

Continued Relevance of COBOL in Business and Academia: Current Situation and Comparison to the Year 2000 Study

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Abstract

This research reports the results from a set of two surveys conducted at the end of 2002 from business, government, and non-profit employers who may be using COBOL applications in their information systems and from academic institutions with undergraduate CIS/IS programs that may offer COBOL instruction in their curriculum. The surveys asked questions of respondents very similar to surveys conducted by the same authors in 1999 and reported by the authors in early 2000. Time trends between the previous study and this study are examined. The current survey also obtained data pertinent to emerging technologies that were either too new or not existent in 1999. The perceived impact of these new technologies upon business and non-profit organizations as well as upon academic curriculum is reported through discussion of IS/IT executives' and academics' perceptions concerning the importance of the COBOL language in future IS/IT business application development over the next 10 years.

Keywords: COBOL, IDE, CIS curriculum, application development, legacy application

INTRODUCTION

Nearly 80 percent of IS/IT managers surveyed in this study indicated that the COBOL language should continue to be offered in college curriculum compared to almost 90 percent in the 1999 study (Carr and Kizior, 2000). The decline is coupled with the desire by IS/IT managers for college CIS/IS cur-

riculum to require a second computer language. Inclusion of a second appropriate language would better enable students to assist in the re-hosting of COBOL applications without the need for extensive rewriting. Currently, more than 70 percent indicate that object-oriented, Java, and Microsoft platform features of the COBOL language should be integrated into COBOL in-

struction in college curriculum. Re-engineering and re-hosting COBOL applications for component-based architecture was also stated as being important by nearly 70 percent of the IS Managers. One of the surprising observations was that almost 95% of the academic respondents continue to indicate that COBOL language instruction should be offered in the IS curricula. The exact same question asked in the 1999 study obtained an almost identical response.

The central theme displayed by respondents throughout the current study (as well as was observed emerging in the previous study) is one of language integration rather than language replacement. Re-engineering and re-hosting of present applications through the use of integrated development environments (IDEs) that utilize the efficient facilities of each language will dominate IS manager needs in the future. These needs are being translated into demand to obtain application development (AD) programmers that will have the appropriate programming integration skill sets (Halpern and Carr, 2002). Academic CIS/IS curricula will need to implement various curriculum changes in order to produce graduates who are at least adequately introduced to skills associated with integrated application development.

Many business and industry information systems executives are indicating increased concern about the present need to maintain the large inventory of 'legacy' code while at the same time developing new e-commerce oriented systems. A major concern is how to integrate new technologies with existing 'legacy' applications without incurring costly application rewrites. Many COBOL programming language vendors such as Micro Focus have integrated Java and .Net facilities into their integrated development environments thereby allowing integration of existing COBOL applications without expensive application rewriting. Many educators are currently being challenged concerning the content and scope of their curricula in order to successfully market graduates from their computer information systems (CIS/IS) programs that will meet business and industry need for entry level programmers who can operate in these new integrated development environments.

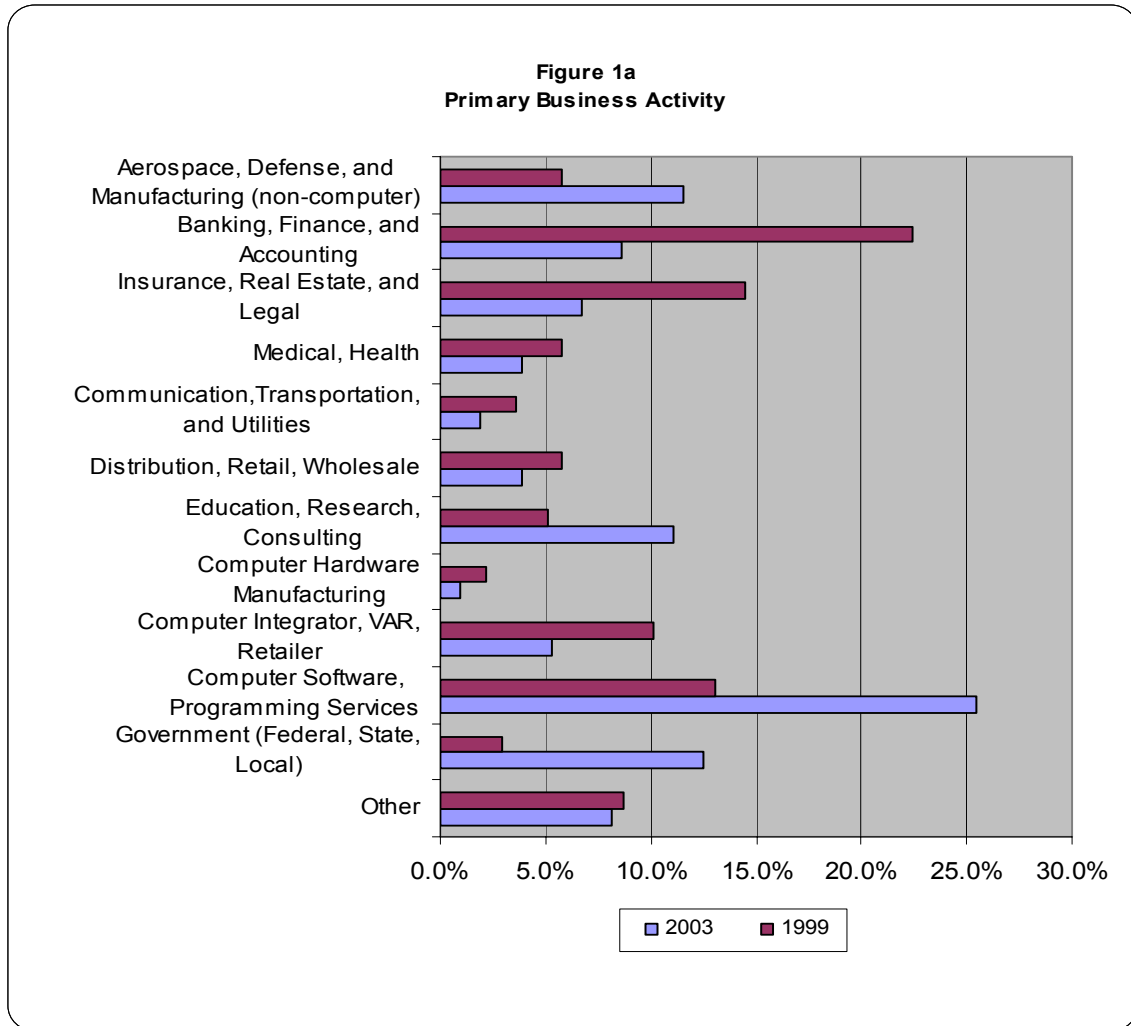
The demise of the COBOL language in the development of 'modern' business applications has been forecasted for many years by academic and industry 'pundits' (Hayes, 2002; Yourdon, 1997). COBOL applications and mainframe computing continues to dominate a large segment of the business community where major applications are still driven by conventional data and transaction processing requirements. It has been estimated that nearly 200 billion lines of COBOL code are used in today's business applications with several billion lines of new COBOL application code added annually (Arranga, 1997; Stern, 2000). The requirement to maintain existing COBOL applications necessitates continued demand for new replacement COBOL programmers.

Most IS activity for the foreseeable future will focus on new application demands associated with e-commerce and the web. This will necessitate that application developers will have to focus not only on new Internet technologies, but ways of "linking" existing mainframe IS applications to the Internet. This will once again augur a new demand for IS staffs with knowledge of the business rules and mainframe processes. Who better to provide this resource than the COBOL programmer? Given these facts and this new development environment what is going to happen to the demand for COBOL programmers? How should IS programs in academic institutions respond to this new environment? In an effort to provide some clear answers for IS managers and academicians this current research has been conducted. Results from analysis of survey data may assist in providing clearer vision as to what IS managers are planning and the knowledge and skill set that they will require of future IS graduates over the next five to ten years. Planning and implementation of college and university IS program curriculum can then be conducted in a manner that will produce graduates who will meet business and industry needs.

RESEARCH METHODOLOGY

The major hypothesis examined in this research is to determine to what extent the evolving COBOL language will continue as a major programming language for development of business applications over the next 10 years. A corollary hypothesis is to examine what trends may have occurred in the usage of COBOL since the 1999 study. The current survey instrument included addi-

called just 'business') who currently may or may not use COBOL applications in their information systems. A second group consisted of academic institutions that have CIS/IS programs that may or may not be currently offering COBOL instruction in their curriculums. A slightly different questionnaire was sent to each group in order to capture demographic and operational data unique to each.



tional questions to obtain data that allow examination of new application development technologies emerging since 1999 and how existing COBOL business applications could be integrated into these new e-commerce and internet business applications. The present research consisted of survey questionnaires sent to two groups of respondents. One group consisted of business, industry, and non-profit employers (often

Response to the survey instrument was solicited from 4700 business and industry executives and managers and 2000 academic institutions that may or may not utilize COBOL applications or offer COBOL instruction in their academic curriculums. Response was received from 208 business and non-profit institutions and 68 higher education institutions. The response rate was 4.2 per-

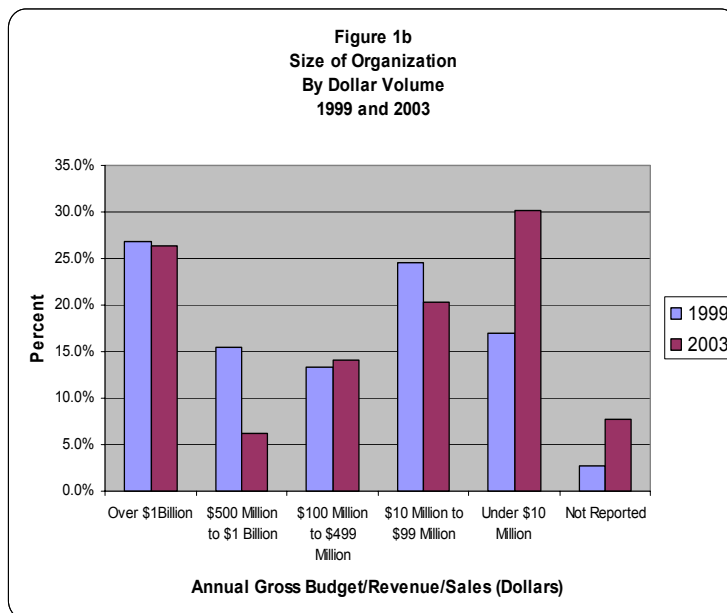
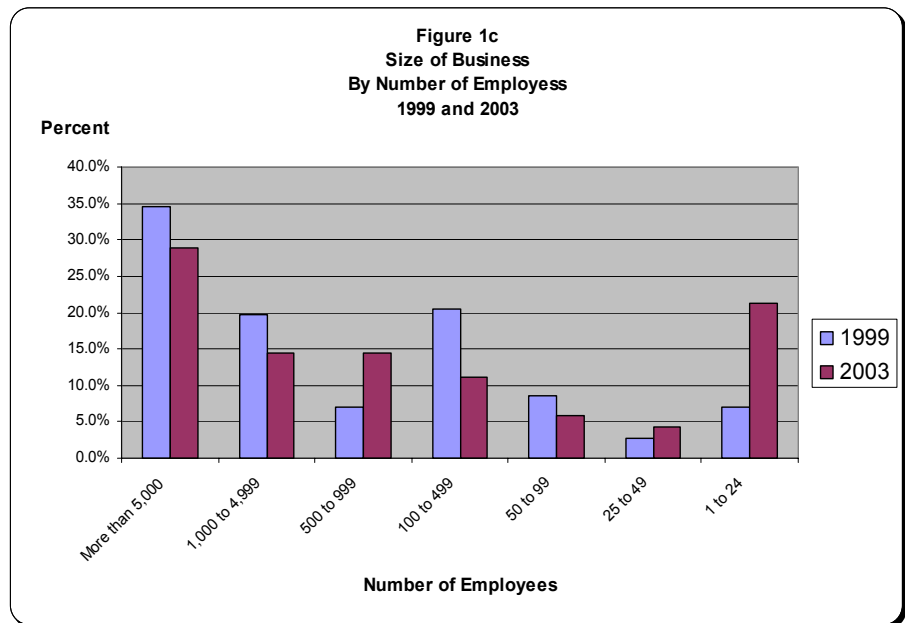
cent from business and 3.8 percent from educational institutions.

A more definitive explanation of the research methodology is offered in the Appendix.

DEMOGRAPHICS

Demographic information about business organization respondents is displayed in **Figures 1a, 1b, and 1c**. Information from both the 1999 and the current study are provided for comparison. **Figure 1a** shows the distribution of respondents by primary business activity while **Figure 1b** shows the size of business by gross dollar volume either in budget (for non-profit), revenue, or sales. And **Figure 1c** indicates size of the organization in terms of number of employees. Business and organizational re-

sponses were received from all regions of the United States. Thirty-four percent of the responses came from the South while all other responses were nearly evenly split among the Northeast, Midwest, and West Census Regions. Foreign response was 17% and mostly from European countries. There are some significant differences between this study and the 1999 study with respect to reported primary business activity as shown at **Figure 1a**. There is a significant decrease in the number of banking, finance and accounting firms down from 22.5 percent in

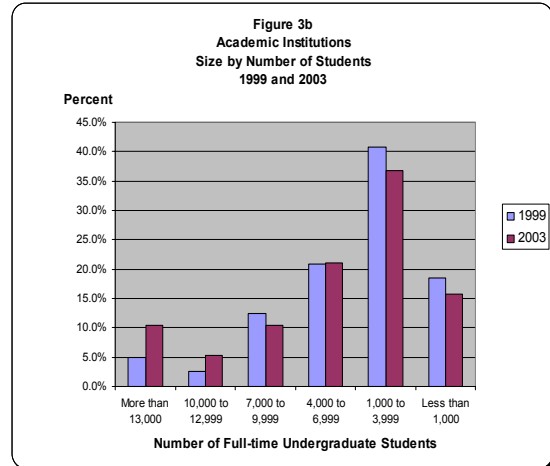
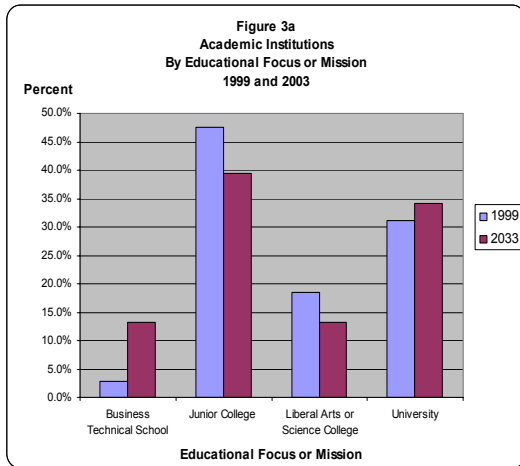


1999 to 8.7 percent in 2003. Insurance, real estate and legal firms declined in number from 14.5 percent in 1999 to 6.7 percent in 2003. Government, Computer vendors (all types), and education, research, and consulting firms are more represented in the current study. Nearly 60 percent (77 percent in 1999) of businesses indicated multi-state operations. More than 40 percent of business reported multi-national operations in both 1999 and 2003.

Size of the enterprise is reported by Dollar Volume in **Figure 1b** for both 1999 and 2003 with more than 25 per-

cent indicating volume in excess of 1 Billion. There were some significant differences in both the number of mid-range firms (\$10-99 million) and smaller firms (under \$10 million) represented in the survey between the 1999 and 2003 studies.

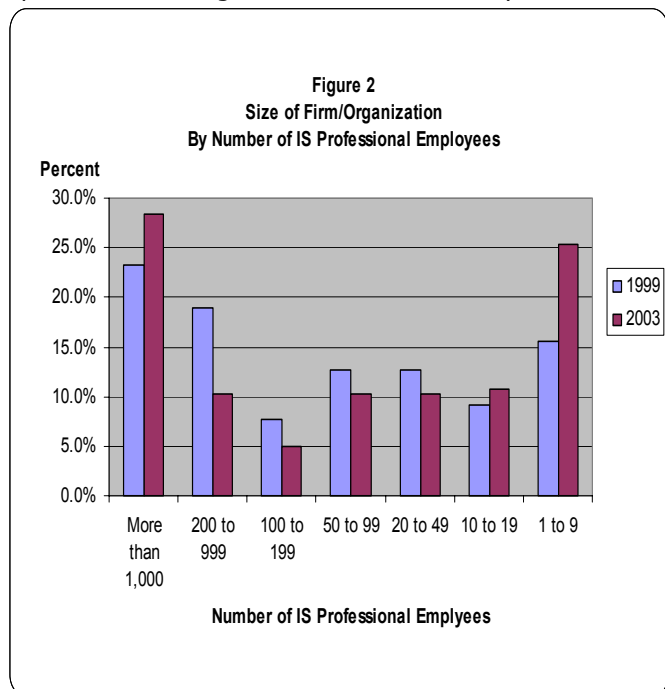
Responses from educational institutions were received nearly uniformly across all geographic regions of the country. The focus or mission of education was centered at the junior college (2-year) or university (4-



Another measure of firm size is the number of employees indicated at **Figure 1c**. Nearly 35 percent of the businesses reported 5,000 or more employees with more than 60 percent reporting 500 or more employees. Again, significant differences occur in the number of mid-range firms (100-499 employees) and small firms (1-24 employees) represented in the 2003 study as compared to the 1999 study. More than 20 percent of firms report 1 to 24 employees compared to only 7 percent in the 1999 study.

year) educational institution as displayed in **Figure 3a** below. These institutions represented 74 percent of the institutions responding to the current study which was unchanged from the 1999 study.

Further demographic information of interest in this study is the number of IS professionals employed within the organization as displayed in **Figure 2**. Fifty percent of the businesses reported Information Systems (IS) departments employing 100 or more IS professionals. A little more than 25 percent reported 1,000 or more professional IS employees. More than 50 percent of the respondents reported that their major job function was either senior or middle IS/MIS/DP management or application project management. The median age was in the 40 to 49 year age group and only slightly more than 10 percent of respondents were female.



The size of educational institutions as represented by the number of full-time undergraduate student enrollment is shown at **Figure 3b** below. The median size was

Table 1. IS/IT Managers' View of Beneficial Skills for Entry-level Programmers			
Methodology/Technology	The technical skill is beneficial		
	YES	NO	Opinion not stated
	data in percent		
OO-Cobol	58.2	27.4	14.4
Integration of Cobol w/ Microsoft platform, languages and applications	61.1	25.0	13.9
Integration of Cobol w/ Java platform, languages and applications	55.8	30.8	13.4
Use of Cobol in distributed OLTP applications	44.2	39.9	15.9
Integration of CICS and IMS Cobol applications into Java and Microsoft platforms	45.7	39.4	14.9
Re-engineering COBOL applications for service-based or component-based architectures	56.7	28.4	14.9
Re-hosting Cobol applications to new hardware and software platforms	55.8	29.8	14.4

3,000 undergraduate students which was nearly the same as reported in the 1999 study. Institutions with graduate programs reported a median size of 300 graduate students while 25 percent of institutions reporting more than 1000 graduate students. The data were very similar in the 1999 study.

Nearly 75 percent of the colleges or universities responding were public institutions with more than 85 percent utilizing the semester system as contrasted to the quarter system for course instruction. There was no significant change from what was reported in the previous study.

The median size of institution as measured by number of tenure-track faculty was 80 in 1999 and 110 in the present study. About 25 percent of institutions reported 175 or more tenure-track faculty in both studies. The median CS/CIS/IS/MIS department size is 8 tenure-track faculty members with 25 percent reporting more than 15 tenure-track faculty members. There did not appear to be any significant difference in the above data over the time between the studies. However, nearly twice as many institutions reported utilization of instructors/lecturers (38 percent) than in the 1999 study. There was also a significant decline in the number of Assistant Professors employed with a related increase in the number of Associate/Full Professors indicating a 'graying' and stable fac-

ulty in CS/CIS/IS/MIS faculties. Summarizing this data creates a profile of the typical institution responding to this survey as a junior college or four year public institution whose program is conducted on a semester basis and who has about 80 tenure track faculty with 8 faculty members in a more stable and 'graying' CIS/CS/IS/MIS department than existed in the

1999 study.

RELEVANCE OF COBOL REVISITED

The major hypothesis of this research was to examine the question "Will the COBOL language continue to be a major programming language for development of business applications over the coming decade?" The following summary of observations from professional and academic respondents to the survey is indicated below. A more exhaustive statistical report is forthcoming by the authors in later research using the data obtained from the surveys.

More than 56 percent of the IS Managers in enterprises responding to the survey are currently developing and maintaining code written in the COBOL language. This was a significant decline from 87 percent responding in the 1999 study. Nearly 60 percent of organizations utilizing COBOL reported code inventories exceeding 5 million lines of code while nearly 30 percent reported use of 20 or more million lines of COBOL code. There was no significant change in this observation from that observed in the 1999 study. Most respondents reported use of some version of Micro Focus COBOL. From those institutions reporting use of Micro Focus the Net Express IDE was mentioned most often. Other CO-

BOL vendors mentioned less frequently were IBM and Fujitsu.

About 30% of programming effort was expended solely in the maintenance of existing 'legacy' COBOL code. This was a decline from more than 50 percent expended to maintain COBOL applications reported in the 1999 study. Only 10 percent of current programming effort is expended in developing new applications utilizing the COBOL language, a decline from 20 percent in 1999. About 10 percent of the programming resources are expended in a mixture of new application development and application maintenance which represents another substantial decline from the 30 percent indicated in the 1999 study. If COBOL was not the current principle language used for application development respondents mentioned utilizing C++, Java, and Visual Basic in declining order of importance.

As in the 1999 study, nearly 70 percent of the respondents reported use of embedded

about 70 percent of the DBMS platforms utilized.

Fifty percent of the organizations reported 25 or more COBOL programmers currently on their IS staffs while 25 percent reported employing 100 or more COBOL programmers. Ten percent of the businesses responding to the survey hire 500 or more COBOL programmers. In the hiring of new entry level programmers more than 50 percent indicate a desire that the applicant have two semesters of COBOL. Another 22 percent indicated a need for a one semester requirement and 15 percent stated a need for a three semester requirement. Only 10 percent of IS managers stated that COBOL education was not an employment requirement. This translates into the fact that more than 70 percent of IS managers responding think that a minimum of one semester of COBOL should be required in current IS curriculums.

In academic institutions the median annual enrollment in COBOL courses declined from 40 students in 1999 to about 30 students in 2003. However, 25 percent of colleges enrolling more than 80 students remained constant between the two study years. Approximately ten percent of the colleges and universities enroll more than 150 students annually in COBOL courses and this observation also remained constant between 1999 and 2003. Currently, part-time or adjunct faculty provides nearly 45 percent of COBOL instruction on college and university campuses. The

SQL with their COBOL applications. Oracle was the predominate DBMS used followed very closely by DB2. Both of these made up

1999 study reported 31 percent. This observation could possibly account for the large

Table 2. IS/IT Managers' Response to Company/Organization Decision ...			
Methodology/Technology	To adopt or utilize listed Methodology/Technology		
	YES	NO	Opinion not stated
	data in percent		
OO-Cobol	18.3	68.7	13.0
Integration of Cobol w/ Microsoft platform, languages and applications	30.8	56.2	13.0
Integration of Cobol w/ Java platform, languages and applications	20.2	67.3	12.5
Use of Cobol in distributed OLTP applications	16.3	69.8	13.9
Integration of CICS and IMS Cobol applications into Java and Microsoft platforms	19.2	65.3	15.5
Re-engineering Ccobol applications for service-based or component-based architectures	31.7	55.3	13.0
Re-hosting Cobol applications to new hardware and software platforms	31.7	55.3	13.0

predicted decline in academic institutions that may be removing COBOL from curriculum and thereby not attracting and providing needed professional development incentive (investment) to retain qualified tenure track faculty to teach COBOL and the more interoperable technologies needed to teach in a mixed-language environment. In contrast to these observations nearly 85 percent of academic respondents report the desire that COBOL instruction continue to be offered in their curriculums as compared to about 90 percent in the 1999 study.

The IS Managers' View of the Future

IS managers were asked several questions relating to recent technological developments in the COBOL language. Data pertaining to IS/IT managers' knowledge level and adoption of these new object-oriented and web/e-commerce based technologies are indicated at **Appendix Table 1** (inserted as appendix table to conserve space). With respect to the eight methodologies and technologies listed more than two-thirds reported that they either had no knowledge or had very limited knowledge (seminars/literature review only) pertaining to the technologies listed. Only approximately one-third of managers who may have had adequate knowledge of any of the listed technologies were either in the planning phase to adopt or had already adopted the technology.

When asked the question concerning knowledge of availability of education or training and possible attendance on the same list of methodologies or technologies IS managers indicated at **Appendix Table 2** that on average 56 percent of them had no desire to attend any class. Similarly, 17 percent had no knowledge concerning these education programs and 19 percent knew about the programs but had not attended any sessions. Only 9 percent of respondents had attended a one or more training sessions, while only 6 percent indicated sufficient knowledge to adequately implement one or more of the listed technologies within their organizations. As reasons for not attending training, nearly 54 percent reported limited time availability while only 36 percent reported financial resource limitations. Slightly more than 10 percent reported distance to training site as the limiting factor

affecting non-attendance to education or training courses.

When answering a question concerning industry needs, 64 percent of IS/IT respondents indicated that they were either very familiar or slightly familiar with current IT industry needs for employees with adequate COBOL skills. Over 35 percent of IS managers indicated that there currently exist an undersupply of employees with adequate COBOL skills while only 18 percent said that there was an oversupply of employees with COBOL skills. This observation points to the 'looming' shortage of adequately trained programmers who have the requisite COBOL skill set to maintain existing legacy applications while at the same time re-engineering, re-hosting, and extending these applications to web-based and e-commerce based applications using mixed program language environments (Micro Focus, 2002). IS managers were asked to specify skill sets that would be beneficial for students to pursue in their college education. The data is presented at **Table 1** below. Nearly the same set of technologies listed in Appendix Tables 1 and 2 and discussed previously was utilized to solicit IS manager opinion. It is interesting to note that while a significant number of IS/IT managers have little knowledge of the listed technologies they have the view (44 percent to 61 percent) that it would be beneficial for new entry-level programmers to possess one or more of these skills sets to obtain entry-level programmer positions. This observation poses a significant problem that confronts academic education CIS/IS program curriculum.

In the 1999 study, more than 45 percent of IS managers stated that COBOL would continue to be used over the next 10 years at the existing level while less than 15 percent indicated that COBOL would be eliminated or replaced in the organization. Now, IS/IT managers in the present study report that 38 percent will continue use of COBOL at the existing level while 27 percent indicate that COBOL will be eliminated or replaced within the next 10 years. This data reflects a gradual decline in the importance of COBOL in application development over the next 10 years unless technological advancement in COBOL language integration with other languages and technologies can be adopted by

Table 3. IS Mangers' Perception about Use of Object-Oriented Methodologies		
Response choice	1999	2003
	data in percent	
O-O will become the standard for future programing development	25.7	33.9
O-O is a fad and will not be seriously implemented	2.1	5.6
O-O will be popular as a structured form but will not replace structred methodology	62.9	52.2
O-O development is too risky to implement at present	2.9	3.3
Other	6.4	5.0
Totals	100.0	100.0

the current or future COBOL user community.

Slightly more than 30 percent of the respondents indicated in 1999 that COBOL would decline in importance in application development compared to 29 percent today. However, about 5 percent of IS mangers said in 1999 that use of COBOL would actually increase over the next 10 years and this is the same percent reported by IS managers in the present study.

Data at **Table 2** below reports IS/IT managers' response to company or organization action to adopt and utilize one or more of the technologies integrating legacy COBOL applications with mixed language/platform environments. Slightly less than 50 percent of these managers indicated that their organization was planning or had taken action to integrate object-oriented or web-based features of the COBOL language along with existing COBOL applications in 1999. Now, almost 70 percent of IS managers indicate an adoption of OO-COBOL and Web-based features of the Microsoft or Java languages and platforms. Managers responded almost identically, 63 percent, to the adoption and use of re-engineering and re-hosting technologies as they did in the 1999. It appears that IS managers can not make a clear distinction between re-engineering and re-hosting technologies since they give almost

equal response to use or adoption of these technologies. Ten percent of respondents indicated action to use OO-COBOL for new program development in 1999 compared to an increase to more than 18 percent in 2003. IS/IT managers were asked if they envisioned that OO-COBOL would replace or compliment structured COBOL. Seventy-six percent indicated

that OO-COBOL would be a compliment rather than replacement in the current study compared to 89 percent in the 1999 study. Inversely, 13 percent of respondents are now indicating that OO-COBOL is used to replace structured COBOL. Manager responses pertaining to use of Object-Oriented methodologies are further summarized and compared in **Table 3**. There is a slight increase from 1999 to present in the perception that O-O methodologies will become the standard for future programming development providing greater compliment to existing structured methodologies.

Managers were asked several questions pertaining to their perception of the impact that selected new programming initiatives would have upon their current application development environment. Summary analysis of their responses is indicated at **Appendix Table 3**. While there was limited response to these questions, note the perceived effect of the C# initiative upon both the replacement of COBOL applications and as a language of choice for both application and web development. Also, note that Java is perceived to have a much greater impact than Visual Basic.Net on web development and about equal perceived impact upon application development. Neither Java nor Visual Basic.Net is perceived to greatly effect the replacement of COBOL. This conclusion is supported by further observation that it is

Table 4.			
IS/IT Managers' Perception			
Concerning Academic Cobol Instruction Content			
Methodology/Technology	To include the listed Methodology/Technology		
	YES	NO	Opinion not stated
	data in percent		
OO-Cobol	66.3	21.2	12.5
Integration of Cobol w/ Microsoft platform, languages and applications	62.5	24.5	13.0
Integration of Cobol w/ Java platform, languages and applications	62.0	25.0	13.0
Use of Cobol in distributed OLTP applications	54.8	31.7	13.5
Integration of CICS and IMS Cobol applications into Java and Microsoft platforms	50.0	35.6	14.4
Re-engineering Cobol applications for service-based or component-based architectures	59.1	26.9	14.0
Re-hosting Cobol applications to new hardware and software platforms	59.6	26.4	14.0

not competing language application development that is impacting the replacement of COBOL applications; but, rather, implementation of enterprise application packages such as SAP, PeopleSoft, and other packaged enterprise applications (Hayes, 2002).

The responses from IS managers regarding continued placement of COBOL in CIS/IS curriculums is an important observation for educators. In the 1999 study 88.6 percent

Table 5.		
Academic Respondents Teaching the Specified Programming Language		
Language Description	1999	2003
	data in percent	
1. ASP.Net	nr	7.9
2. Basic	53.6	34.9
3. Visual Basic.Net	nr	69.8
3. C	38.2	31.7
5. C++	71.8	84.1
6. C#	nr	11.1
7. Visual C/C++	49.1	42.9
8. COBOL	90.7	83.3
9. Java/HTML	70.9	82.5
10. Pascal	19.1	4.8
nr = not reported in 1999		

of IS managers indicated that COBOL should continue to be offered in college curriculums while in the present study the number has declined to 78.7 percent. This decline of almost 10 percent may have significant impact upon academic programs as CIS/IS academic administrators look for evidence to eliminate COBOL instruction from academic curriculums. Almost 90 percent of managers from the 1999 study indicated that

both O-O and web-based features incorporated into the new COBOL language standard be integrated into COBOL instruction in college curriculums since these same IS managers responded that these features would be utilized to compliment current inventory of structured COBOL code. In the current study a slightly different question was asked that focused on IS managers perception of what should be incorporated into CIS/IS COBOL curriculum based upon methodologies and technology which were just beginning to evolve at the time of the 1999 study. **Table 4** indicates current IS managers' perception concerning topics that should be incorporated into COBOL instruction in academic curriculums.

Nearly two-thirds of IS/IT manager's indicated that O-O COBOL should be included and integrated into COBOL instruction while more than 60 percent also indicated that the Java and Microsoft languages be integrated with COBOL instruction. This observation gives powerful evidence to academic CIS/IS program administrators that COBOL should continue to be taught in a mixed-language interop-

erable environment using 'modern' integrated development environment (IDE) platforms currently offered by most COBOL vendors.

With the fact that there are scarce teaching resources available in higher-education CIS/IS programs and the assumption that only two semesters of the CIS/IS curriculum can be devoted to learning a computer language, IS managers in the 1999 study were about evenly split as to whether students should take two separate computer languages or learn one computer language thoroughly over a two semester required course sequence. In the present study nearly 64 percent of IS managers responded that two languages be taught in a two semester programming sequence with COBOL still being required and either Java or Visual Basic.Net elected in a second required semester.

The Academics' View of the Future

The relevant importance of the COBOL language in current CIS/IS curricula as compared to other languages in both the 1999 study and the present study is shown at **Table 5** below. COBOL instruction continues to be offered as a single course in nearly 85 percent of CIS/IS curriculums and nearly 70 percent continue to offer an advanced COBOL course. These observations have declined by less than 10 percent since the 1999 study. Nearly 30 percent of academic respondents still require a two course sequence of instruction in COBOL as compared to 47 percent in the 1999 study which is a substantial decline. Many CIS/IS programs are now requiring a second programming language in their curriculums which has impact upon the two-course COBOL requirement. The C++ language is currently taught in more than 84 percent of academic programs. It should be noted that C++ is taught predominantly in Computer Engineering and Computer Science programs. Note also the high percentage of Java (at 82.5 percent) and Visual Basic.Net (at 69.8 percent) currently being taught in all computer related academic programs. The popularity of Java and Visual Basic.Net is related not only to industry needs for these skills but also to the proliferation of the publication of appropriate teaching resources and freeware software for student

and academic institutional needs in these languages.

An important observation is that more than 75 percent of the academic respondents continue to require learning the COBOL language as an integral part of the CIS/IS/MIS degree major or program. There was no significant change in this observation when compared to the 1999 study. Nearly 55 percent of the respondents require a two-semester course sequence in COBOL instruction to complete the degree program which is a slight increase compared to 47 percent responding to the same question in the 1999 study.

In 1999 when asked what the instructional requirement for COBOL was 5 years ago over 56 percent responded with the same course length as presently required. Now, looking back 5 years the response is 73 percent to the same question. Refer to **Table 6**.

	1999	2003
Same length	30%	11%
Less than current length	28%	47%
Deleted from curriculum	17%	17%

Similarly, when asked in 1999 what the instructional requirement for COBOL would be 5 years from then 30 percent responded with the same length, 28 percent with less than the current length and 17 percent indicated COBOL instruction would be deleted from their curriculum. The same questions in this study resulted in responses of 11 percent same, 47 percent less, and 17 percent to delete from curriculum. This observation predicts a noticeable downward trend in the amount of COBOL instruction that will be included in future CIS/IS academic program curriculums. It is important to note, however, the amount of COBOL (per se) instruction may decline but that greater emphasis may be placed upon integration of COBOL and interoperability with other languages and DBMS facilities in academic curriculum.

A major observation is that many COBOL vendors such as Micro Focus now offer application development platforms that integrate Java and .Net technologies with COBOL into integrated, mixed-language development environments.

The present study indicates that more than 60 percent of academic respondents perceive a shift to make COBOL an elective subject rather than required within CIS/IS curriculums. CIS/IS curriculums appear to be changing to meet industry needs as evidenced by IS managers in **Table 1**. Slightly

Scenario	To be:							
	Not Likely		Possible		Very Likely		Underway	
	1999	2003	1999	2003	1999	2003	1999	2003
	all data in percent of respondents							
A substantially shorter course	71.6	52.9	22.1	33.3	5.3	6.3	0.9	5.9
Offered at higher curriculum level	77.8	72.0	16.7	16.0	4.4	8.0	1.1	4.0
Made an elective	33.7	38.0	43.5	30.0	9.8	12.0	13.0	20.0
Eliminated from the curriculum	61.1	49.0	24.4	39.2	11.1	9.8	3.3	2.0
Replaced with another language	43.3	40.4	40.0	34.6	13.3	15.4	3.3	9.6

Table 7 below shows educational response to the likelihood of change in COBOL instruction in CIS/IS curriculum scenarios with 1999 and 2003 responses compared. While a little less than 30 percent of academics indicated a substantially shorter COBOL course requirement in 1999, 47 percent are indicating shorter COBOL course requirements in 2003. Most programming language courses have historically been offered at the beginning level of the curriculum as evidenced by nearly 78 percent of respondents indicating that offering COBOL at a higher level in the curriculum was not likely to occur in the 1999 study. However, some movement is underway to have COBOL instruction occur at more advanced senior-level standing in CIS/IS curriculums where more mature students can better assimilate the more complex programming development environments. This observation comes from the fact that integration and interoperability features of COBOL instruction with other language facilities (VB.Net, Java, SQL, etc) cannot occur until these other CIS/IS courses have been taken. This is a shift in likelihood from that observed in 1999. More than 40 percent of respondents indicated that the current COBOL course requirement may possibly become an elective in 1999 as compared to only 30 percent in 2003.

more than 50 percent of academic respondents in 2003 believe that COBOL will be eliminated from academic curriculums compared to less than 40 percent in 1999. A more interesting opinion is one that is nearly split as to whether some other language will replace COBOL in CIS/IS curriculums. As data in **Table 5** suggests there has been a large increase in teaching Java and Visual Basic.Net (VB.Net) over the last four years associated with a slight decrease in COBOL instruction. This suggests that CIS/IS curriculums are now requiring students to obtain two language skill sets with COBOL still being one of the languages required while another language (Java or VB.net) becomes a required second language elective. Within the next five years more than 33 percent of academic instructors who currently teach COBOL indicated that O-O COBOL or Web-based COBOL instruction will replace structured COBOL. Nearly 50 percent of Academic instructors indicated that these topics will complement current COBOL instruction.

Academics were asked the same set of questions relating to recent technological developments in the COBOL language as were IS managers. Data pertaining to academics' knowledge level of these new technologies are indicated at **Appendix Table 4**. Of the technologies listed only 22 to 29 percent had extended knowledge of O-O COBOL or CO-

BOL Web Application technology and less than 10 percent had implemented these technologies into COBOL instruction. Of the other technologies surveyed the response was even much less. This observation is not much different than observed with IS managers' responses shown at **Appendix Table 1**.

When academic COBOL instructors were asked questions concerning their knowledge about education and training programs provided to assist them to obtain needed knowledge and skills to implement the new listed technologies into instruction positive response was 27 to 30 percent for only O-O COBOL and COBOL Web application technologies. See **Appendix Table 5** for appropriate data. Response to the other six listed technologies range only from 5 to 9 percent. More than 60 percent of academics indicated a strong willingness to attend training sessions but indicated that cost to attend and lack of education institution financial support for their continued professional development prohibited their attendance. Academics in CIS/IS programs were asked questions pertaining to the impact of selected new programming initiatives upon CIS/IS curriculum. Academic response data is shown at **Appendix Table 6**. Similar questions were asked of IS/IT managers (**Appendix Table 3**.) Note that there is not much response to either C# or Java replacing COBOL in academic curriculums. Observe that nearly 20 percent of academic respondents believe that VB.Net will replace COBOL instruction. Also note the substantial academic response who indicated that Java will become the language of choice for both application development and web development in future years.

CONCLUSION

The data obtained from both the professional IS managers and academics questionnaires was extensive and only a partial set of preliminary conclusions and findings can be presented at this time. Trend comparisons of results in this study to those obtained in the 1999 study were made to the extent that demographic differences between the studies would allow.

There appears to be a slight downward trend in the development of new 'traditional' COBOL business applications. However, this downward trend is mostly 'masked' by the current impact that integrated, multi-language, development environments have upon the re-engineering and re-hosting of legacy business applications into more modern e-commerce, web-based, interoperable applications. The central over-riding theme of IS managers' response to this study is to seek to employ programming technologies that integrate current legacy applications with new technologies without the need for major rewriting of the current applications.

Observed data support continued significant use of legacy COBOL applications well into the next decade with a simultaneous need to continue to study and teach COBOL in academic CIS/IS curriculum over the same future time period. Other studies previously cited along with the reported data herein indicate that billions of lines of structured (legacy) COBOL application code still have a very useful life span and still need to be maintained. Large investment in these applications along with major reinvestment that occurred to solve the Y2K problem and the need to recapture investment in these systems will necessitate continued future demand over the next 10 years.—This provides a good outlook for IS graduates who have a good grasp of the COBOL language **as well as other** skill sets needed to integrate COBOL application with 'best practices' of other programming technologies.

Both professional IS/IT executives and managers as well as academic response to this current study indicate that the COBOL language will not be significantly replaced in future application development. Response to the study does support significant integration of existing COBOL applications with demonstrated 'best practices' associated with new emerging programming methodologies and technologies. Evidence from participants to this study as well as trends from the 1999 study indicates that two major topics are currently driving the application integration issue.

First, the use of object-oriented methodology will be increasingly important in future application development whatever the programming language(s) utilized. However,

one only needs to look back at how long it took the IS community (professionals and academics alike) to embrace structured methodology to recognize that a methodology or technology no matter how effective or efficient it may be takes considerable time to make impact upon implementation in business applications. The current theme supported by evidence in this study indicates that object-oriented methodology will compliment but not replace structured methodology in the development of future business applications over the next 10 ten years. Respondents strongly support integration of object-oriented features of the COBOL language standard in the modification and maintenance of existing COBOL applications as well as in academic COBOL instruction.

Second, future application development over the next 10 years will be driven by application integration and interoperability requirements. COBOL application integration along with the Java platform or .Net platform technologies is also a major methodological issue confronting IS managers and academics alike. COBOL vendors such as Micro Focus have integrated object-orientation and web-based technologies using both Java and .Net capabilities into their COBOL compiler/workbench products. In addition, both Sun and Microsoft have implemented technology that allows integration of COBOL language applications into their programming environments. The arrival and beginning utilization of mixed-language, interoperable, integrated COBOL development environments (IDEs) such as provided by Micro Focus in business application development are now focused upon IS efficiency through application integration rather than rewriting.

Evidence in the present study shows that while most IS managers are aware of technological developments in COBOL compiler design associated with mixed-language integration they do not have sufficient knowledge of these environments to manage implementation or deployment of them at acceptable risk levels. Academic educators are also lacking in knowledge to effectively teach these new methodologies and technologies to adequately prepare students to meet business and industry needs for future programmers. The current study along with the results from the 1999 study confirm the fact that both IS managers and educators find it

extremely difficult to gather sufficient funding or the required time to obtain sufficient education and training to enable them to operate adequately in an integrated application development environment or to teach the requisite integrated skill sets demanded from graduate entry-level programmers.

Gone are the days of 'just' the COBOL programmer (or any other programming language). What IS managers' need today are programmers with a range of programming skill sets that will enable them to integrate (link) legacy (structured) applications and to extend these applications into modern business applications through the use mixed-language, integrated application development environments. Observations from the study indicates that IS manager's now need to: 1) encourage, existing experienced COBOL (usually single-language) programmers to obtain appropriate IDE skill and knowledge through human reinvestment; and 2), influence academic CIS/IS curriculum in local colleges and universities to provide graduates who have initial IDE knowledge and skill adequate to entry-level programming requirements. Academic CIS/IS programs and educators need to maintain a closer association with IS manager's long-term programming employment needs through: 1) updating their own methodology and technical skill sets through appropriate research and study or through outside technical training; and 2), greater association with local IS managers and involvement of them on curriculum advisory boards and development of more cooperative use of employer supported intern programs.

The preliminary analysis obtained from the present research and comparison to the previous 1999 study strongly indicates that over the next 10 years the modern COBOL language will continue to be widely used either in new stand-alone COBOL application development using current expanded technical facilities of the language or through use of current evolving IDE features of the COBOL language that allow integration with other programming languages and emerging technologies.

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APPENDIX

Appendix - Research Methodology

A brief review of research methodology used in the study was presented previously. A more detailed discussion is presented here.

In an attempt to overcome some criticism of the previous 1999 study each group, both business and academia, were further each subdivided into two sub-groups. A survey instrument was sent to 2200 randomly selected business and industry information executives who were known to be major users of COBOL applications in their current information systems. The same survey instrument was sent to 2500 information executives from an independent randomly generated list of IT executives who may or may not currently use COBOL applications in their information systems. An academic survey instrument was sent to 1000 randomly selected CIS/IS programs throughout the United States that were strongly believed to provide COBOL language instruction as a part of their curriculum. The academic survey instrument was also sent to another 1000 CIS/IS programs randomly selected from an independently generated list of CIS/IS programs from which it was not known whether or not their CIS/IS programs offered the COBOL language as a part of the educational curriculum. The academic survey was sent to the Chairperson of the CIS/IS Department. The business and industry survey was directed to IS directors or executives who over-see information resources within their organizations.

Both survey instruments contained the category of questions capturing demographic background data unique to each group. The business and industry instrument contained a category of questions that captured data relevant to their computer applications and information system functions. The academic instrument contained a category of questions obtaining data pertinent to the nature and content of CIS/CS/IS/MIS programs. Both survey instruments contained questions in the later category pertinent to existing status as well as questions about perceptions about future status of educational programs or information system functions. Each survey instrument attempted to capture both longitudinal (time-oriented) and latitudinal (cross-section) data. The wording of each question was kept consistent and in the same order as questions contained in the 1999 survey instrument. A few additional questions were asked in the current survey instrument to target use of new application development technologies which were either too new or non-existent at the time of the 1999 study. Each survey instrument mailed was coded so that the sub-group source data could be identified without disclosing the identity of the participant. Participants could respond either by mail or through use of the internet.

Responses were received from 208 business, industry, and non-profit organizations and 68 higher-educational academic institutions. The response rate was 4.4 percent for business organizations and 3.2 percent for academic institutions compared to the 1999 study of 2.8 percent and 3.7 percent respectively. Nearly 10 percent of the responses from the business segment were from the non-COBOL business sub-group while over 13 percent of the academic responses came from the non-COBOL academic sub-group. Preliminary comparison and review of the data did not indicate noticeable differences among the COBOL and non-COBOL sub-groups for either the business or academic groups. An attempt was made to secure participation from non-respondents through a second notification mailing but received negligible results. About 17 percent of the respondents were located outside of the United States. No attempt has been made to analyze data comparisons among U. S. and foreign business institutions in the present study.

Appendix - Tables

Appendix: Table 1.					
IS/IT Mangers' Knowledge Level/Usage of Selected Methodology/Technology					
Methodology/Technology	Respondent Rating Score (%)				
	Have no knowledge	Have limited knowledge	Have extended knowledge	Planning to adopt or have adopted	Do not plan to adopt
OO-Cobol	45	31	8	5	11
Cobol Web Applications and Web Services	43	27	8	8	14
Integration of Cobol w/ Microsoft platform, languages and applications	49	20	11	9	11
Integration of Cobol w/ Java platform, languages and applications	56	19	2	8	15
Use of Cobol in distributed OLTP applications	57	15	5	6	17
Integration of CICS and IMS Cobol applications into Java and Microsoft platforms	57	17	3	5	18
Re-engineering COBOL applications for service-based or component-based architectures	51	19	7	5	18
Re-hosting Cobol applications to new hardware and software platforms	48	15	8	13	16

Appendix: Table 2.					
IS/IT Mangers' Knowledge of Education/Training for Selected Methodology/Technology					
Methodology/Technology	Respondent Rating Score (%)				
	Have no desire to attend	Do not know about these programs	Know about but have not attended	Have attended one session	Have attended and adequately trained to implement
OO-Cobol	52	17	23	4	4
Cobol Web Applications and Web Services	49	17	25	6	3
Integration of Cobol w/ Microsoft platform, languages and applications	52	17	25	2	4
Integration of Cobol w/ Java platform, languages and applications	57	18	19	2	4
Use of Cobol in distributed OLTP applications	57	15	5	6	17
Integration of CICS and IMS Cobol applications into Java and Microsoft platforms	62	15	16	2	5
Re-engineering COBOL applications for service-based or component-based architectures	63	17	15	2	3
Re-hosting Cobol applications to new hardware and software platforms	56	17	21	1	5

Appendix – Tables (continued)

Appendix Table 3.					
IS Managers' Perception of New Programming Initiatives					
Effect Upon Current Application Development					
New Programming Initiatives	Will replace	Will not replace		Will become language of choice for development of	
	Cobol	Visual Basic	C C++	Applications	Web sites
	data in percent of respondents				
What effect will the current:					
1. C# initiative have on current application and web development	12.1	na	27.4	21.2	21.1
2. Java initiative have on current application and web development	7.2	na	na	13.8	32.9
3. Visual Basic.Net initiative have on your current application and web development	7.7	28.2	na	16.9	18.3
na = not applicable					

Appendix – Tables (continued)

Appendix: Table 4. Academics' Knowledge Level of Selected Methodology/Technology				
Methodology/Technology	Respondent Rating Score (%)			
	Have no knowledge	Have limited knowledge	Have extended knowledge	Have Implemented into Instruction
OO-Cobol	16	47	29	8
Cobol Web Applications and Web Services	27	45	22	6
Integration of Cobol w/ Microsoft platform, languages and applications	42	38	11	9
Integration of Cobol w/ Java platform, languages and applications	68	24	6	2
Use of Cobol in distributed OLTP applications	70	21	8	1
Integration of CICS and IMS Cobol applications into Java and Microsoft platforms	57	32	9	2
Re-engineering COBOL applications for service-based or component-based architectures	57	26	15	2
Re-hosting Cobol applications to new hardware and software platforms	54	30	11	5

Appendix: Table 5. Academics' Knowledge of Education/Training for Selected Methodology/Technology					
Methodology/Technology	Respondent Rating Score (%)				
	Have no desire to attend	Have no knowledge of these programs	Have knowledge but have not attended	Know about and have attended one session	Have knowledge to include in Cobol instruction
OO-Cobol	16	16	38	17	13
Cobol Web Applications and Web Services	18	22	33	21	6
Integration of Cobol w/ Microsoft platform, languages and applications	22	37	33	6	2
Integration of Cobol w/ Java platform, languages and applications	18	50	24	8	0
Use of Cobol in distributed OLTP applications	34	40	21	5	0
Integration of CICS and IMS Cobol applications into Java and Microsoft platforms	25	43	26	6	0
Re-engineering COBOL applications for service-based or component-based architectures	27	38	27	5	3
Re-hosting Cobol applications to new hardware and software platforms	29	38	24	6	3

Appendix – Tables (continued)

Appendix Table 6.					
Academics' Perception of New Programming Initiatives					
Effect Upon CIS/IS Curriculum					
New Programming Initiatives	Will replace	Will not replace		Will be language of choice for development of	
	Cobol	Visual Basic	C C++	Applications	Web sites
	data in percent of respondents				
What effect will the current:					
1. C# initiative have on current application and web development	3.4	na	37.3	13.6	1.6
2. Java initiative have on current application and web development	8.5	na	na	23.7	25.4
3. Visual Basic.Net initiative have on your current application and web development	18.6	13.6	na	15	15.0
na = not applicable					