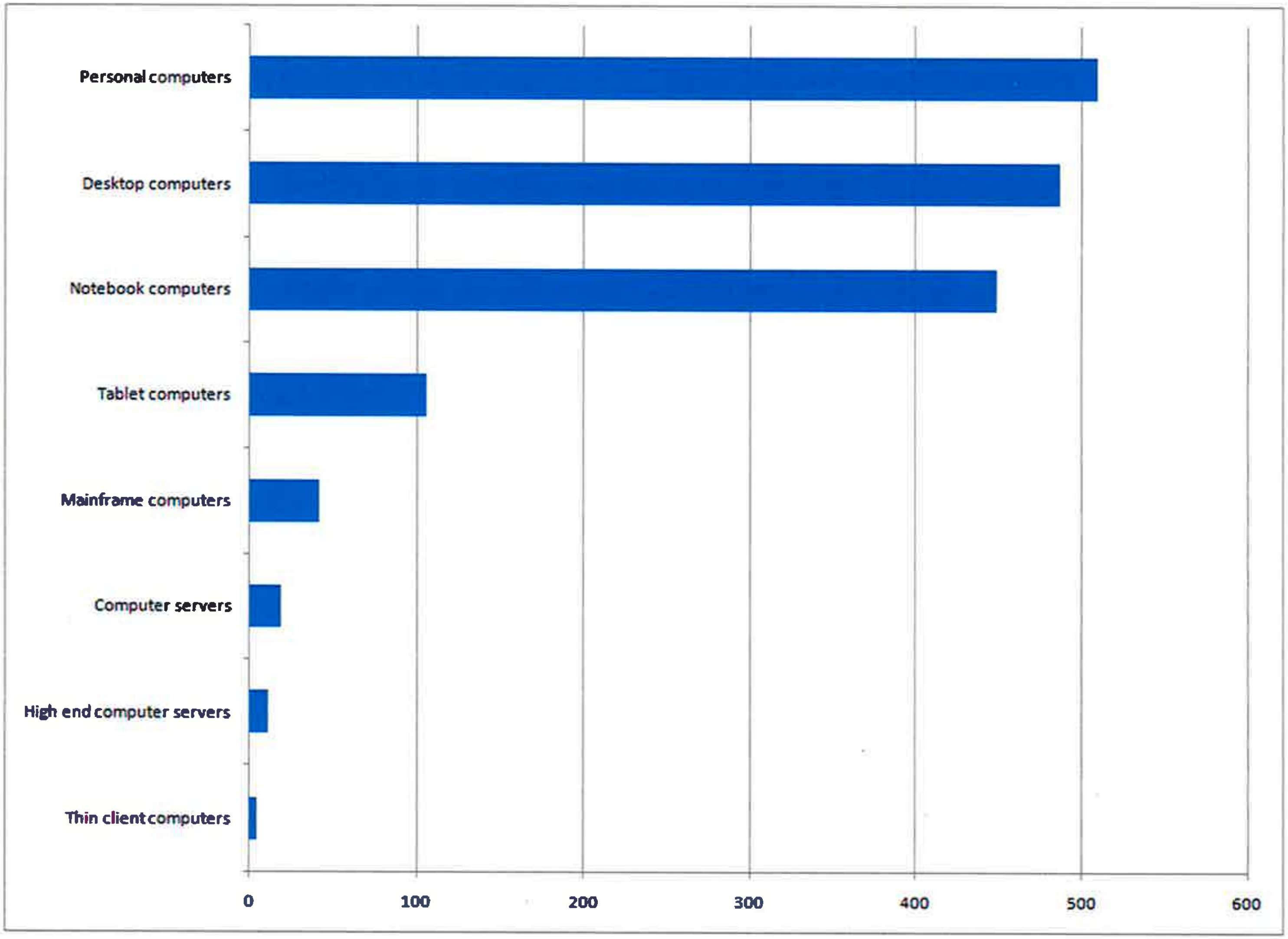

Figure 11. Non-IT Cluster Computer Tools

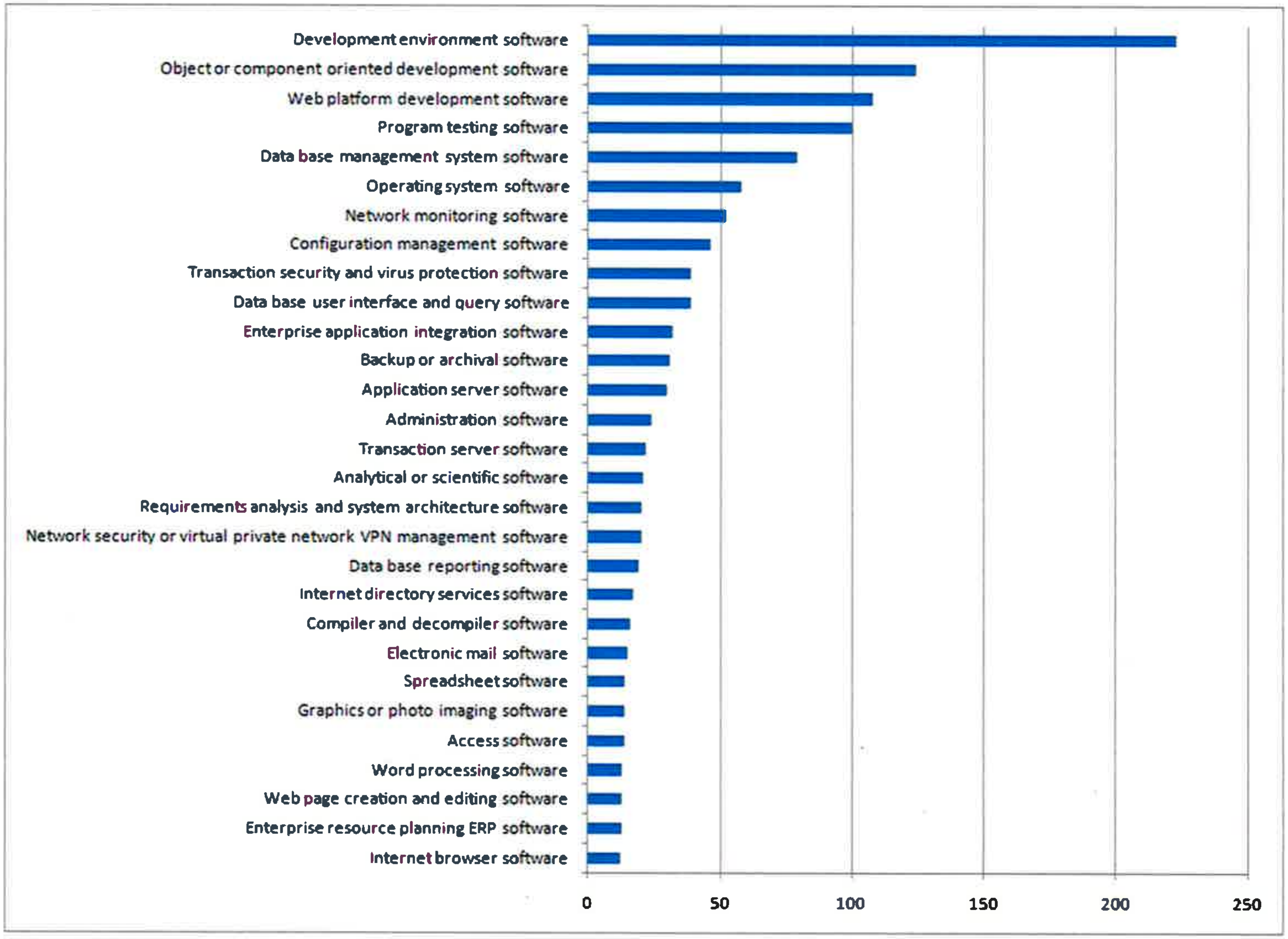

Figure 12. Top IT Cluster Software

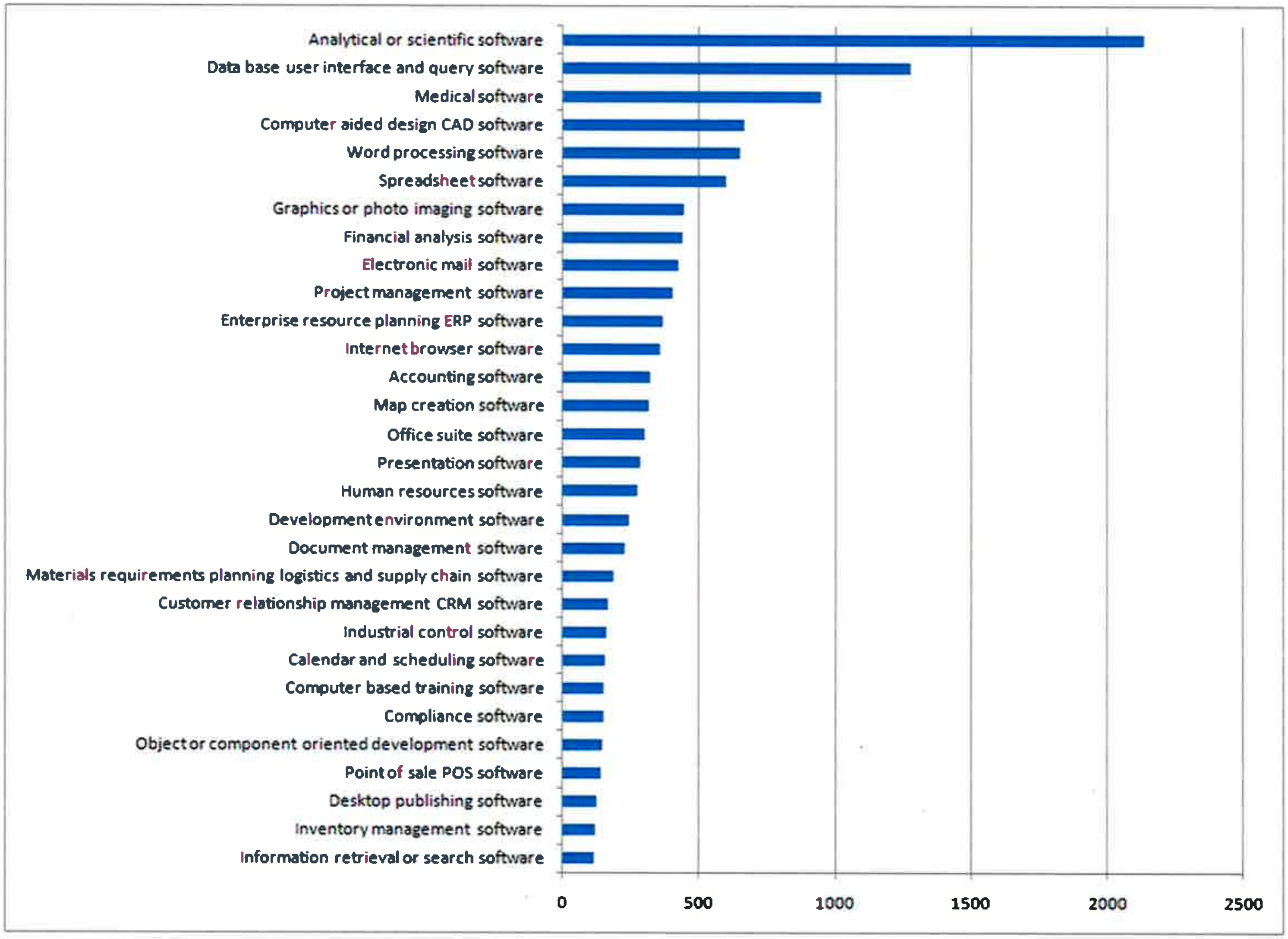

Figure 13. Top Non-IT Cluster Software

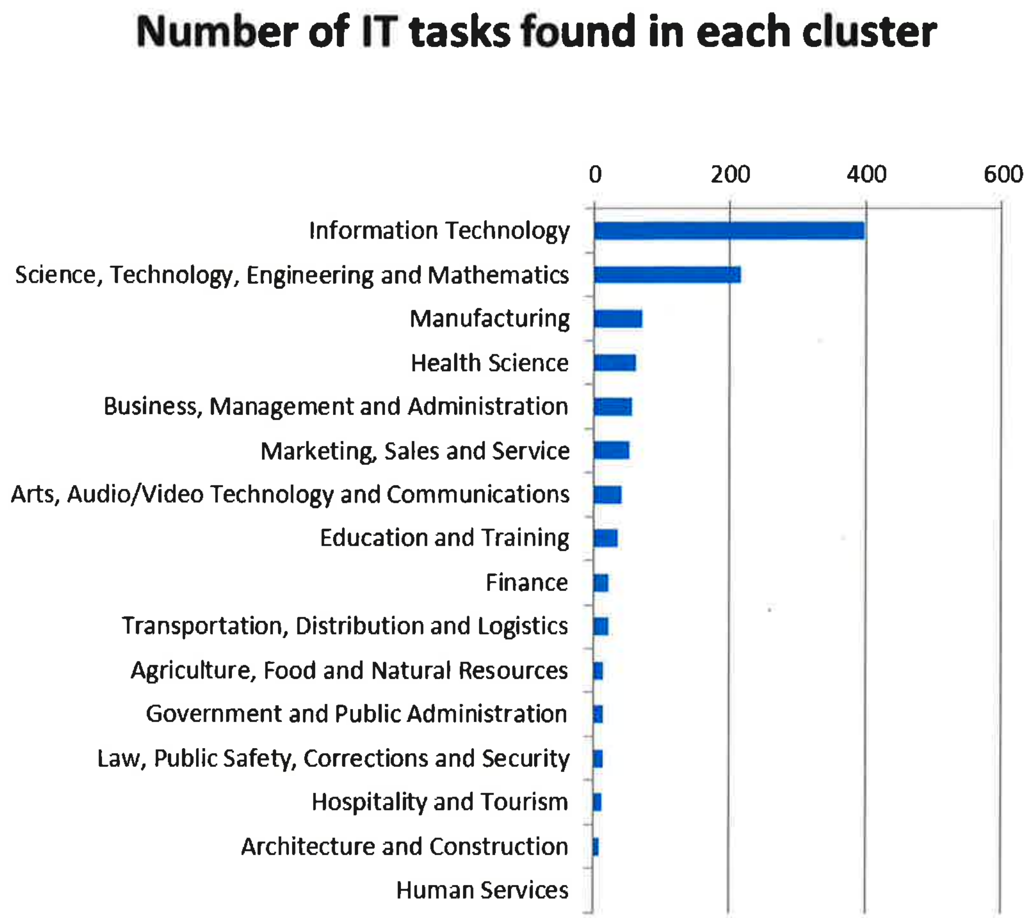

Figure 14. Number of IT tasks per Cluster

Skill Gaps and Gluts

The material in this section relates to contractual deliverables 1, 4 and 5 (see "Appendix A. Contractual deliverables" on page 72).

The purpose of this analysis was to determine the extent to which Maine's IT workforce consists of individuals with skills requested by Maine employers (match), skills not requested or in excess of requested (gluts) or without requested skills (gaps). Matches indicate that the IT worker marketplace is working. Gaps indicate a growth in demand without an accompanying growth in supply or a constant demand with shrinkage in supply, possibly due to an ageing workforce. Gluts indicate a growth in supply without an accompanying growth in demand, possibly due to misdirected training efforts or shrinkage in demand for a particular skill due to that skill becoming obsolete. Without historical data we cannot determine which of the possibilities is most likely but anecdotal evidence from industry sources can be used to help diagnose the situation. For example, the data shows a gap in the Oracle Dba skill; industry sources indicate that this is most likely an increase in demand without an accompanying increase in supply.

Were action to be taken based on our gaps and gluts analysis the action should be conditioned on whether a gap or glut is supply-driven or demand-driven. In the case of the Oracle Dba skill it is likely that this gap is demand-driven, so effective action must attempt to increase the supply. This action could take the form of incentives for relocation of individuals with this skill to Maine or retraining of Maine residents in this skill or incentives to current college/university students to acquire this skill. Another possibility might be to simply publicize the gap. If workers are unaware of this employer need and have the resources to acquire the skill, this might be all that is necessary.

Sources of data

Two relevant datasets were analyzed:

1. Survey data in the form of an Excel® file from TechMaine's survey of March-August 2009 (Kumiszcza, 2009), from which the respondent names were removed. This data was obtained via a voluntary online instrument with an incentive[3]. Participation was solicited from TechMaine's members and contacts, users of the TechMaine Web site, visitors to the Maine Career Centers and from Maine employment agencies. There were 288 respondents (256 currently working in-state) representing an estimated response rate of "...approximately three to ten percent ..." and 3% of Maine's IT workforce in that year. The survey author says it best: "...the census should be viewed as an exploratory project on workforce's skills and skills gaps rather than a statistically valid sample of a specific sector."

   The TechMaine data consisted of one row per respondent. Several columns contained data that indicated whether the respondent was currently employed and if so, in what county of Maine. Other columns contained data indicating the respondent's self-

[3] The incentive was a free copy of Kaspersky anti-virus software, worth about $40.

assessment of his or her level of mastery in the skill represented by that column. Levels of mastery ranged from Basic to Intermediate, Advanced and Expert, with a blank or N/A indicating that the respondent did not possess (or did not choose to disclose) the given skill. Among the skills represented were QuickBooks, White Box Testing and Object-oriented Analysis and Design. Some columns represented certifications such as Adobe Certified and IBM AIX. According to Kumiszcza, the choice of skills to be included in the survey was made by consulting "industry sources."

1. A computer-based analysis of some Maine job postings on the Web done by Burning Glass[4], received from John Dorrer, then Director of the Center for Workforce Research and Information (CWRI), Maine Department of Labor on September 1, 2010. This data was in the form of an Excel® file with two sheets. One sheet listed the number of postings for computer and mathematical jobs (SOC codes 11- and 15-) found for each of 100 computer or mathematical skills; a second sheet, not used in this study, listed jobs with other SOC codes (not 11- or 15-) that required at least one computer or mathematical skill. It is not known what specific Web sites were accessed, how many postings were analyzed or what the exact date of access was. In particular, we do not know what the coverage of actual job openings was and whether the actual coverage is representative of all computer and mathematical job openings in Maine.

The Burning Glass data for computer and mathematical jobs consisted of one row per skill, each row listing the number of job postings requiring that skill. It is not known how the Burning Glass skill list was determined. It includes such skills as Oracle Dba and the problematic (ambiguous and overly general) skill Data Processing.

How the results were obtained

We analyzed the data two ways. In the first, we constructed a scaled comparison of the number of unemployed TechMaine respondents possessing at least one skill equivalent to a Burning Glass skill, compared to the Burning Glass count of job postings containing that skill. As we shall see, this analysis has limited value. Second, we compared the ranking of Burning Glass skills to the ranking of equivalent skills in the TechMaine respondents. This comparison is discussed in detail in "The Ranking Comparison" on page 33.

Skill equivalence

The analysis of this data was significantly complicated by the lack of a common list of skills. In particular, the skills identified by the Burning Glass analysis differed, in many cases, from those identified in the TechMaine survey. Accordingly, an effort was made to construct a "skill equivalence" map. The actual map consisted of an Excel® sheet consisting of two columns and somewhat more than fifty rows. In the first column, a skill name from the Burning Glass list is given, while in the same row in the second column, a skill name from the TechMaine list may be given, or the cell may be blank. A blank cell in the second column means that there is no

[4] http://www.burning-glass.com/

TechMaine skill that corresponds with the Burning Glass skill. Since multiple TechMaine skills can correspond to a given Burning Glass skill there may be two rows with the same Burning Glass skill in the first column and different TechMaine skill names in the second column. Since multiple Burning Glass skills can correspond to a given TechMaine skill there may be multiple rows whose first cell is different but whose second cell is the same.

The construction of the skill equivalence map was done by manually scanning the TechMaine skill list for each Burning Glass skill and entering an equivalent in each case that a judgment of correspondence was made. This judgment is subjective, based on the authors' understanding of the given skills. This understanding is based, in turn, on the experience of the authors in the IT field. Thus there can be no guarantee that the map is strictly correct. Further, it is believed that there is an implicit context associated with each identification of a Burning Glass skill – while the skill Oracle Dba may be independent of context the skill Data Processing surely is not. Without a commonly understood and well-defined list of skills, and without knowledge of context, this is the best we can do.

The Scaled Comparison

In order to assess gaps and gluts, then, for each Burning Glass skill we began by counting unemployed TechMaine respondents possessing at least one equivalent TechMaine skill at a mastery level of Advanced or Expert. Gaps would have been less obvious had we chosen to include Intermediate-level skills and we reasoned that if the primary focus of a job posting was to acquire the given skill, Intermediate-level skills and below would not suffice.

Now we were faced with two dilemmas: we do not know how representative the TechMaine data is of the skill supply in Maine and we do not know how representative the Burning Glass analysis is of employer demand. It seems likely that respondents possess higher levels of skill and higher-paying skills than in the workforce in general. Our reason for believing this is that many of the respondents were solicited because they are employed by members of TechMaine, and some of the respondents may have responded because of their higher level of identification with the profession. If this is true, and we must emphasize that it is only a surmise, we may be underestimating the size of a gap because more individuals with that skill have responded than is typical[5]. Similarly, we may be underestimating the size of a glut, because fewer of the individuals with that skill have responded than is typical.

Additional reasons for doubting how representative this data is of the Maine IT workforce in general include the relatively high unemployment rate (16%) as compared to the unemployment rate of the entire workforce at that time (8.2%), and the uneven geographic distribution of respondents (Kumiszcza, 2009). In particular, 65% of the respondents listed Cumberland as their county of employment, while CWRI data indicated that 50% of IT workers worked in that

5 Here we are assuming that respondents are more likely to be more "professional." Further, we assume that the more "professional" a respondent is the more he or she networks and explores other job opportunities, and the more aware they are of what skills are in demand. Thus they are more likely to have skills that are in demand.

county. This probable geographic bias may be due to the fact that TechMaine is headquartered in Cumberland County and holds its meetings there.

(Center for Workforce Research and Information, 2009) gives the size of Maine's Computer and Mathematical workforce in 2008 as 8390. The TechMaine survey solicited over 5000 potential respondents and had 256 respondents who were either unemployed or currently working in-state, for an estimated response rate of 6%, somewhat low for an incented survey. If the survey were typical, each respondent would represent 8390/256 or 33 current or potential in-state workers.

The scaled comparison suffers from a number of defects:

- The number of respondents in the TechMaine survey was low. For our sample and population size, at 95% confidence the error rate is over 6% for employed workers and 15% for unemployed workers. In effect, we have little confidence in our scale factor.
- It is likely that the TechMaine survey was significantly biased.
- We have no context for the Burning Glass skill categories.
- We do not know what proportion of Maine demand is represented by the Burning Glass analysis. In effect, there is an unknown scale factor.

Figure 15 on page 37 shows a ranked scaled comparison between supply (scaled survey data for unemployed workers) and demand (un-scaled Burning Glass data). This figure includes some Burning Glass skills that are either overly broad or ambiguous (e.g., Troubleshooting) or skills with no clear survey equivalent (e.g., Shell Scripting). The conclusion might be drawn from this figure that Java is a gap and Computer Hardware is a glut, but because of the uncertainty in scale factors this conclusion is in doubt.

The Ranking Comparison

In order to remedy some of the defects of the scaling comparison, we undertook a comparison that does not require guessing at scale factors. This comparison abandons any attempt at assessing either the actual demand or the actual supply of skills represented in Maine. It focuses on how skills are ranked, both in the Burning Glass analysis and in the survey. For example, Programming is the #1 skill in the Burning Glass analysis but it was the #4 skill among employed Maine IT workers and #8 among the unemployed. Our measure computes a supply skill rank disparity of -4 for employed workers and -8 for unemployed workers. We call the measure a "supply skill rank discrepancy" to remind us that it measures the difference between the supply skill rank and the demand skill rank.

This unusual measure does not suffer from the scale-factor issue discussed previously but it is not directly related to gaps and gluts. We argue that it is indicative, however, especially in the extreme cases. One of those is the Java skill, where the skill rank disparity is between -24 and -33 for employed and unemployed workers, respectively. The demand rank is 4; the supply ranks are 28 and 37. Employers ask for this skill much more frequently than it is encountered in workers' self-assessed skills. This is strongly indicative of a gap. Another case is Help Desk

Support, where the skill rank disparity is approximately 38 for both employed and unemployed workers. The demand rank is 46; the supply ranks are about 8. Employers ask for this skill much less frequently than it is encountered in workers' self-assessed skills. This is strongly indicative of a glut.

Accordingly, we focus our analysis on the supply skill rank disparity measure.

Results

The results of the Gaps and Gluts analysis using the supply skill rank disparity measure are shown on pages 38-42. Each page represents results for ten Burning Glass skills; overall, the results represent the top fifty Burning Glass skills. Most frequently requested skills are at the top of each chart. Problematic Burning Glass skills are shown with an asterisk. These skills were either ambiguous in the extreme or had no corresponding TechMaine skills.

Insights

In Figure 16 on page 38 we see that the supply rank disparity is about the same for both employed and unemployed workers. With a few exceptions throughout all of the figures this indicates that unemployed workers are not atypical. Java and Oracle have the most negative supply rank disparity and appear to be gaps. 38 respondents listed their Java skills as Advanced or Expert but only two unemployed respondents did, indicating a relatively high employment level for the Java skill. Without historical data it is premature to speculate on whether this is a demand-driven or supply-driven gap, but anecdotal evidence indicates a growth in demand, and similarly for the Oracle skill. The SQL skill appears to be a gap as well, but not as obviously as Java and Oracle. The Operating Systems skill might appear to be in slight oversupply, but the definition of that skill is ambiguous and overly inclusive. The Computer Hardware skill appears to be in slight oversupply among unemployed workers, but the magnitude is not significant. This skill is associated with troubleshooting and break/fix activities related to desktop and laptop personal computers, and is a relatively low-value skill.

In Figure 17 on page 39 the most pronounced discrepancies are SAP (undersupply) and Quality Control (oversupply). In fact, most respondents listed Quality Control as a skill, although it may be that this is more of a work attribute than a specific competence.

In Figure 18 on page 40 Workflow Analysis and Website Production appear to be in oversupply, while only Mainframe is in marginal undersupply and is likely to be an actual gap, most likely supply-driven, as this is a skill possessed by older workers who are now retiring in substantial numbers. Anecdotal evidence confirms that Website Production is in at least adequate supply. Workflow Analysis is a puzzle – business process analysis and design is a rather formal specialty and it is likely that the respondents are not claiming this specialty, but rather a generalized capability.

In Figure 19 on page 41 the supply rank disparity is enormous for System Analysis, ranked 36 in demand and between 3 and 4 in supply. As we have noted for other skills, it is likely that respondents are not claiming System Analysis as a specialty but rather as a generalized capability. Note however the possible gluts for Application Server and Web Application

Development, consonant with the glut noted in Website Production. Routers is an interesting case, being in strong oversupply only for unemployed workers. This would argue that unemployed workers have more operational skills than skills in software development.

In Figure 20 on page 42, the dominance of skills with a strong positive supply rank disparity is remarkable. In large part, this is because these skills are in lesser demand (supply ranks 41-50). Note the apparent clear oversupply in Help Desk Support, a lower-level skill found in call centers. The apparent oversupply in Debugging is puzzling but perhaps the respondents were interpreting it in a broader sense as relating to any break/fix activity or to Web Application Development. At some level, skill with Servers is quite common and the coupling to MySQL, a very common database for Web sites, can be seen in the figure.

The strong oversupply in Object Oriented Programming is perhaps the most puzzling result, given the gap in Java. 92 respondents claimed this skill, while its demand rank was 47. It may be that this skill was not accurately analyzed in the job posting data, as it is crucial to Java programmers.

In Figure 21 on page 43 is shown a histogram of skill rank disparities for selected skills, omitting ambiguous or unmatched skills. Vertical bars in this histogram count the number of skills whose rank disparities fall within a given range. The range labels actually label the tick mark to the right: in the figure the interval with range label -30 actually represents the range interval from -30 to -34. For example, the leftmost vertical bar indicates that there was one skill for unemployed workers whose rank disparity was between -30 and -34. This skill was Java, whose skill rank disparity is -33. The bar just to the right indicates that there was one skill for employed workers whose rank disparity was between -30 and -34. That skill was Oracle, whose skill rank disparity is -31. You can verify this by reference to Table 2 on page 44.

Some examination of Table 2 on page 44 reveals that for the most part, unemployed skills rank disparities are similar to employed skills rank disparities for the same skill. There are some exceptions, for example Business Process and Data Warehousing, but for the most part the distribution of disparities is similar. We can draw a tentative conclusion that the unemployed are not atypical. That is, the frequency with which a given skill appears in the unemployed workforce is about the same as that of the same skill in the employed workforce.

Figure 21 shows a distribution of skill rank disparities that is approximately normally distributed. The extremes of this distribution are indicators of possible gaps (large negative disparities) and gluts (large positive disparities). Focusing first on gaps among the employed, skills with rank disparities less than -14 (an arbitrary choice) include Oracle, SAP, Java and .NET. The first two of these are typical of needs in medium-sized to larger enterprises; the second two are typical of software development, especially for those enterprises.

Now focusing on gluts, skills of the employed with rank disparities greater than 20 (an arbitrary choice) include Help Desk Support, Debugging, Object Oriented Programming, Systems Analysis, MySQL and Servers. With the exception of Object Oriented Programming and possibly

Systems Analysis, these are operational skills, not development skills. Again we see Object Oriented Programming as an anomaly, as identified earlier.

In summary, we find first that most unemployed workers are not atypical. The most pronounced gaps are in Java, Oracle and SAP with less pronounced gaps in Unix, .Net, Visual Basic, SQL, JavaScript and Mainframe (there is a small gap in Cobol as well). This represents two patterns: gaps in Cobol and Mainframe, probably due to worker retirement, and gaps in programming and database, probably due to employer growth. It is troubling that these latter gaps correspond to jobs in high demand with high value. These gaps also contribute to a difficulty for employers to meet growth targets.

There are two patterns of gluts. The first is in Help Desk Support, Troubleshooting and Computer Hardware, all operational skills related to PC installation and maintenance. The second pattern is in Web Application Development, Servers, MySQL and Website Production, all related to basic Web site development. These patterns are troubling in that they are both well-represented in the respondents and they correspond to jobs with relatively low value.

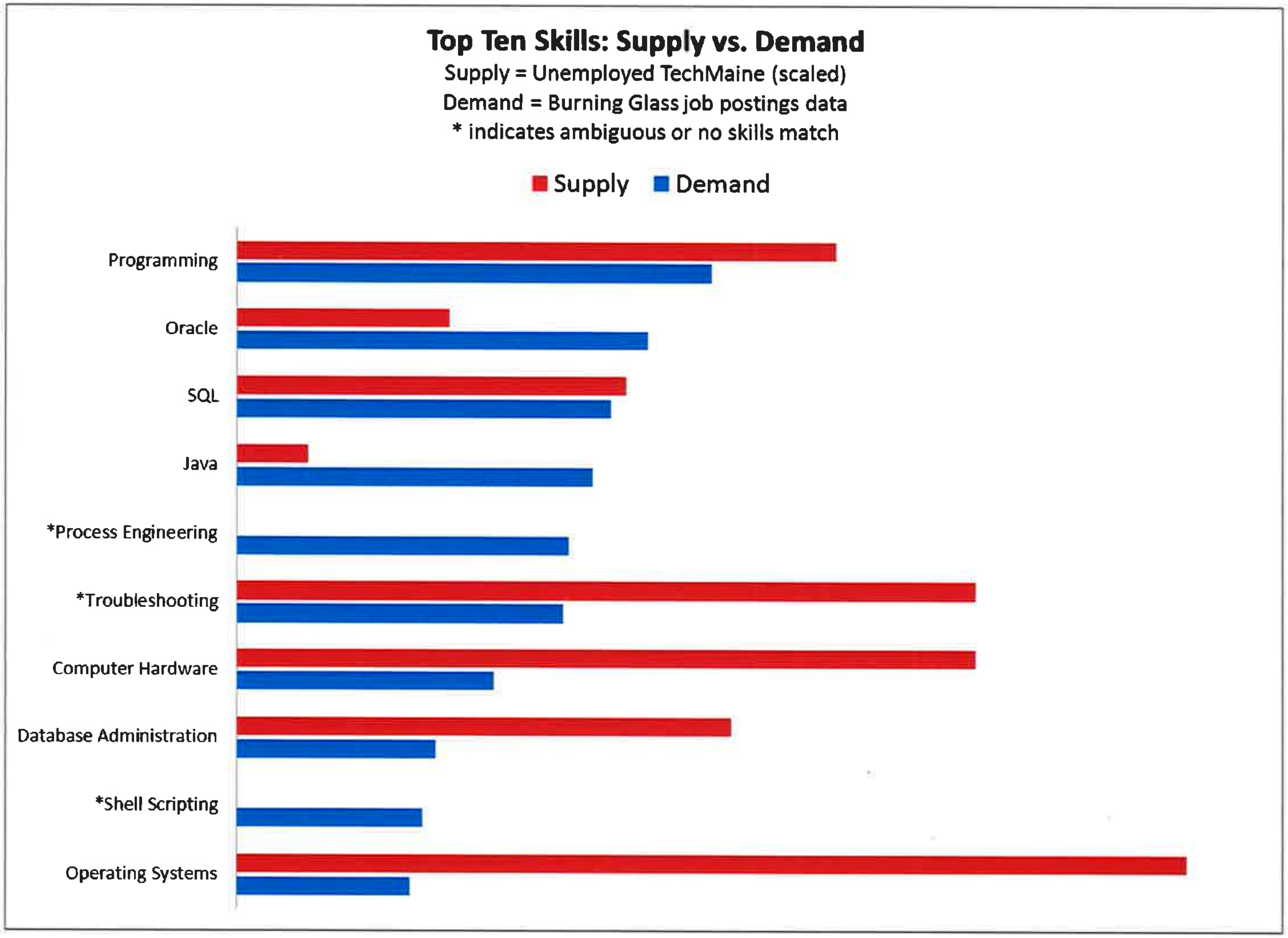

Figure 15 - Top Ten Supply vs. Demand

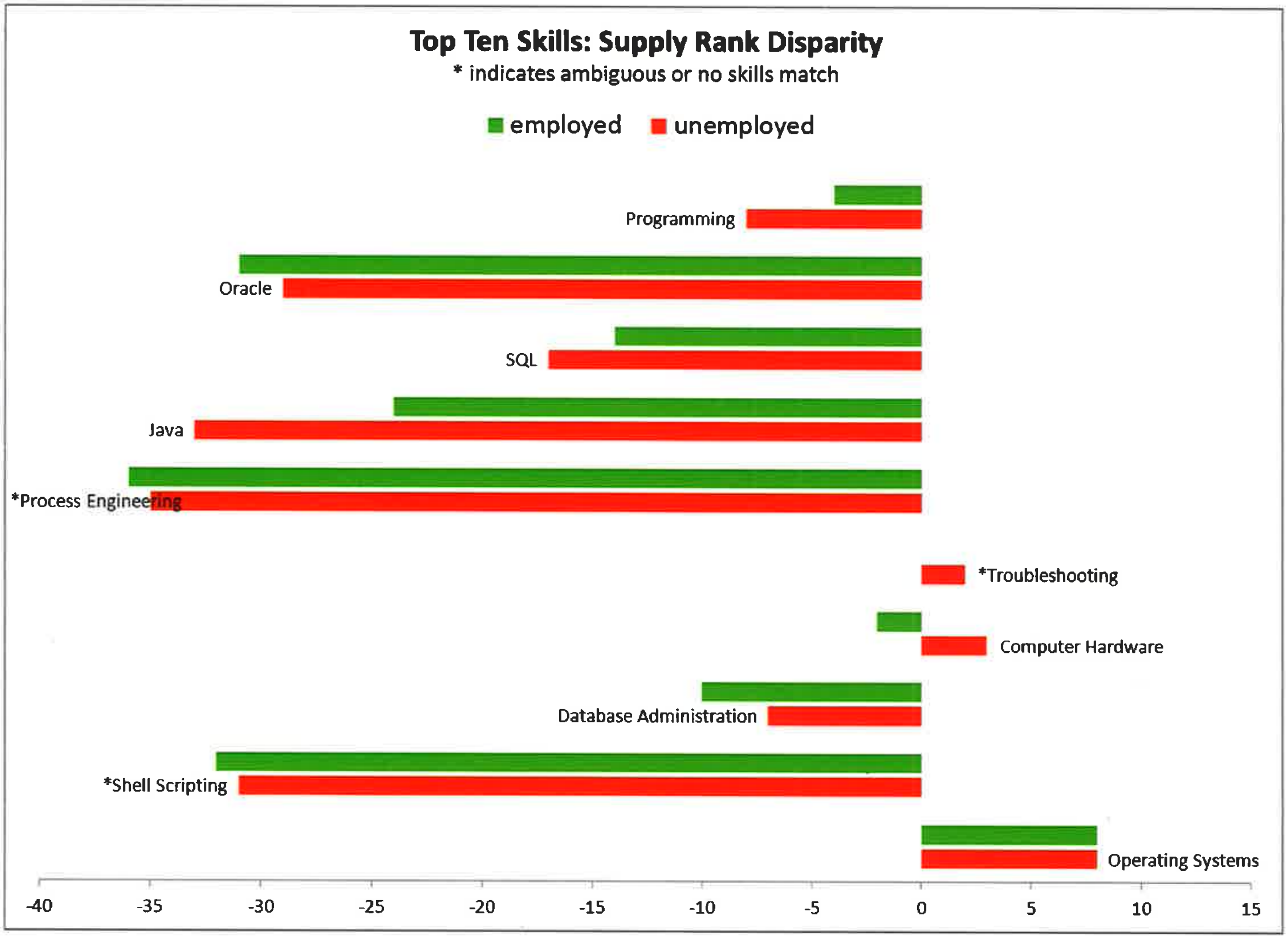

Figure 16 – Top Ten Skills Supply Rank Disparity

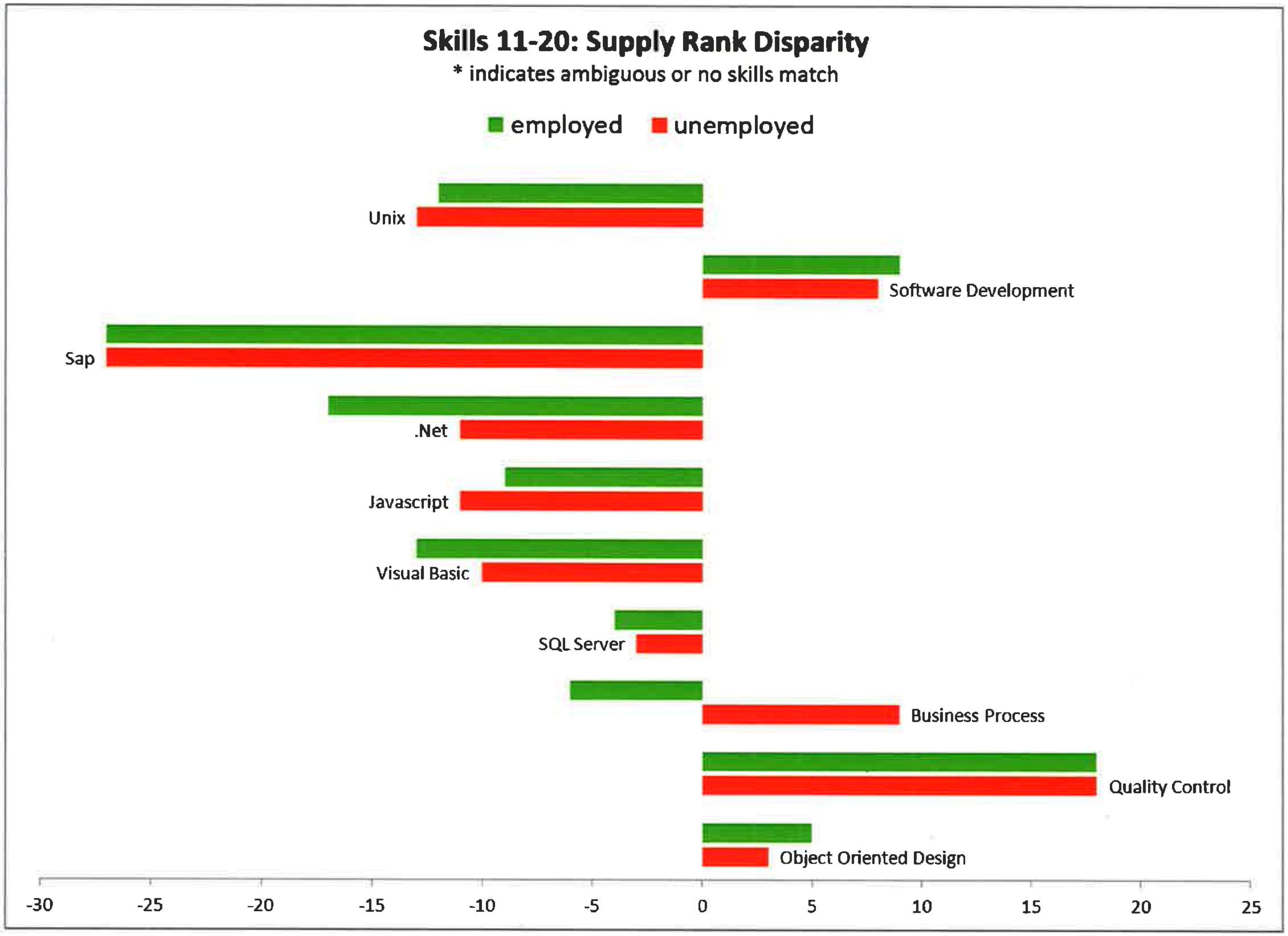

Figure 17 -- Skills 11-20 Supply Rank Disparity

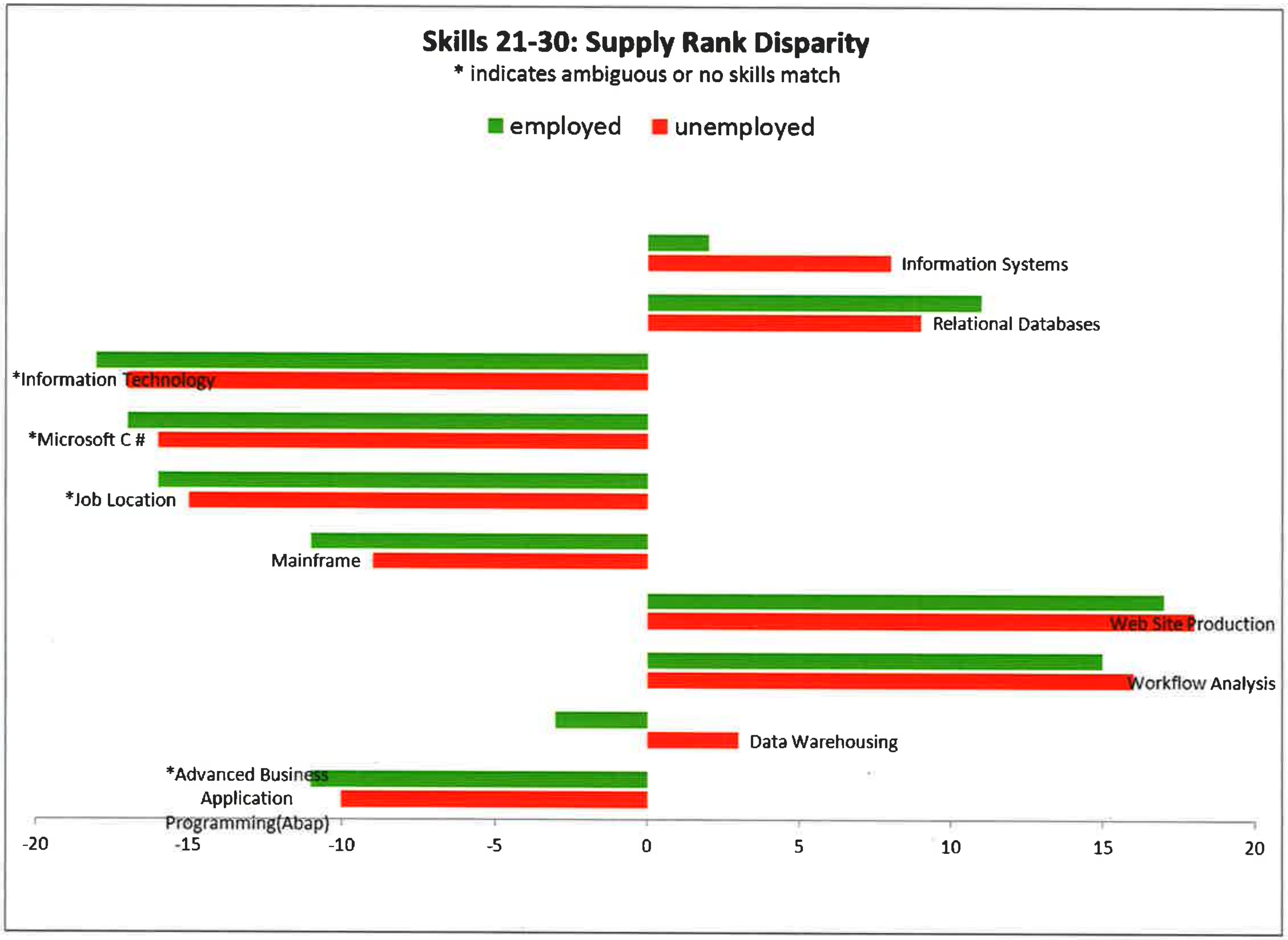

Figure 18 -- Skills 21-30 Supply Rank Disparity

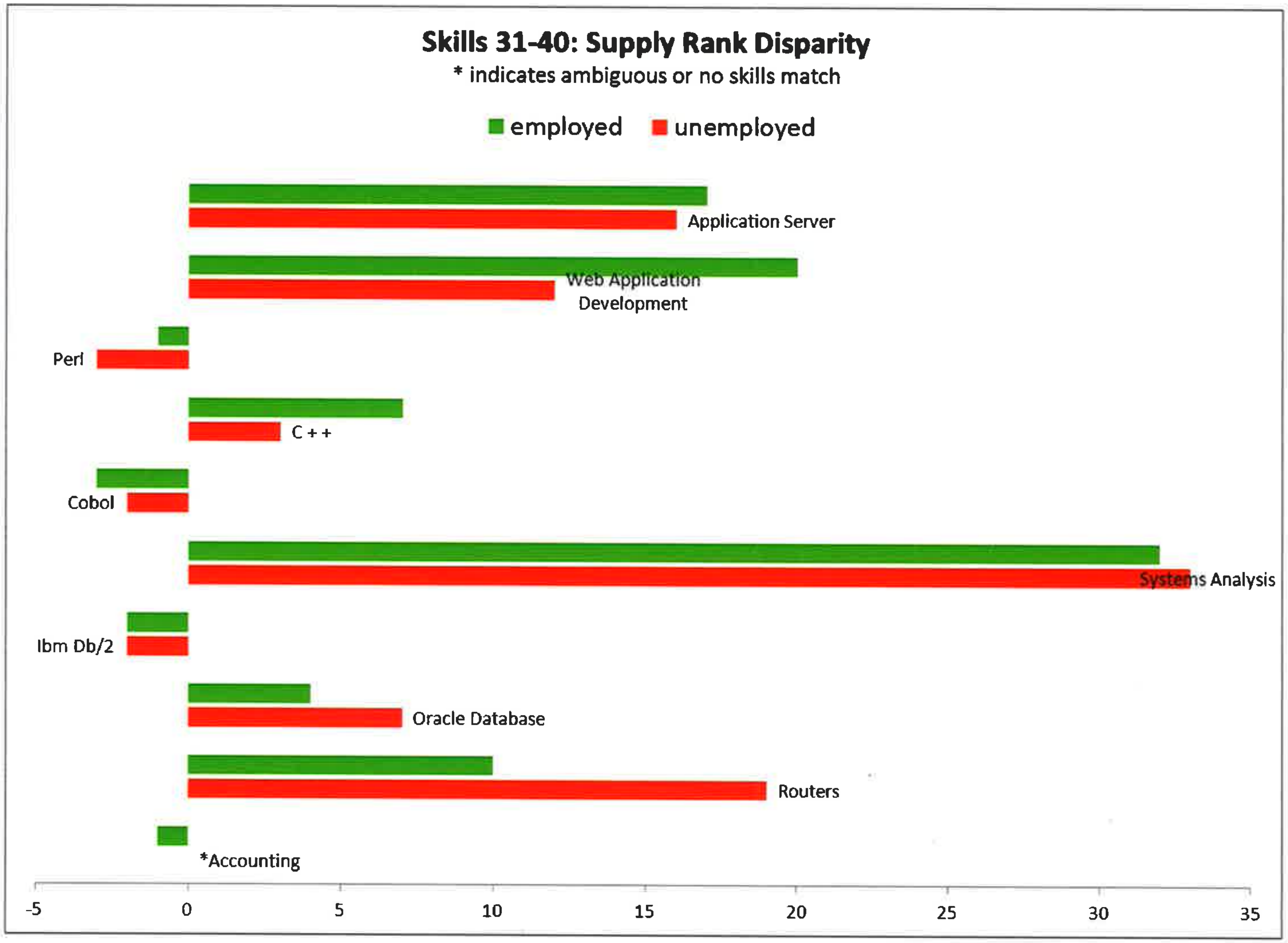

Figure 19 -- Skills 31-40 Supply Rank Disparity

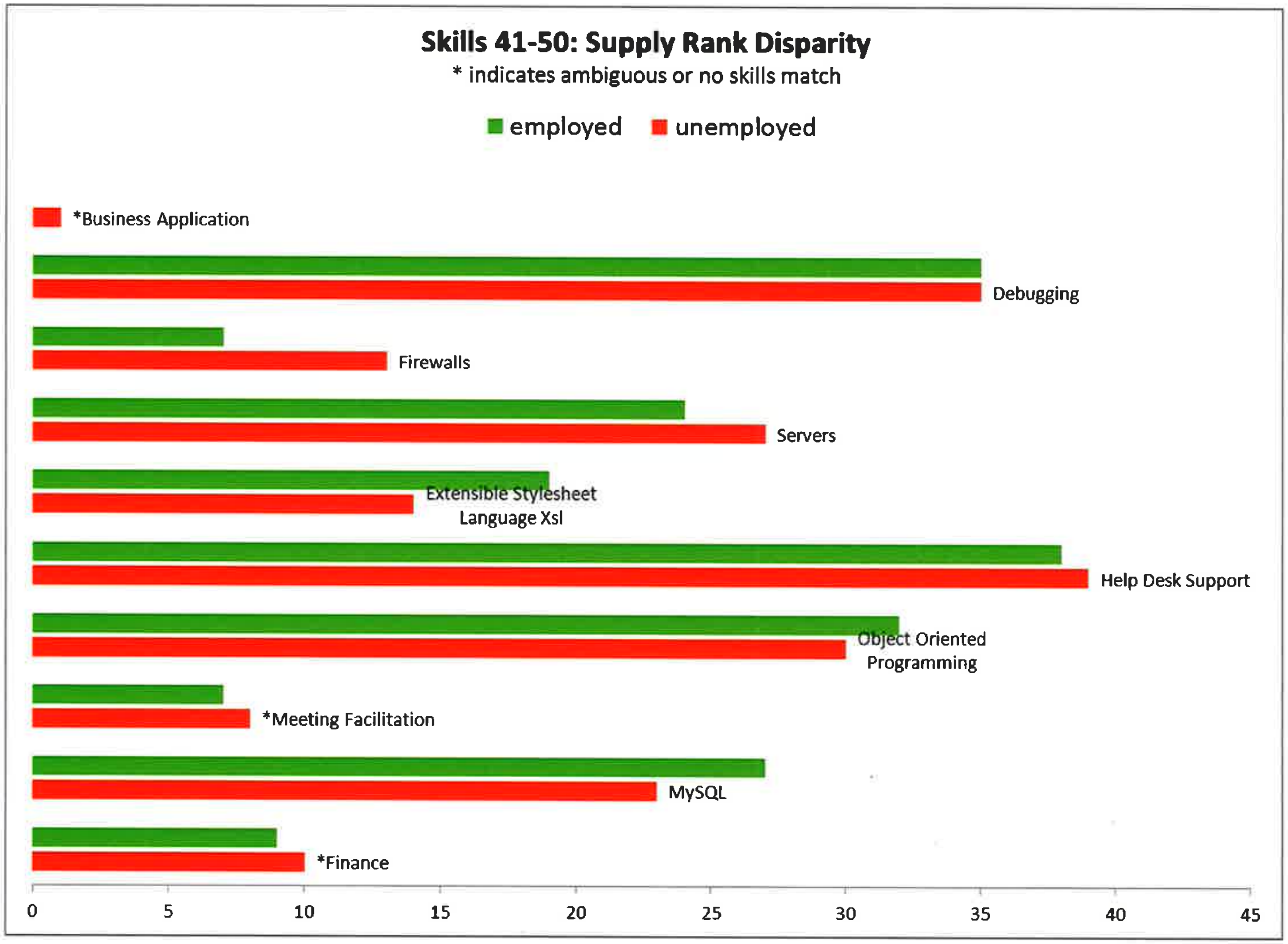

Figure 20 -- Skills 41-50 Supply Rank Disparity

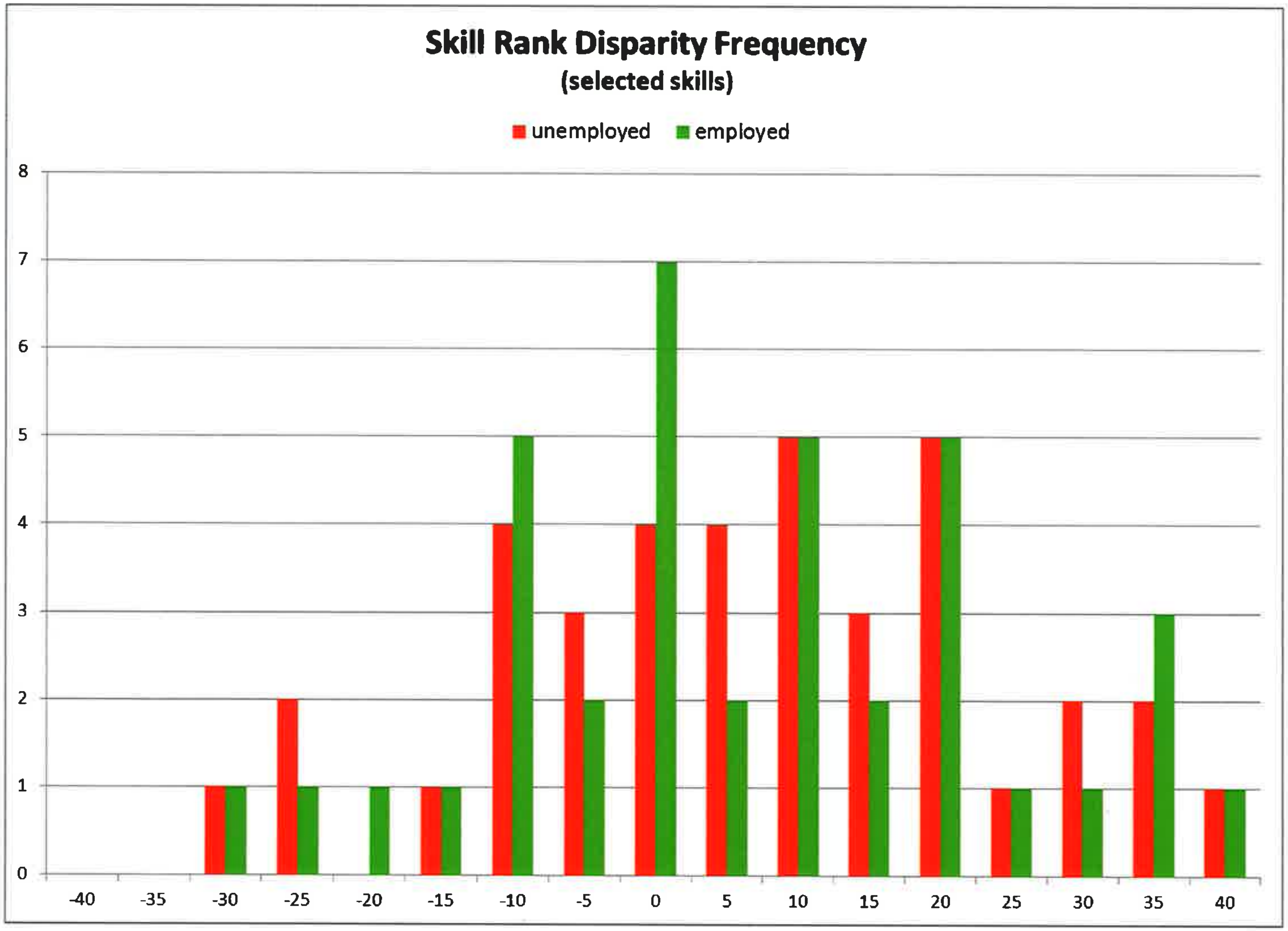

Figure 21 – Skill Rank Disparity Histogram

unemployed	
skill	rank disparity
Oracle	-29
Java	-33
Sap	-27
SQL	-17
Unix	-13
.Net	-11
Javascript	-11
Visual Basic	-10
Mainframe	-9
Programming	-8
Database Administration	-7
SQL Server	-3
Perl	-3
Cobol	-2
Ibm Db/2	-2
Computer Hardware	3
Object Oriented Design	3
Data Warehousing	3
C + +	3
Oracle Database	7
Operating Systems	8
Software Development	8
Business Process	9
Relational Databases	9
Web Application Development	12
Firewalls	13
Extensible Stylesheet Language Xsl	14
Workflow Analysis	16
Application Server	16
Quality Control	18
Web Site Production	18
Routers	19
MySQL	23
Servers	27
Object Oriented Programming	30
Systems Analysis	33
Debugging	35
Help Desk Support	39

employed	
skill	rank disparity
Oracle	-31
Sap	-27
Java	-24
.Net	-17
SQL	-14
Visual Basic	-13
Unix	-12
Mainframe	-11
Database Administration	-10
Javascript	-9
Business Process	-6
Programming	-4
SQL Server	-4
Data Warehousing	-3
Cobol	-3
Computer Hardware	-2
Ibm Db/2	-2
Perl	-1
Oracle Database	4
Object Oriented Design	5
C + +	7
Firewalls	7
Operating Systems	8
Software Development	9
Routers	10
Relational Databases	11
Workflow Analysis	15
Web Site Production	17
Application Server	17
Quality Control	18
Extensible Stylesheet Language Xsl	19
Web Application Development	20
Servers	24
MySQL	27
Systems Analysis	32
Object Oriented Programming	32
Debugging	35
Help Desk Support	38

Table 2. Workers Skills and Rank Disparities

Others' views of key skills

We gathered some data from other sources (IBM and Global Knowledge Training LLC), concerning projections of emerging IT skills.

IBM

Pete Mitchell, IBM Senior Expertise Management Consultant, made an overview of IBM's "Market Valued" skills program available for the purposes of this study. The PowerPoint® file IBM Market Valued Skills Program 2010 Externalv1.ppt is dated 12 August 2010. The Market Valued Skills program identifies skills that have high value in the consultant services marketplace and projects skills which will have increasing value. This program aids in recruitment, retention and training.

Figure 22 on page 49 shows IBM's view of market valued skills over time and in 2010. Six skill categories are shown as trends. Although the Cobol, C and HTML skills still have value at the present time they are not among the "hot" skills needed by IBM consultants. The object-oriented programming languages C++ and Java retain their value, while Gaming has apparently peaked. The figure identifies project management, security, "T-shaped" professionals[6] and architects as skills having well-established value, while business analytics, cloud computing (virtualization), "Smarter Planet,"[7] sales and industry knowledge are projected to be the valued skills of the future. The box "Interpersonal Skills" is a reference to the well-established need for skills relating to communication and cooperation.

Figure 23 on page 50 shows IBM's view of specific skills which can be projected to have high value in the 2009-2014 timeframe. These are broken down into eight categories: Application, Operating Systems, Networking, Services, Database, Enterprise Application Suites (e.g., SAP, PeopleSoft), Web/eCommerce and a cross-specialty category containing Architects and Project Managers. This view adds detail to the previous figure. It is instructive to compare this skill listing with that of Table 2. As we have noted before the skill classification issue intrudes (IBM's forms yet another classification).

[6] T-shaped professionals have deep expertise in one or more subjects but a broad exposure to many others. This enables them to contribute creatively in their primary area of expertise but also to understand and contribute in all of the areas needed for consulting opportunities.

[7] Smarter Planet refers to IBM's initiative in applying information technology to optimizing business, government, utilities, transportation and all agencies contributing to global good governance.

IBM skill	Description
Service-Oriented Architecture	a large-enterprise (e.g., Unum) skill
Virtualization	a core operational skill for large enterprises
Wireless/Mobile	a core system design and implementation skill of broad applicability
Cloud	large-scale virtualization, both public and private
Business Analytics	Mathematical modeling and recommendations: a major success story at Amazon, now being widely deployed in eCommerce
Security	a vital and deep specialty
Project Management	a cross-industry, cross-specialty skill: a career itself

Table 3. Selected IBM skills not reflected in Maine's IT workforce

Table 3 lists some selected IBM skills from Figure 23 which are not reflected in Table 2. These are not industry-specific IT skills: they are needed broadly across all IT-intensive industries. Their absence from Table 2 may be a reflection of the specific skills list present in the survey. They are also absent from the Burning Glass skill classification with one exception: that data identifies Network Security as a top-100 skill.

IBM skill	Description
Enterprise Application Suites	SAP, PeopleSoft (Oracle) et. al.
Database Administrator	design, implement and manage databases
Software Engineer, Applications Development	a core business skill, not the same as Web Application Development
Cobol (from Figure 22)	Still a valued skill, but needs are not increasing

Table 4. Selected IBM skills ranked low in Maine's IT workforce

Table 4 lists some selected IBM skills from Figure 22 and Figure 23 which are reflected in Table 2 but with low (negative) skill rank disparities. These are also not industry-specific IT skills: they are needed broadly across all IT-intensive industries.

Although we cannot conclude that the poor match between IBM's projection of Market Valued skills and the skills of the Maine IT workforce is an authoritative indication of a current or future gap, the situation is unsettling. One way to address this concern is to solicit anecdotal input from local industry as to whether they value the same skills as does IBM.

Global Knowledge Training LLC

Global Knowledge, headquartered in Cary, NC, specializes in IT and Business Training. (Miller, 2010) list 11 skill areas projected to be in demand in 2011. These are (order does not imply priority):

1. Cloud Computing, including Software as a Service, Utility computing and Web and Platform Services
2. Programming
3. Virtualization
4. Voice
5. Project Management

6. Business Intelligence
7. Security
8. Web 2.0
9. Unified Communications
10. Social Networks and Networking
11. Helpdesk

Summary

The skills of Maine's IT workforce and the needs of Maine's IT employers are not a perfect match. Workforce skills are abundant in Web site development (for simple sites with moderate traffic volumes) and operations, and these skills are in some demand. But workforce skills are less abundant for more-demanding, cutting-edge needs, involving development, transition to more modern systems and systems architectures, and for intense, complex IT. There is also a growing need for skills in mature, even legacy IT, driven by the retirement of workers who possess those skills.

We categorize employers having IT workforce needs into three segments:

A. Enterprises using IT, by deploying and integrating commodity hardware and software and using it to support a business which is typically not otherwise IT-related. Some of these enterprises employ workers with IT skills whose jobs may not even reflect the need for these skills, and where IT is not an explicit part of the job description. We (and others) call such workers members of the "shadow IT workforce." This report has little to say about the shadow IT workforce[8] except to note that many jobs require IT literacy (see "Computer Literacy" on page 60).

   Maine's IT workforce appears to have the required skills for this category of employer.

B. Organizations providing IT to others, especially to other enterprises or to other departments within the larger enterprise. These organizations are service providers to others, some internally and some externally. As service providers they must translate their customer needs into systems and services, with service definitions and guarantees. As this is an area of IT that has been changing rapidly (e.g., service-oriented architectures, ITIL compliance, massive data warehouses and cloud computing) these organizations may require skills updates to their workers. Interestingly, organizations in this category are also experiencing needs for skills in IT technologies that have been around for a long time: so-called "mainframe" skills. This is because of the unexpectedly

[8] Data on the shadow IT workforce is hard to come by, but anecdotal evidence is quite common and supports the notion that basic usage, configuration and deployment skills are being developed in workers primarily through informal means – apprenticeship, personal experience and exposure in high school.

long life of certain key software systems and because of the extraordinary service guarantees that are possible when services are provided from mainframe systems.

Although we see evidence of relevant operational and development skills (especially for Web sites) in Maine's IT workforce we do not have evidence that workers yet understand the requirements of service provision, especially best practices in service delivery. We do not see advanced skills well-represented in Maine's IT workforce.

C. Enterprises developing IT, because of the insufficiency of currently-available solutions or a perceived business opportunity in software or services. These enterprises typically demand advanced skills (and advanced degrees) from their workers. These skills are more typical of software development than of service development, as in enterprises falling into the previous category.

   We see noticeable gaps in Maine's IT workforce in these skills. This may be a consequence of lesser demand, or of inadequate supply. More likely, workers with these skills have migrated out-of-state to take advantage of better and better-paying jobs elsewhere, as anecdotal evidence suggests.

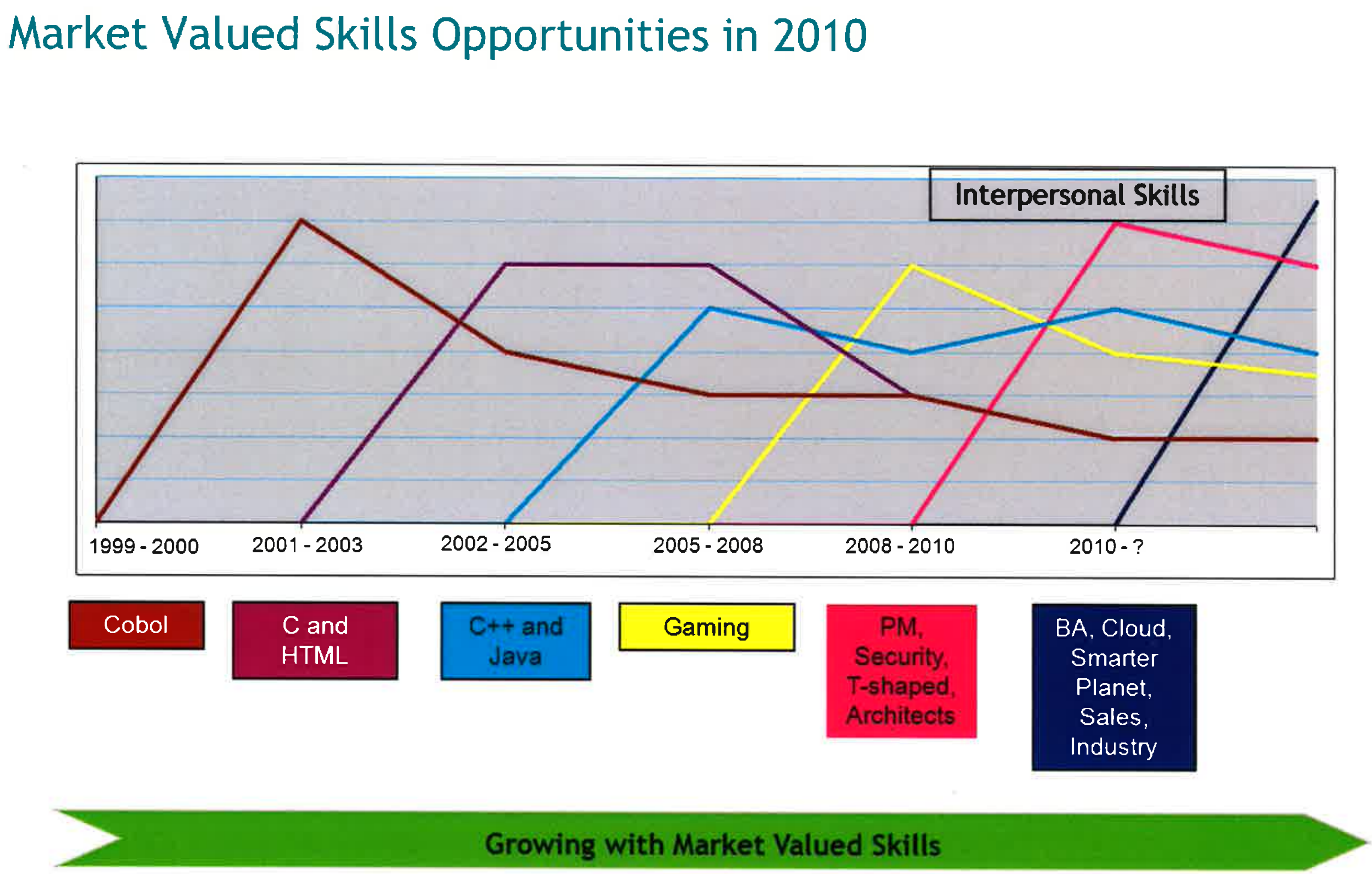

Figure 22. IBM Market Valued skills

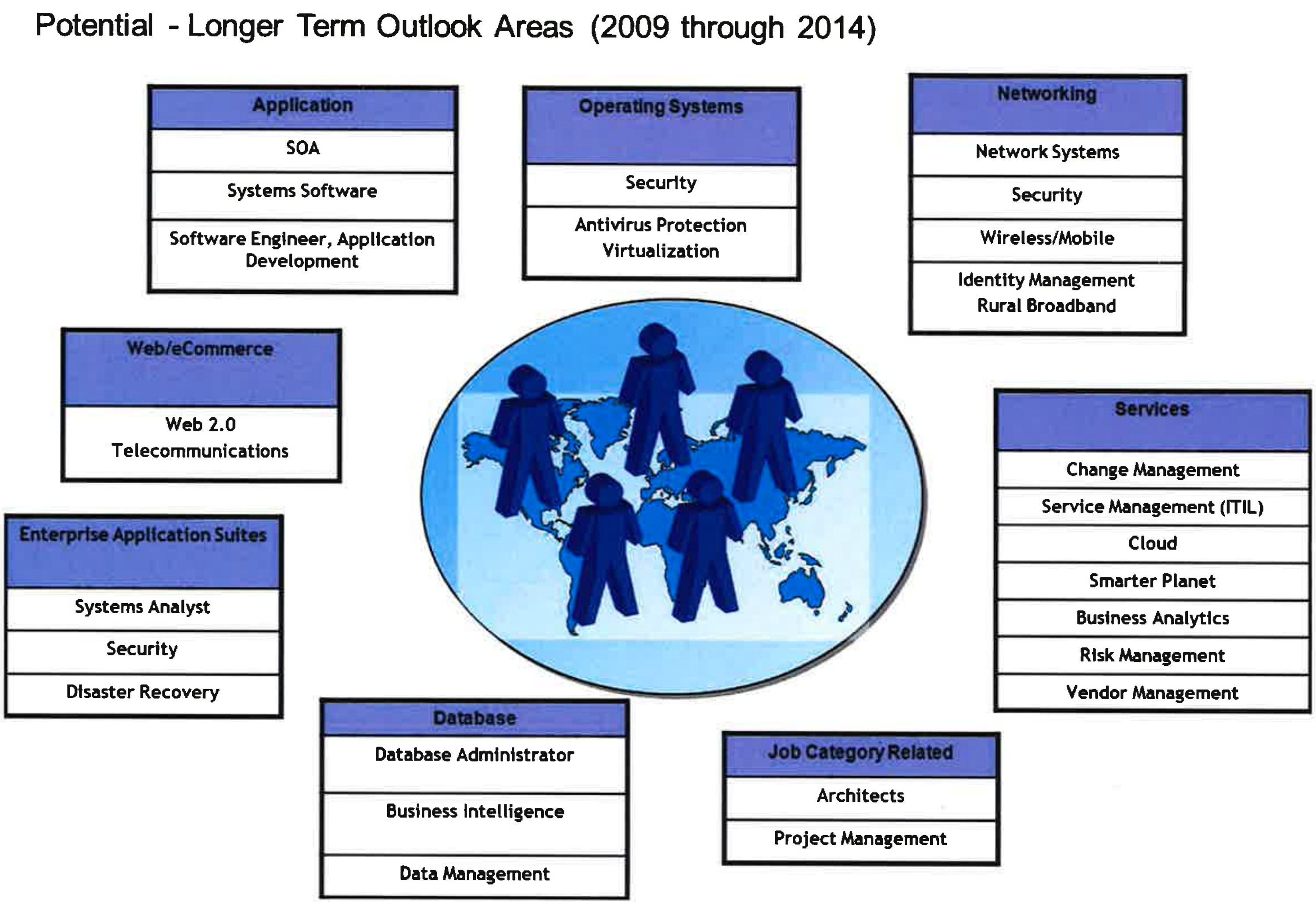

Figure 23. IBM skills outlook

Training Capabilities

The material in this section relates to contractual deliverables 6 and 7 (see "Appendix A. Contractual deliverables" on page 72).

The purpose of this data-gathering and analysis was to first to survey course offerings in IT, characterize them in terms of the skills they train for, and assess their sufficiency to update and sustain Maine's IT workforce in the light of known skills demand[9]. Two of us (Bantz and Wilson) have experience in curriculum development for IT and although we have done our best to be relevant to our students' needs our methodology in choosing skills to train for has been driven by anecdotal evidence rather than actual data. We believe that we are not alone in this ad hoc methodology, although many curricula are driven by industry-standard recommendations (Curricula Recommendations -- Association for Computing Machinery, 2011) and certification requirements (CompTIA Certifications, 2010).

We did not capture online course offerings. To do so would have had to acknowledge that online courses offered by establishments outside the state of Maine are, from the student point of view, nearly indistinguishable from those offered by establishments inside the state, and to survey all online IT courses was too big a job. But the more important reason for omitting them is that they are less relevant to two groups of students of concern to us: advanced students, and students just entering IT. We believe that such students benefit from at least a partial in-class experience, as do students who are not experienced with online materials or who are not disciplined in directing their own study. We acknowledge the importance of online courses in specific technologies (e.g., in specific software products, such as SAP and PeopleSoft) and in certification, and we believe that improvements in educational technology will extend their reach to much of IT. For more, see "Future work" on page 67.

Sources of data

One dataset was obtained and analyzed:

1. With help from others, a USM undergraduate, Nick Cheung, compiled a list of educational and training institutions having a "bricks and mortar" presence in Maine. He then visited their Websites to obtain publicly-available data on each of the courses that they offer in IT. This data was captured in an Excel® spreadsheet with one worksheet listing all institutions and a second listing all courses[10]. In the second worksheet the data captured for each course included the school in which that course was taught, the course title, course description and prerequisites. A list of the institutions with the number of courses captured for each is shown in Table 5 on page 55.

[9] A secondary purpose is to begin building a searchable database of IT courses that could be used for career counseling.

[10] Not all courses captured were relevant to our (IT) interests.

How the results were obtained

Our first attempts to search the course descriptions for Burning Glass skills yielded an unacceptable number of false negatives, except for a small subset of skills (e.g., Java, C++) which were successfully searched. Subsequent to capture two of us (Bantz and Paradis) manually added from zero to five Burning Glass skills to each course row. In retrospect the fact that annotation was found necessary was not surprising given that course descriptions are typically not written in terms of skills taught, nor is there a commonly-accepted list of skills which might appear if they were. The annotation was, at times, quite subtle. For example, Bantz annotated a project management course with the Quality Management skill, even though the course description made no such reference, because project management typically includes a module on quality management.

Although in this case our data coverage was far more comprehensive than in the TechMaine survey, we still wanted to compare training capabilities to employer needs, and our data for those needs is without validated coverage, so we again rely on the skill rank disparity measure described in "The Ranking Comparison" on page 33. In this case, the measure, called "training rank disparity" is the difference between the relative number of times a given skill is found in the course data and the number of job postings citing that skill. The measure is strongly positive for skills that are often taught and rarely needed, and is strongly negative for skills that are rarely taught and often needed.

The skill rank for courses is shown in Table 6 on page 56. To the right, a tornado diagram shows that the most-frequently taught skill, Programming, is found in over a quarter of the courses taught but that the distribution of skills taught in courses has a very long tail.

Results

The results of the Training Capabilities analysis using the skill rank disparity measure are shown on pages 57-59. Each page except the last represents results for ten or more Burning Glass skills; overall, the results represent the top forty-four Burning Glass skills. The last page is a histogram of the skill rank disparities. Most frequently requested skills are at the top of each chart. Problematic Burning Glass skills have been omitted.

In the analysis of these results the interpretation of a rank disparity is less straightforward than in the Skill Gaps and Gluts analysis performed earlier. A significant rank disparity may exist because the training institution is anticipating a future need for a new skill (it is less often the case that an increased need for an old skill is anticipated). Institutions may also have a very strong emphasis on certain foundation skills such as Programming, believing that these skills underlie a broad range of other IT skills[11]. In some cases the Burning Glass skill list does not list the key skill, Security, directly, so other skills (e.g., Firewalls) stand in for them.

[11] There is observed evidence that this particular skill, Programming, is less relevant to other IT skills than in the past. As the IT world has become dependent on existing and mature software systems (application servers, databases, software suites) the challenge to IT is often to select and configure these systems, rather than to create a new one.

Insights

In Figure 24 on page 57 we see that the top skill found in courses and in the Burning Glass analysis of employer needs is the same: Programming. That is, the skill rank disparity for Programming is zero. As can be seen from Table 6 on page 56, the Programming skill dominates the list of skills taught (28% of courses). It should be noted that only 7% of job postings, however, mentioned Programming as a desired skill. Thus the bias towards Programming is much greater in courses taught than in job postings.

Similarly, the skill rank disparity for Java is slightly negative, reflecting the strong need for Java skills but the propensity of training institutions to offer a range of programming languages, such as C++ and C#.

However, in the figure we see five cases of strong positive skill rank disparities: Web Site Production, Relational Databases, Object Oriented Programming, Web Application Development and Firewalls. Are these being over-taught? In the cases of Object Oriented Programming and Relational Databases, we believe that these skills are less-often found in job postings because other skills stand in for them: Java and Oracle. Firewalls appear in courses taught because training institutions have anticipated employers' needs for security, even though these needs are not well-represented in job postings. We do see strong positive skill rank disparities for the Web site skills, probably because the employers who need these skills (e.g., who make use of the shadow IT workforce) are not well-represented in the Burning Glass analysis.

In Figure 25 on page 57 we again see a number of strongly positive skill disparities, but for the first time some strongly negative ones as well. SQL is a highly sought-after skill not mentioned often in course descriptions. This is because there are relatively few courses taught in the practical use of databases, and this also accounts for the slightly negative skill disparity for Database Administration as well. The strongly positive skill disparities for Servers and Routers reflect some emphasis on these in courses but less in job postings, probably because larger employers already have sufficient networking staff and this is a rather mature specialty, while smaller employers are in need of such staff but don't advertise for them. The strongly positive skill disparity for Extensible Stylesheet Language correlates with the Web skills discussed for the previous figure.

What remains are the System Analysis and Debugging skills. The latter may be assumed in job postings rather than made explicit. All hands-on programming courses address debugging, for example. But the System Analysis skill is puzzling. We would have expected this skill to be under-taught, as it is difficult to teach, requiring a case study approach or service-based learning. The key is that System Analysis is ranked low in the Burning Glass analysis. We suspect that this low ranking is not a true indicator of need, but rather a problem with skill vocabulary. Anecdotally IT workers who can talk to the customer are prized.

Now in Figure 26 and Figure 27 on page 58 we see many strongly negative disparities, one exception being Help Desk Support which is taught rarely but even more rarely asked for. The skills with strongly negative disparities are in specific systems (e.g., Oracle, .net, Unix, SAP, Microsoft's SQL Server) and in a few ambiguous skills (e.g., Troubleshooting and Shell Scripting). Mainframe and Cobol, skills appropriate to legacy systems, are not outstandingly under-represented in courses.

The histogram of training skill rank disparities, shown in Figure 28 on page 59 is very approximately normal, perhaps weighted on the negative side (under-taught skills) and with a few strongly positive skill rank discrepancies (over-taught skills).

Summary

We can draw a few conclusions from this analysis. First, our training institutions have not focused on specific products or systems, perhaps preferring to teach foundations. But our employers are asking for these specific product skills so that new employees can be immediately productive. In the past, in some companies, the practice was to send new employees to schools run by IT system vendors. This is expensive (the courses themselves were expensive and to this must be added the employee's expenses while away) and lengthens the time to employee productivity. Also, some companies are reluctant to invest in new employees due to the increased mobility of the IT workforce[12]. Still, there may be creative ways of addressing this problem through online courses. We also provide a recommendation "The Instant University for IT Skills" concerning this issue.

Second, the presence of strongly positive training rank disparities suggests to us that communication between curriculum developers and the employment marketplace is not as complete and effective as it should be. As a concrete example, we are not convinced that Programming, especially beyond the introductory level, plays as important a role for IT employers (7% of job postings) as its dominance in skills taught (28% of courses taught) might suggest. Some very basic programming skills are required for testing and maintaining systems, and this is evident in Shell Scripting being ranked tenth among Burning Glass skills. But IT has evolved from the days when any new function required programming. A considerable preponderance of current IT work is now concerned with selection, installation, configuring, tuning and maintaining systems and with providing content (e.g., Web site content, data management) to them, as opposed to programming. Conversely, we do not find this evolution well-represented in curricula. We also provide a recommendation "Tighten the Linkage between Curricula and the Marketplace" concerning this issue.

[12] This mobility assertion is not substantiated here and the recent economic downturn may have affected it as well.

School	Location	Number of courses captured
Eastern Maine Community College	Bangor	121
VTECH	South Portland	73
University of Southern Maine	Portland	53
York County Community College	Wells	53
University of Maine Orono	Orono	42
Washington County Community College	Calais	42
Thomas College	Waterville	40
University of Southern Maine	Gorham	37
Kennebec Valley Community College	Fairfield	31
Northern Maine Community College	Presque Isle	31
Husson University	Bangor	28
Colby	Waterville	23
University of Maine Augusta	Augusta	22
Bowdoin	Brunswick	20
University of Maine Farmington	Farmington	17
Southern Maine Community College	South Portland	17
Saint Joseph's College	Windham	14
University of Maine Fort Kent	Fort Kent	13
Capitol Computers	Augusta	12 (links broken)
University of Maine Machias	Machias	4
University of New England	Biddeford	4
Burgess	Bath	4
University of Maine Presque Isle	Presque Isle	1
Central Maine Community College	Augusta	Unclear course information
Bates College	Lewiston	No courses listed
NTI	South Portland	Unclear course information
Seacoast Career	Sanford	No specific courses
Husson University	South Portland	Courses not offered at location
Andover College	Lewiston	Unclear course information
Andover College	Portland	Unclear course information
Beal College	Bangor	No courses listed
College of the Atlantic	Bar Harbor	No courses listed
Heartwood College of Art	Kennebunk	No courses listed
Maine Maritime Academy	Castine	No courses listed
Maine Media College	Rockport	No courses listed
New England School of Communications	Bangor	No courses listed
University of Southern Maine	Lewiston-Auburn	Unclear course information
Unity Collge	Unity	No courses listed

Table 5. Maine training establishments with number of courses captured

Rank	Skill	Occurs	%
1	Programming	185	28.07
2	Operating Systems	62	9.41
3	Computer Hardware	55	8.35
4	Web Site Production	43	6.53
5	Relational Databases	35	5.31
6	Object Oriented Programming	35	5.31
7	Web Application Development	30	4.55
8	Firewalls	27	4.10
9	Java	26	3.95
10	Object Oriented Design	25	3.79
11	Servers	25	3.79
12	Routers	24	3.64
13	Software Development	22	3.34
14	Database Administration	14	2.12
15	Systems Analysis	14	2.12
16	Process Engineering	10	1.52
17	Visual Basic	10	1.52
18	Extensible Stylesheet Language	10	1.52
19	SQL	9	1.37
20	Debugging	9	1.37
21	Data Warehousing	8	1.21
22	Oracle	7	1.06
23	Quality Control	7	1.06
24	c + +	7	1.06
25	Help Desk Support	6	0.91
26	.net	5	0.76
27	Business Process	5	0.76
28	Oracle Database	5	0.76
29	Unix	4	0.61
30	c #	4	0.61
31	Application Server	4	0.61
32	Javascript	3	0.46
33	Business Application	3	0.46
34	Mainframe	2	0.30
35	Perl	2	0.30
36	Cobol	2	0.30
37	Workflow Analysis	1	0.15
38	MySQL	1	0.15
39	Troubleshooting	0	0.00
40	Shell Scripting	0	0.00
41	Sap	0	0.00
42	SQL Server	0	0.00
43	Advanced Business Application P	0	0.00
44	DB2	0	0.00

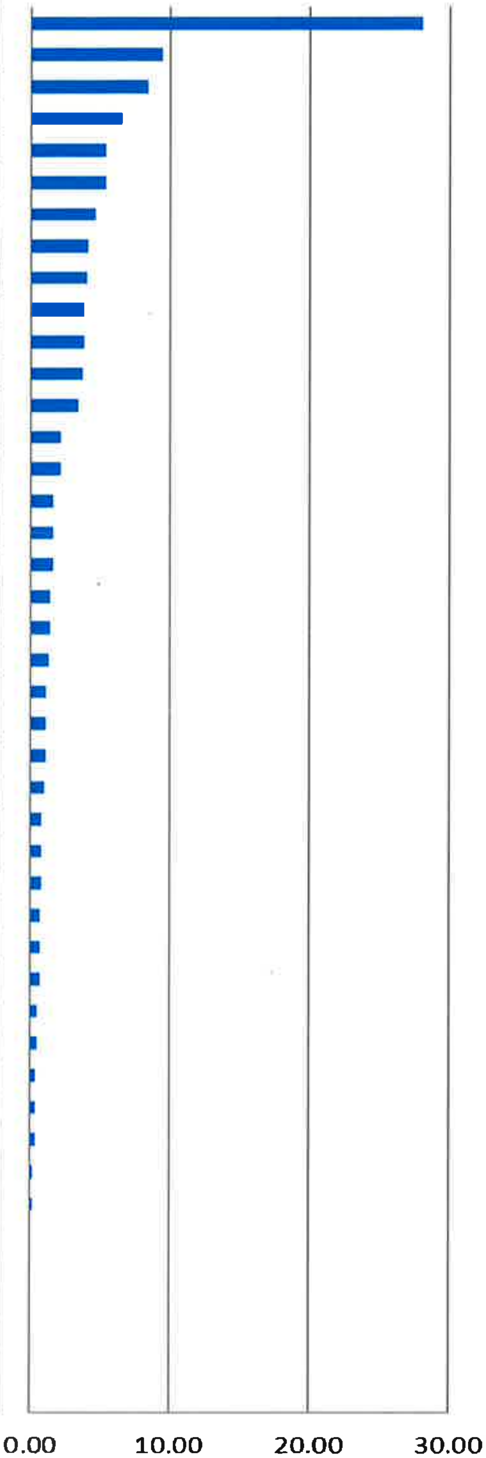

Table 6. Rank of skill in courses

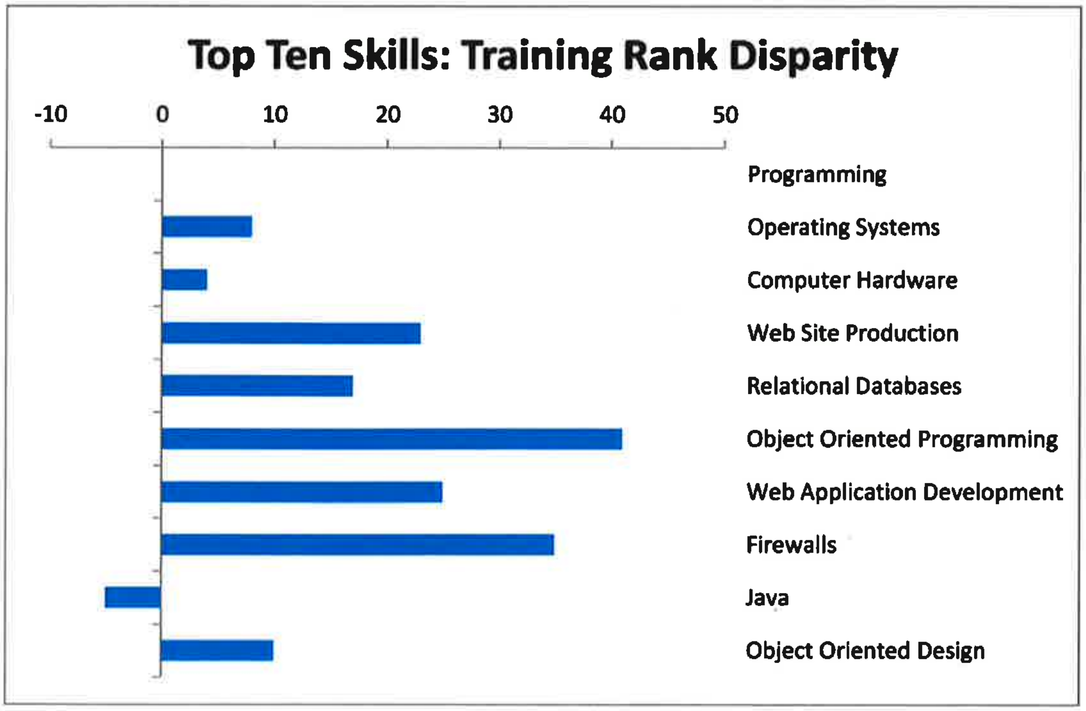

Figure 24. Top Ten Skills Training Rank Disparity

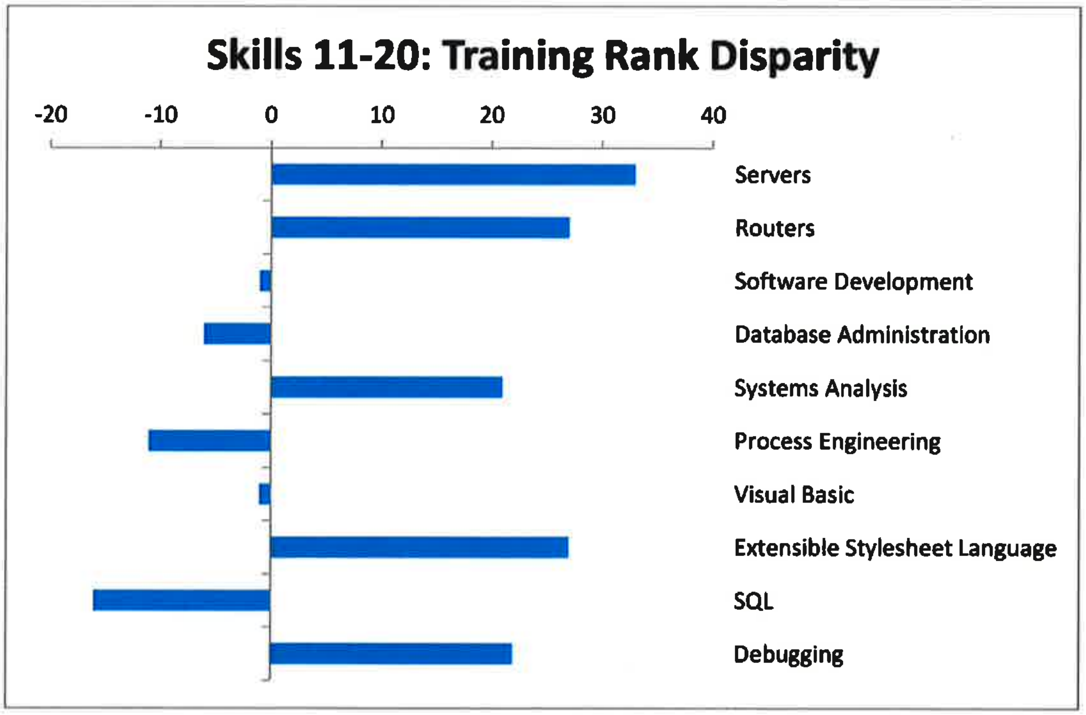

Figure 25. Skills 11-20 Training Rank Disparity

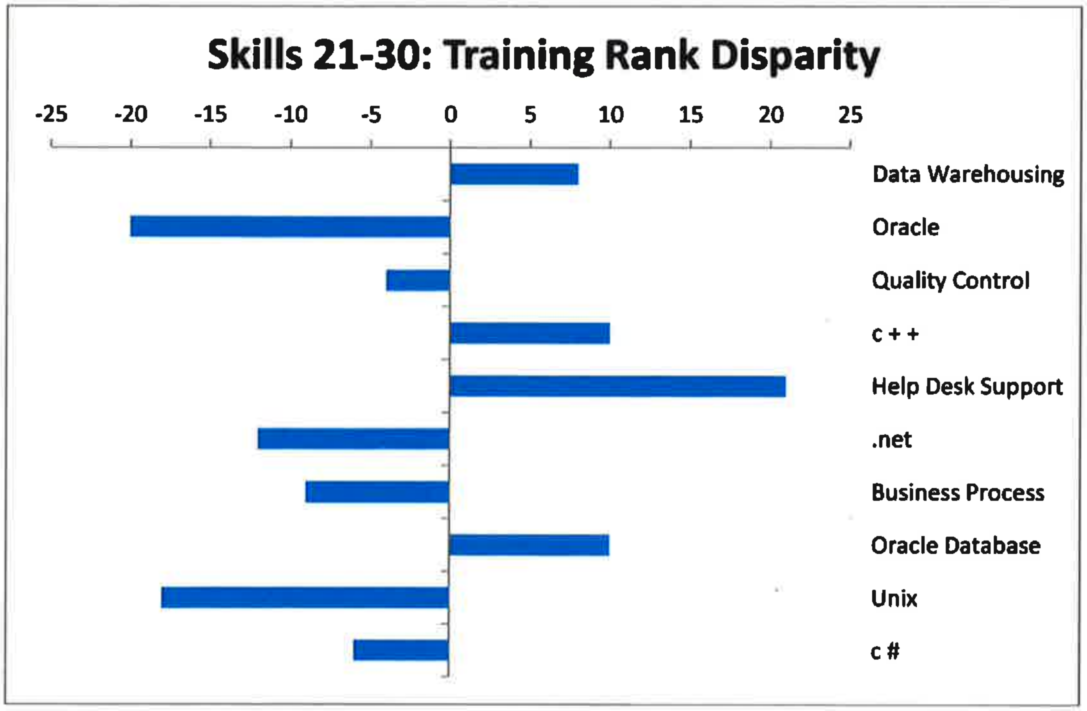

Figure 26. Skills 21-30 Training Rank Disparity

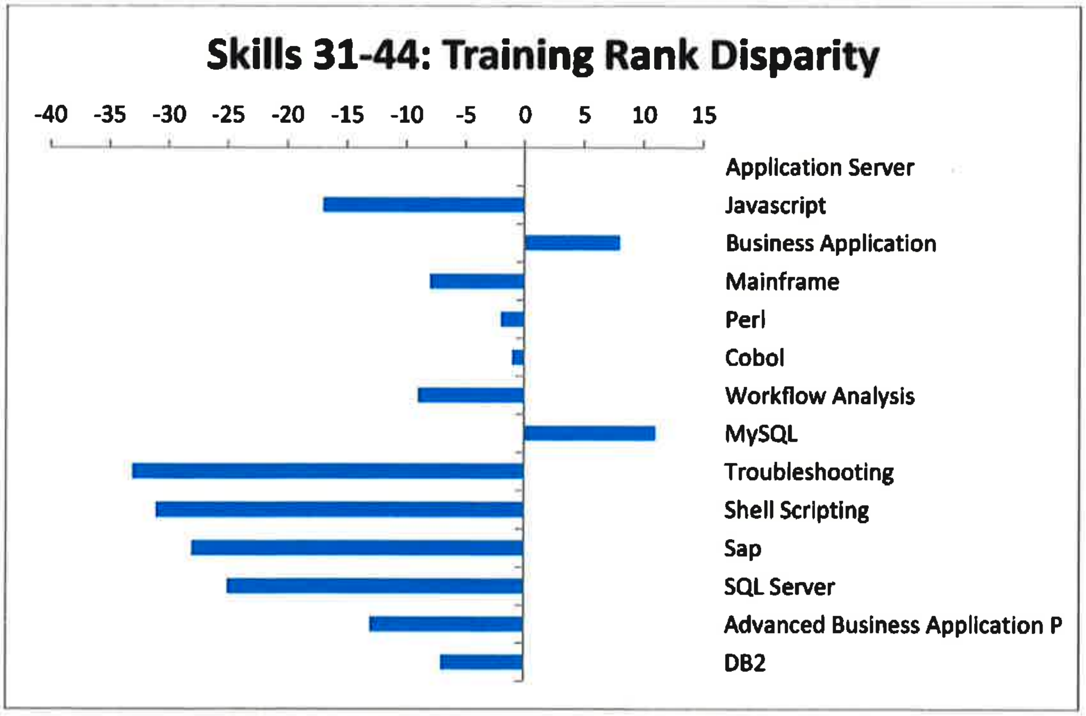

Figure 27. Skills 31-44 Training Rank Disparity

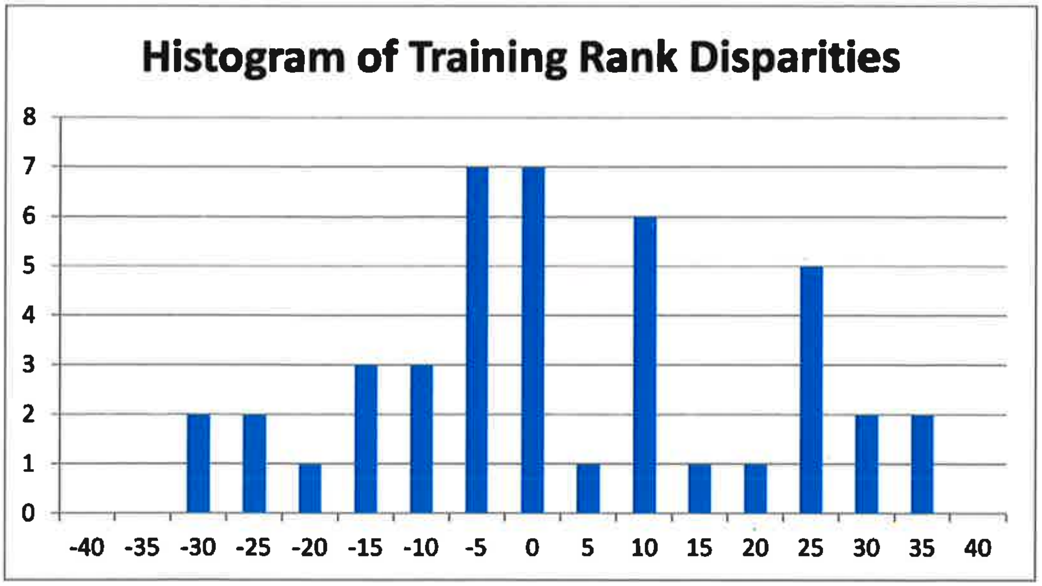

Figure 28. Histogram of Training Rank Disparities

Computer Literacy

The material in this section relates to contractual deliverable 8 (see "Appendix A. Contractual deliverables" on page 72).

Basic computer literacy for the purpose of this project is defined by (Sloan & Halaris, 1985) *"...whatever a person needs to know and do with computers in order to function competently in our society"* and should be differentiated from an introduction to computer science. The thrust of this definition is aimed more broadly and fits a liberal arts or more general model of computer literacy in contrast to a computer science based definition or more technically-driven model found in science, technology, engineering and mathematics (STEM) fields; however, this definition is general enough to serve a broad range of job descriptions, settings, and contexts that are found in Maine.

In surveying a number of computer literacy or introduction to computer classes over the years there are a number of common topics that are most frequently addressed. At USM there have been two primary courses in computing; one from Business, ABU190, which focuses on spreadsheets and problem solving, and one from Technology, ITT181. Both are introductory, 100 level courses, and should be considered to be survey courses rather than an in-depth treatment of a complex technical subject.

The common topics in computer literacy courses are:

1. Overview of the microcomputer system (generally how it works and how to turn it on and interface with the system, including file management).
2. Introduction to Word processing using a modern text editor such as Microsoft Word.
3. Presentation software is addressed typically with Microsoft PowerPoint or Open Office, Impress.
4. Introduction to Spreadsheets using a spreadsheet application such as Microsoft Excel.
5. Introduction to use of Email using a mail client such as Microsoft Outlook or Google Mail (web-based).
6. Introduction to the World Wide Web (Internet) including how to use a browser with an application such as Microsoft Explorer or Mozilla Firefox.
7. In some cases a rudimentary overview of databases, most typically using Microsoft Access or MySQL
8. Graphic applications, such as Microsoft Paint or GIMP are introduced and often integrated into Microsoft PowerPoint or Microsoft Word exercises.

Of these eight topics, there is considerable agreement among academics that word processing, general usage of the computer, email and "surfing" the web would be the most frequently taught and the most popular. In terms of job skills and competencies, spreadsheets are thought to be critical and databases are also seen as very important; however, most academics who teach introductory aspects of spreadsheets and databases wish that they could spend more quality time on these two applications. They are a must for the successful operation of most modern businesses.

In Appendix A. Contractual deliverables on page 72, deliverable 6, a comprehensive list of computer courses provides descriptions of introductory computing courses at the post-secondary schools in Maine. For the purposes of deliverable 8, the following is the description of USM's Department of Technology course ITT181 Introduction to Computers, which is a general treatment of computing, and the School of Business and Academic Outreach's course ABU 190 Spreadsheets and Problem Solving, which targets business with an emphasis on problem solving with spreadsheets.

ITT 181 Introduction to Computers

An introduction to current and emerging computer applications. The course includes an overview of basic computer hardware and operating system, file management, and general application software. Emphasis is on computer terms, concepts, and the integration of activities, including operating system functions, word processing, spreadsheets, databases, graphics, and communication. Lecture and lab. Credits 3.

Note that this is a three (3) credit hour course, meaning that it meets either twice a week for approximately 50-60 minutes or twice a week, for a total seat time of 100 to 120 minutes per week. This course is taught in a fourteen week semester; hence the total engagement time is approximately 25-30 hours, depending on the pace of the instructor and other factors.

See the syllabus at http://usm.maine.edu/~zanerj/181/admin/181syllabus_F10.html for details of the course and the pedagogical as well as technical (lab based) approach(s) employed in teaching this course.

ABU 190 Spreadsheets and Problem Solving

An examination of problem-solving techniques using modern computer applications software. Primary focus is on the use of electronic spreadsheets as a problem-solving tool, including proper spreadsheet model design and the use of appropriate graphical representation of model results. Other computer problem-solving software is examined. Interpretation and effective communication of results, both written and oral, are practiced. Prerequisite: MAT 101B (C- or higher) or equivalent proficiency and computer literacy. Credits 3.

Summary

Computer literacy and/or basic computer skills should not be considered as a gateway or introduction to the discipline of computer science. Computer literacy and basic competencies are required across a broad spectrum of human endeavors , from business to science to the arts and humanities, and include, word processing, spreadsheets, email usage, effectively using the Internet, and in some cases rudimentary database skills. In this study, literacy and competency with and about computers and computing are closely coupled, but given the range of how computers are used in modern society such a definition is open to debate. The crux of the issue, for the job seeker in Maine, is what the software applications are and what "habits of mind" are associated with computing that will result in winning a job, success in the market, and continued gainful employment.

Conclusions and recommendations

Here we summarize our conclusions and suggest actions based on them.

Conclusions

This study is a rare example of a study of workforce, needs and training capabilities at the level of skills. Although our study is based on available data that is limited in some respects and questionable in others, we believe that our analysis has yielded valuable insights into the skills of Maine's IT workforce, employer needs and training capabilities.

We remain committed to the view that IT workers need to be able to communicate effectively to team members, executives and clients; that they be able to collaborate with others, including non-IT workers, and that they possess basic knowledge of how enterprises function.

As we observed in "IT Skills needed in all Job Clusters," our study supports the widespread need for computer literacy in the workforce as a whole. Few jobs, even those in Human Services, do not have a requirement for significant computer usage. Many non-IT jobs have needs for what we have characterized as "hard" IT skills.

As we observed in "Skill Gaps and Gluts" it appears that Maine's IT workforce does not adequately support Maine employers with needs for advanced skills or skills in IT technology development, yet the training capabilities exist in Maine for these skills. It may be that workers are unaware of the need for these skills or of the training capabilities for them. It may be that these training capabilities are not easily accessible to students not enrolled in a degree-granting program. Or it may be (and likely is) the case that workers with these skills can find higher-paying jobs elsewhere. We see an absence of more forward-looking skills in all sectors of Maine's IT – employer needs, workers' capabilities and training. We see rough evidence that unemployed workers are not atypical in their skills mix.

We see two patterns of workers' skill gluts; skills related to PC installation and maintenance, and skills related to basic Web site development. We see gaps in programming, in experience with several major software suites (SAP, Oracle) and with legacy (mainframe) systems.

The gaps and gluts we have noted are symptomatic of a marketplace in which the various stakeholders do not have quick, effective, accurate communication among them. We would hazard a guess that the average Maine IT worker is unaware of a burgeoning need for mainframe system skills, for example. Training establishments may be similarly unaware. Poor communication damages a marketplace.

As we observed in "Training Capabilities," specific categories of skills, such as those needed for mainframe systems, are not well-supported by Maine training establishments. This is not a criticism of those establishments – more likely it is a consequence of the inputs to the curriculum development processes. In general, as the need for a new skill is created by technology or business innovation, there is an unmet need for a quick, targeted response by training establishments. In general, our training institutions, like many, prefer to focus on foundations rather than on specific products and systems.

We also observed that curricula do not currently reflect some of the major evolutionary changes in IT, most likely due to communication between curriculum developers and the employment marketplace that is not as complete and effective as it should be.

Major recommendations

Our recommendations are ordered by our judgment of their importance, with the most important (and most ambitious!) first.

Web-based IT Workforce Marketplace Pilot

The State of Maine should plan and execute a pilot program to create a Web-based marketplace involving employers, workers and training establishments. In this marketplace a worker can advertise his or her availability and skill set; employers can advertise their needs, including future needs for skills, and training establishments can advertise their offerings, costs and capacities. Tools should be deployed in this marketplace so that workers can evaluate their skills and estimate the costs and timetables to upgrade them, employers with current needs can locate workers with the right skill sets and potential employers looking to move to Maine can evaluate how quickly and with what cost they can acquire an effective workforce. Training establishments can evaluate their curricula and forecast future needs. And Maine's Department of Labor can obtain detailed, accurate data so that public policy can be formulated and its implications understood, and so career centers can be more effective in their guidance to workers.

This marketplace is best achieved by a federation of existing systems, with the focus on data integration. As we have repeatedly noted in this report, skill data integration has been significantly hampered by the lack of a common skill vocabulary. Our work has one approach to this problem: the skill map, relating skill terms in different vocabularies.

While this is an ambitious goal it is also an achievable one. University researchers, industry and information technology and service providers, working together, are now capable of building systems for this marketplace that are flexible, long-lasting and efficient. At least one major IT technology and service provider has articulated and is pursuing its vision for such a marketplace.

The Instant University for IT Skills

The University of Maine System, acting in concert with the Community Colleges of the State of Maine and commercial training and certification establishments, should establish an Instant University, allowing fast-reaction delivery of education and training to both employed and unemployed Maine IT workers. An example of the need for this capability is the growing skill gap in mainframe computing systems caused by retirement of Baby Boomers. But IT is an extraordinarily dynamic set of occupations and this need for retraining and skill upgrades is characteristic of the profession.

An example of this capability exists in USM's Center for Continuing Education, which has developed an infrastructure for recruiting faculty, ordering and replicating materials, contracting and assessing courses, and with the Gorham, Lewiston-Auburn and Portland campuses and University College at Bath/Brunswick the delivery sites are already in place. While our speed of response was not exactly instant, two of the authors of this report (Bantz and Wilson) have experienced the value of this infrastructure in the responsive LodeStone programs.

Tighten the Linkage between Curricula and the Marketplace

As we observed in our summary of training capabilities on page 54, we suspect that curricula relevant to IT has not kept pace with the evolution of the application of IT to business needs via the integration and customization of existing software, as opposed to programming new software. There are other examples of a lack of appreciation of current IT practice in the curricula of Maine's education and training providers.

One approach to this communication gap would be the establishment of a periodic conference to be attended by IT curriculum designers and industry professionals (CIOs, operations managers, architects) to create a new line of communication among them, aimed at increasing the relevance of the IT curricula on the one hand, and improving joint knowledge of the future evolution of IT on the other. Curriculum designers must think long-term, so they are concerned with providing strong foundations for their students, but also with identifying emerging trends incubating in the research community. Industry professionals can benefit from this latter insight.

Note also that our first recommendation, the Web-based IT Workforce Marketplace Pilot, also will tighten the linkage between curricula and practice, as curriculum designers will have access to data reflecting the unsatisfied skill needs of employers and workers.

Address the Shadow IT Workforce

We believe that much of Maine's economy (at least small and mid-size businesses) depends on workers who perform IT tasks part-time and do not have IT job classifications. While some of this is captured in our discussion of "IT Skills needed in all Job Clusters" many jobs have IT responsibilities that do not appear in any job description. This workforce is vital, because IT is vital to virtually every Maine business, but it is often poorly-trained and unaware of best practices in the support of IT and the provision of IT services. This puts a large part of Maine's economy at risk, specifically in the areas of security, business continuity and the flexibility to exploit consortia based on sharing data and services.

One approach to mitigating this risk is to provide the shadow IT workforce with online training. This is a low-cost way to update basic IT skills. If this training were coupled with a certificate, or better yet, a license, employers could be assured that their IT was being maintained by workers with at least sensitivity to the attributes of IT needed to avoid putting a business at risk.

The development of online courses, certification and/or licensing exams and in general the infrastructure needed to support this recommendation is not a trivial job. It could begin with a statewide conference on basic business IT, to which the key stakeholders (training establishments, IT providers, government) would be invited, and from which an action plan would be expected.

Future work

Here we list (in no particular order) our suggestions for future work.

1. Our work was significantly hampered by the lack of a common skill vocabulary and a clear definition of the constituents of each skill. The Burning Glass data had just one word or phrase per skill, while the Detailed Work Activities of the O*NET supplemental data file uses action phrases, as does the IBM skill classification. It is very difficult to make use of skill databases written for human consumption, where a given skill may have many different representations. If a skills-based approach such as ours comes to have accepted value, we believe that the effort necessary to standardize, define and register skills will be well worthwhile[13].

2. As we identified in "Others' views of key skills" on page 45, the poor match between IBM Market Valued skills and the skills of the Maine IT workforce should be investigated further. A first step would be to contact local industry and get confirmation (or denial) that the IBM skills are valued in Maine's IT employment market.

3. We do not understand why, on the one hand, Maine's training resources are capable of training workers for the advanced skills needed by its employers and, on the other hand, these skills do not appear more often in Maine's IT workforce. We have anecdotal evidence that advanced students leave the state in significant numbers, and we have speculated that this may be due to salary disparities[14]. The explanation is important to any effort seeking to formulate public policy to address this gap.

4. As briefly discussed in "Summary" on page 47, Maine's shadow IT workforce is important to many Maine employers, yet is not well-understood. In particular, how skills are developed in this workforce is unknown. As this workforce is responsible for the IT infrastructure of many Maine businesses (and of the reliability, adaptability and security of such) its skills are of significant interest. One of our recommendations, Address the Shadow IT Workforce, addresses this issue.

5. This report does not attempt to quantify skill needs, skill obsolescence or training needs by skill. This is because our data is incomplete, opaque and in some cases, questionable. Yet actions have a cost, and their value must be evaluated in order to justify this cost, and without quantitative data the value cannot be assessed. Sources of accurate, quantitative data should be created or identified and that data obtained. One of our recommendations, the Web-based IT Workforce Marketplace Pilot, addresses this issue.

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[13] An alternative is to research, acquire and adapt recently-reported software for the legal profession, capable of full-text search without the constraints of keyword searching.
[14] This begs the question as to why Maine employers are not offering competitive salaries!

6. Our efforts to survey training capabilities did not include online training resources. One such library is maintained by TechMaine. The available resources are vast and very relevant to many IT skills, especially those in specific software and hardware products. Any systematic attempt at creating a customized curriculum for a specific worker should include such courses.

7. We began this work with an emphasis on building a model of the IT marketplace in Maine. We are now convinced that such a model is not possible without better data, but the structure of such a model could be developed in anticipation of that data. Such a model could help employers, training institutions and government explore new scenarios to understand the consequences of their or others' actions.

8. Although we have made no attempt to do so, we believe that our methodology (in the broadest sense) is applicable to any occupational cluster. The key is a commonly accepted vocabulary of skills (or at least a common understanding of those skills) with a clear description of their constituent capabilities. In some occupations (e.g., chemical technician) this exists. It would be very interesting to address another cluster to see whether similar results to ours could be obtained.

Glossary

CWRI	The Center for Workforce Research and Information, Department of Labor, State of Maine.
IBM	The International Business Machines Corporation, headquartered in Armonk, NY.
IT	Information Technology
ITIL	The Information Technology Infrastructure Library, a publication of the United Kingdom Office of Government Commerce.
MDoL	The Department of Labor, State of Maine.
SOC	Standard Occupational Codes
USM	The University of Southern Maine, with campuses in Portland, Lewiston-Auburn and Gorham.

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Appendix A. Contractual deliverables

All work will be performed by USM.

1. Select a classification of IT skills and levels of mastery. Since workforce skills, industry needs and training capabilities use different classifications provide equivalence between the selected classification and other relevant classifications.

   This deliverable has central importance to this proposal. Without a skill classification it is impossible to match skill deficits with the skill development of a specific training curriculum. At present there does not appear to be a single authoritative IT skill classification.

2. Analyze O*NET data to determine the IT skills needed by workers in each of the 16 key occupational clusters. From this, determine which skills are cluster-specific and which skills are common across clusters.

   As this data does not adhere to a common classification of IT skills, even within the data, the analysis must be performed on a likelihood basis. For example, since the same skill has a different textual representation across clusters, analysis can only be performed on the basis that two skill representations are likely to represent the same skill.

3. If data on non-IT-cluster worker IT skills can be found, determine which skills are cluster-specific (and job-specific, if possible) and which skills are present across clusters.
4. Analyze available data (Burning Glass analyses) to determine employer needs (e.g., skills, quantities) for IT skills in the IT cluster. If data is available, determine employer needs for IT skills in the other clusters as well.
5. Using available data (TechMaine survey) determine current worker skill capabilities (e.g., skills, quantities available) in the IT cluster and match these capabilities to the needs determined in 4. Identify skills in high demand but short supply, and where excess supply exists (gaps and gluts).
6. Create data describing educational and training courses available from Maine bricks-and-mortar institutions. This data will be created from publicly-available sources. This data will suffer from the same limitations as discussed in 2.
7. Evaluate whether Maine educational and training institutions offer curricula to address the gaps identified in 5. If not, identify needs for new courses or programs.

   This deliverable is the centerpiece of this proposal. While the skills classification, skills surveys and needs projections have their own intrinsic value, it is the focus of this proposal to integrate this information with training capabilities to identify unmet training needs.

8. As discussed at the Augusta meeting of October 19, provide a description of basic computer literacy skills. This set of skills will be required by workers in any cluster with a requirement to use a computer on the job.
9. Create and present a final report to MDoL and to other audiences with an interest in its findings and recommendations.

Appendix B. Computer Literacy Skills Guide and Checklist

This guide and checklist is designed to assist MDoL field workers to determine the skill levels of the person seeking employment and suggested applications and general skills that enable them to perform at a level that would be considered "computer literate" and or "having specialized applications-based skills."

Part 1. Basic Skills

The basic skills listed as I, II, and III, below are the minimum expected of a computer literate/competent user. If a person does not possess skills in at least two of these basic areas, they will need to be enrolled a rudimentary computer skills class or workshop.

I. Basic Required Computing Operations Skills:

- ☐ Start Computer and general navigation
- ☐ Keyboard and mouse use
- ☐ Minimal text editing / word processing

To test these skills, have the client turn on the computer and create a simple text document, such as a document with their name, address, and job(s) sought.

II. Basic Internet Skills

- ☐ Launch browser(s) (Explorer, Firefox, etc.)
- ☐ Navigate with browser(s)
- ☐ Simple searches (Google, Bing, etc.)
- ☐ Create bookmarks

To test these skills have the client to launch a browser such as Firefox and ask them to find the MDoL website (www.maine.gov/labor/) and to bookmark it.

III. Basic Email Skills

- ☐ Find email client application (Outlook, Gmail)
- ☐ Create client account‡‡‡‡
- ☐ Manage client account (store, purge, sort/file email)

To test these skills ask the client to locate the email client application, to fill in the client information and to send an email to himself or herself and one the fieldworker or a designated email practice account and save the emails.

‡‡‡‡ NOTE: The account creation may be too complex for some users, and may be omitted depending on the judgment of the field worker. However, under Applications and Specialized Skills, the client should be able to perform this task.

Part 2. Applications and Specialized Skills

This section is more advanced and addresses more technical specialized applications skills, such as word processing, spreadsheets, and more specialized internet applications, file management, and advanced email. If the client is interested in this level of competency the Introduction to Computers course, ITT181 at USM is a good match (See attached syllabus). There are also specific workshops or courses that are targeted at word processing only, or the ABU190 course at USM Outreach is targeted at spreadsheets. Courses are also available that are designed for how to use the internet and how to search using the Internet; these are available at USM's Lewiston Auburn College.

I. Word Processing

- ☐ Launch Word processor (MS Word, Open Office)
- ☐ Create a cover letter for employment

To test these skills ask the client to format the cover letter document with 1.5 inch margins, use the Times, 12 point font, spell and grammar check the document, and show the number of words in the document. Name the document "cover letter".

II. Spreadsheets

- ☐ Launch the Spreadsheet (MS Excel or Open Office)
- ☐ Create a simple spreadsheet

To test these skills, ask the client to create two columns names and ages, and enter the names of family members in and their ages in the respective columns. Ask the client to calculate the average age of the family members using the formula function. Name the spreadsheet "family".

III. File Management

- ☐ Create a way to organize files
- ☐ Copy files
- ☐ Move files
- ☐ Rename files

To test these skills, ask the client to create a folder on the desktop called "my work"; locate and move the word processor document (cover letter) to the "my work" folder, copy the spreadsheet (family) to the folder "my work" and change the name to "family ages".

IV. Advanced Email

- ☐ Launch Email Client (Outlook or Google/Gmail)
- ☐ Create account

To test this skill, ask the client to create an IMAP account; this means they will have to have some information that can be supplied such as the IMAP server, the SMTP server addresses, and their user name and password. Setting up the email for Gmail is the easier task and all the information is readily available from the Google site.

V. Internet Applications

- ☐ Use Internet applications such as Gmail
- ☐ Use Google News

To test these skills, ask client to use the Gmail account created in IV to send and receive mail from him or herself. Then ask them to save, delete, or archive mail. To test a simple internet information application, ask the client to go to Google news and find the three top new stories of the day in the US.