

**THE FUTURE OF SYSTEM/390:
SUCCESSSES
THREATS
and
REMEDIES**



QUOTATIONS AND REFERENCES

Quotations and references are generally cited within the text of the paper; however, a list of referenced articles and papers is also provided in the References and Bibliography section. References and statistics where not otherwise stated come from the *S/390 Needs and Competencies Survey* conducted by DCTA, Inc., to be published in the Fall of 1999 (see the overview to the survey at the end of this paper).

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THE FUTURE OF SYSTEM/390: SUCCESSES, THREATS and REMEDIES

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July, 1999

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EXECUTIVE SUMMARY

Despite predictions of the "death of the mainframe" by industry pundits and the press, use of the IBM S/390 Enterprise Server has continued to grow dramatically for the last ten years in most of the largest enterprises in the world. Users of S/390 are experiencing a compound annual growth rate in their S/390 environments of up to 50% per year; IBM itself has seen demand for S/390 MIPS escalate by more than 60 percent per quarter since mid-1998. In the first quarter of 1999, IBM reported that 25 percent of that growth came from new business initiatives and applications rather than the growth of existing workloads, and that the portion of the new workloads which was e-business more than doubled.

But a threat does exist to the viability of the S/390, and to the companies and organizations which use it to support and grow their businesses: a threat which, unaddressed, may not only limit the growth of those systems but their accessibility, reliability, and use – and in the process damage the success and growth of its users. That threat is the lack of qualified S/390 professionals. The information technology industry is seeing a pervasive "graying" of the S/390 workforce as the existing professionals grow older and retire, with few young graduates entering the workforce with S/390 skills and abilities.

Schools are not graduating nearly enough computer science students to meet the demand for IT professionals. Almost none of these graduates have any S/390 or large-scale commercial computing knowledge, and very few universities and colleges are interested today in providing this type of education. Addressing this problem will require a solid, ongoing commitment on the part of everybody – schools, employers, and IBM – to provide reasons and a framework for universities and colleges to modify or enhance their curricula; to encourage students to learn S/390; and to get businesses to become active partners in the process.

And we must start now: far too many S/390 professionals are already of retirement age. One IT executive estimated that "IBM has five years" before the lack of S/390 professionals will become so critical that there will not even be time to try and train new hires, and it will start to be impossible to reliably support S/390 in many companies. At that point, those companies may be forced to migrate off the S/390 platform simply to survive, whether other alternatives are as attractive, as cost-effective, or can even offer the reliability and security they need. Given the pervasiveness of S/390, this would not only affect companies: it can affect governments, economies, and society itself.

There are a few hopeful directions. A few schools have continued to offer S/390-focused education or have begun to do so in recent years. Businesses are putting pressure on universities and colleges to adjust their curricula to better prepare graduates in general. IBM has established an internal "Enterprise University" to provide new hires with S/390 education and plans to make parts of that curriculum available to customer employees. And IBM has initiated other actions, including the S/390 University Program in the United States to build business/university partnerships geared to creating and nurturing S/390 education in higher education. But these are only the first steps to what must become a major effort on the part of all concerned parties.

SUCCESSSES: THE SYSTEM/390 IS ALIVE AND WELL

Contrary to predictions, S/390s remain at the core of the computing environments of many organizations, including the largest and most complex users. S/390s are growing rapidly and they are being used for major new business initiatives including e-business and e-commerce. S/390 continues to offer capabilities and price/performance unmatched on other platforms.

Death of the Mainframe?

It has been conventional wisdom for years now that mainframes are "dinosaurs" on their way to extinction, and industry press and experts have been predicting the death of the mainframe – S/390 and its clones – for over a decade. In the most dramatic such assertion, Stewart Alsop, the editor-in-chief of *InfoWorld*, predicted in 1991 that the "last mainframe would be turned off in 1996". In 1996, the last mainframe wasn't turned off, but Stewart Alsop left *InfoWorld*, describing his prediction as "rash" in his last column.

In fact, sales of S/390 MIPS started to pick up dramatically beginning in 1994 and challenges to the conventional wisdom pertaining to cost of computing, conversion costs to new computing models and presumed productivity gains began to appear. Evaluations of S/390 purchases revealed that the apparent downturn in the early 1990s had nothing to do with replacement by other technologies; a Compass America survey of 1994 showed that actual growth in S/390 usage was disguised by substantial improvements in efficiency in S/390 computing resulting in a compound decrease in cost of S/390 computing of 23% between 1989 and 1993; only in 1994 did workload growth become fast enough to drive purchase numbers up.

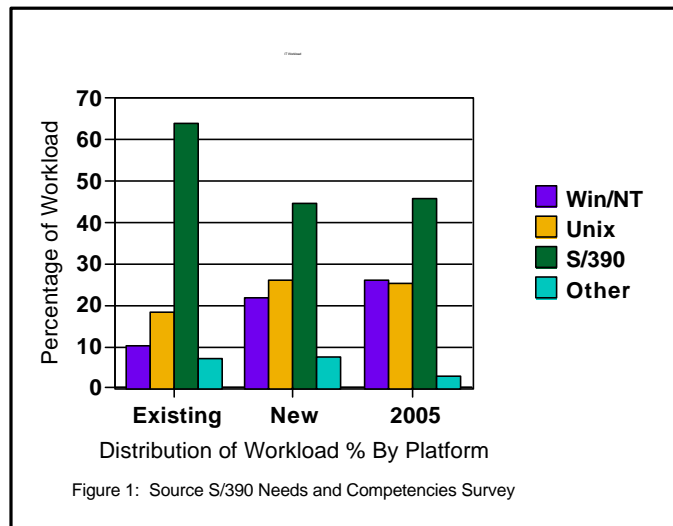
Since 1994 the growth of S/390 computing has continued to be explosive. Users of S/390 have continued to grow their businesses and invest in new applications and initiatives. Analyses of real cost of ownership and cost of computing numbers by users have resulted in reconsolidation of distributed computing implementations, server consolidation and in some cases the abandonment of major strategic initiatives towards client/server and distributed computing. While it would be rash to point to any one reason, it is clear that the S/390 has reemerged as the platform of choice for large-scale commercial computing solutions, especially those needing very high levels of reliability and availability, together with ultimate scalability.

Growth and Exploitation

The explosive growth of the Internet, web enablement and e-business initiatives are driving S/390 growth as much or more than other platforms. IBM's sale of S/390 MIPS grew by 60% in 1995 over 1994, and the META Group projected that large systems would experience a 50% Compound Annual Growth Rate in demand through 1997 and that application growth would represent over 75% of that demand. They were right – and the demand has continued to grow. According to Lou Gerstner, Chairman of IBM, in a May 1999 Analysts' Presentation, IBM has seen three straight quarters of more than 60% growth on S/390 – and over 25% of that growth came from new workloads. Mr. Gerstner also stated that the e-business portion of those workloads doubled – and

the e-business market is forecasted to grow 20% per year. Other IBM executives have stated that they expect that over 50% of new S/390 MIPS which will be shipped in 1999 and beyond will be to service new business initiatives including e-business.

Jeff Jordan, COO of Global Commerce Systems Inc., has estimated that 2/3 of the world's business data and applications reside on IBM servers, with most of that data on S/390 servers. In response GCS has ported its e-commerce solutions to OS/390 and S/390. GCS isn't alone in this – hundreds of applications, especially in the evolving areas of e-business and e-commerce, are being ported to the S/390 to take advantage of the scalability and reliability of the platform, and large-scale users such as Charles Schwab are exploiting the capabilities of the S/390 in the electronic business world. Carl Greiner, VP of Enterprise Data Center Strategies for the Meta Group, observed recently that "because over 70% of the world's business data still remains on the mainframe, solutions that provide easy access via Web technology to legacy applications will be in demand".



The *S/390 Needs and Competencies Survey* conducted by DCTA, Inc. in May, 1999 corroborates Mr. Jordan; Figure 1 shows that about 2/3 (64%) of the workload of the survey respondents is on S/390 today. And in the organizations responding to that survey, close to half (45%) of the workload representing new solutions and strategic business initiatives such as e-business will also be on S/390, frequently in partnership with other platforms. Note that the graphic shows only percentage of workloads, not total magnitude over time.

Significance of the S/390 Workload

S/390 servers provide the data repository for 70% of the world's business data, and they run 2/3 of the business workload in terms of application processing and transactions. But it is important to realize just what workloads and data these are. Of course, all workloads are important to the companies owning them, regardless of what platform they operate on. The significance of the S/390 workload derives from history: for many years almost all computing ran on the predecessors to S/390. As new platforms were introduced and placed into production, and business and organizations began to exploit them, S/390 gradually evolved into the data warehouse for the company, the host for the high-capacity transactional systems and the high-availability, mission-critical systems, even as other platforms provided more of the departmental and local processing and took over types of work (such as graphical interfaces and single-user computing) for which the S/390 host was not well-adapted.

As a consequence, the core business data of the world's largest corporations, biggest institutions, and governmental bodies – the ones who have been using S/390 for years – have continued to grow in size and now depend upon the core enterprise server establishment. Well over 3/4 of the Fortune 500, and virtually all of the governments in the developed world rely upon S/390 for their core business functions, and continue to grow these functions and service new business initiatives with their S/390s.

If the failure of any one computer could doom a company, it would probably be a S/390, because so many of the core strategic business systems run on the S/390. If the elimination of any one platform might actually threaten the world economy, it would probably be the S/390, because so much of the world economy depends on the S/390 today, and because of the lack of a credible alternative. S/390 applications exchange trillions of dollars between international financial centers daily and are the core of almost all large banking and financial institutions. In the travel and transportation industry, virtually all of the reservation systems such as SABRE and APOLLO run on S/390 because no alternative exists which can support the data and transaction rates. The biggest governmental departments and applications run on S/390, and S/390 servers are the repository for the data required for daily operations of most developed countries.

This will undoubtedly change over time as other platforms become more capable and robust, but it will take a very long while. Today, no other computing platform offers the core capabilities of scalability, reliability, availability, connectivity and sheer data processing power for massive databases and transactional systems. Many S/390 based applications today simply cannot be moved to another platform because no other computing platform is available which offers the capabilities, to say nothing of the overall cost/performance.

THREATS: THE FUTURE VIABILITY OF SYSTEM/390

The real threat to the continued viability of S/390 is the lack of qualified S/390 professionals and the growing number of unfillable openings for these people. This is compounded by the aging of the S/390 workforce; if unchecked, before long organizations may not be able to find or hire the people they need to support their systems. Today, S/390 professionals, including new graduates with S/390-focused education, can command a premium of 15%-30% in starting salary or bonuses simply because of the shortage of this talent.

The Shortage of IT Professionals

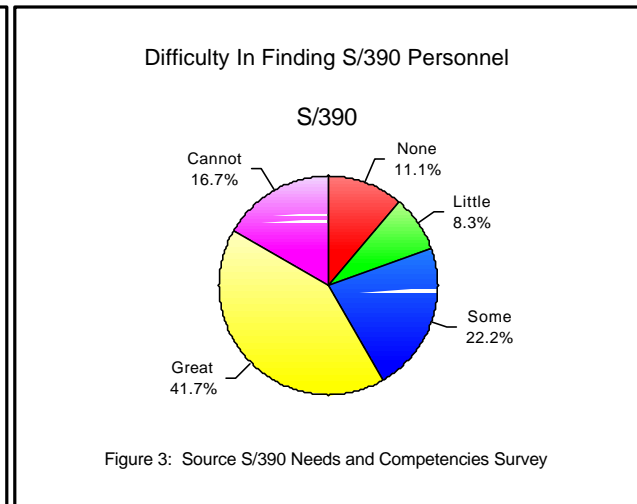
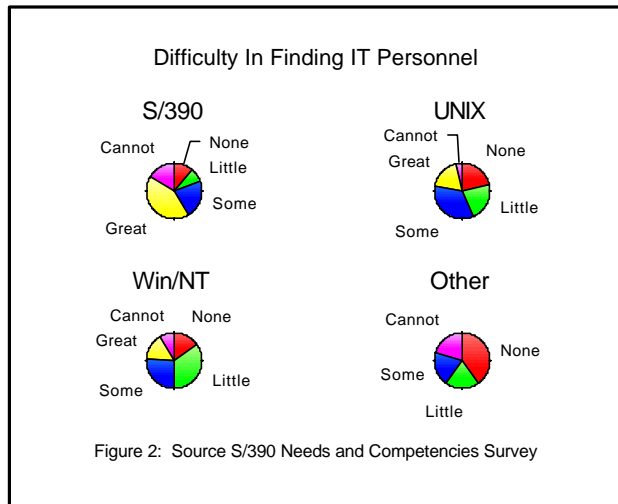
There appears to be little doubt that an overall shortage of information technology professionals exists in the United States. The U.S. Department of Labor's Bureau of Labor Statistics *Occupational Outlook Quarterly* released last year was a special issue charting projections for various occupations from 1996-2006. According to that report, the projected employment growth in information technology fields (systems analysts, DBA, computer support, computer scientists, computer engineers and computer programmers) was 1,133,500 for ten years. This would be an average of 113,350 per year although it's not likely to be distributed evenly. Note also that this number reflects only new positions created as the economy broadens; no attention is given to the replacement of individuals who leave the workforce.

In contrast to this requirement for over 113,000 new information technology professionals per year, the number of graduates in Computer Science and related fields is significantly lower. The Computer Research Associations *1997/1998 CRA Taulbee Survey* of Computer Science Department degree-granting institutions reported on 186 PhD-granting departments, 140 Masters-granting departments, and 138 Bachelor-granting departments. The Taulbee Survey projects 933 new PhD Recipients nationwide. The overall ratio for Computer Science degrees appears to be about 30 Bachelor Degrees and 11 Masters Degrees to one PhD, so 1999 will probably produce about 11,000 Master's degrees and about 31,000 Bachelor of Science degrees, for a total of nearly 43,000. Enrollments in undergraduate programs have nearly doubled since 1995, but have produced at best a 26% increase in BS degrees granted, and perhaps a 10% increase in MS degrees.

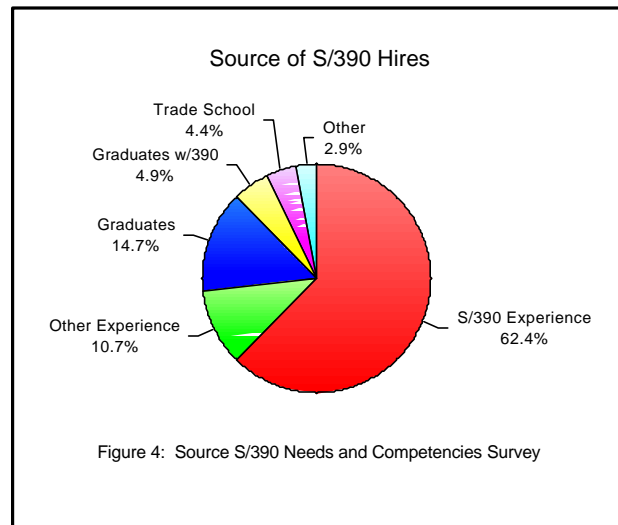
Unfortunately 43,000 is only a little more than a third of the 113,350 estimated by the Department of Labor, and even if these numbers are off by 20 or 30% we can conclude, along with others who have studied this subject, that there will continue to be a substantial shortfall in information technology professionals simply to fill new positions being created.

In late June of 1999, the Department of Commerce released its report on *The Digital Work Force*, indicating that the real problem is far worse: it projects that demand for computer scientists, computer engineers, and systems will more than double in the decade ending in 2006, as compared to the growth rate for all occupations (projected to increase by 14% for the same period), and projects an additional 250,000 IT professionals simply needed to replace those exiting the workforce. (The actual numbers are a growth from 1.5 million to about 3 million IT professionals required, counting replacements.)

The Shortage of S/390 Professionals



Figures 2 and 3 illustrate the relative difficulty in finding IT personnel to work on the major platforms. Four-fifths of the respondents to the *S/390 Needs and Competencies Survey* (81%) indicated some or a great deal of difficulty in finding S/390 professionals; over fifty percent (50%) indicated a great deal of difficulty or that they could not fill their position openings at all. (It should be noted that among those who indicated they could not find people at all, the strongest reason was inability to pay competitive salaries – generally on the part of governmental institutions.) About 5% of S/390 positions in the surveyed organizations were open and most respondents felt that the number of openings were going to increase.



Across our respondents, nearly 2/3 of new hires were of people with S/390 experience already in the workforce, and another 11% came from experienced personnel already in the workforce but who did not already have S/390 experience and were cross-trained. In other words, fully 75% of all new hires for S/390 positions are experienced computing professionals. By contrast less than 15% came from hiring university or college graduates and training them on S/390. A hiring strategy where 3/4 of all new hires are seasoned computing professionals clearly cannot supply the need today, much less the growing need over the next few years to replace retirees.

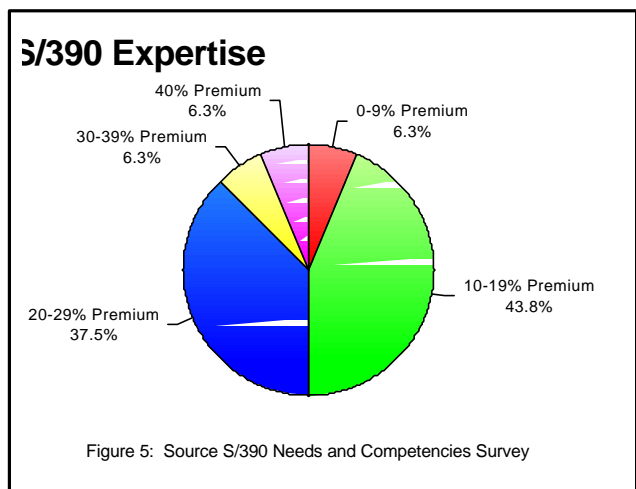
The Department of Commerce *Digital Work Force* report found that for the IT industry as a whole, 75% of computer systems analysts and scientists, and nearly 80% of computer programmers, are under the age of 45. In contrast, while no formal survey has been done of the age of S/390 professionals, the relative age of employees in this area is a major concern to S/390 users. In fact,

from informal polls of S/390 executives and comments made by respondees to the survey, over half of the S/390 workforce is older than 45, and nearly a quarter are over 50. And due to the tendency to hire experienced personnel and the lack of S/390 expertise coming out of universities, very few young people are entering the workforce.

This "graying of the workforce" is starting to create problems in companies using S/390 today and the problem will only get worse: one fifth (nearly 20%) of the responders to the SHARE survey will probably retire in the next 5-10 years, and nearly half in the next 20 years. If few or no new S/390 professionals are available, and organizations continue to grow and exploit their S/390s, how long can it be until the situation becomes untenable?

One IT executive interviewed for the *S/390 Needs and Competencies Survey* who asked to remain anonymous stated bluntly that "IBM has five years before the lack of qualified S/390 professionals will become so critical that there will not even be time to train new hires, and it will start to become impossible to reliably support S/390 implementations". He meant "we have five years". Five years, or not much more, before today's difficulties with finding qualified people become an epidemic – unless answers are found and solutions implemented.

A Premium for Qualified Professionals



S/390 Professionals can command a substantial premium in starting salary or bonuses according to available data, including new graduates with S/390 focus and education. Over 40% of the respondents to the *S/390 Needs and Competencies Survey* indicated that they would pay a premium for S/390 skills. Among those who would pay such a premium (Figure 5), the range was between 7%-40% with the average around 20%.

According to Dr. Rodney Angotti, Chairman of the Department of Computer Science at Northern Illinois University (reported on in more depth later in this paper and one of the few schools with S/390 at the core of its computer science curriculum), NIU's average graduate has 6-12 job offers prior to graduation, and a starting salary of 20%-35% higher than the average computer science graduate nationwide (when adjusted for location), reflecting the distribution in Figure 5.

Dutchess Community College graduates, although graduating from a two-year program, are able to command starting salaries in the mid- to upper thirties, quite respectable in the Hudson Valley. In fact, many S/390 professionals today work as consultants or contractors, having found they can make substantially more money and have a broader range of work options. Some of them are

working as contractors for the firms who used to employ them but let them go in the early 1990s when companies were making personnel decisions based on statements like "the mainframe is dead".

How Big Is The Problem?

There are no really reliable data on the number of S/390 professionals in the United States today, but rough projections can be made using data from the *S/390 Needs and Competencies Survey* and applying conservative estimates. Thus:

- A very rough average across all S/390-using businesses of about 185 IT professionals of which 106 are S/390 professionals (this includes application developers and systems professionals of all types)
- There are more than 10,000 S/390 systems in the United States but many companies have more than one system installed
- If we assume an average of 2 per installation (which is probably conservative) we can postulate on the order of 5,000 installations
- Thus $106 \times 5000 = > 500,000$ professionals covering all aspects of S/390 applications development and support, operations, and systems professionals
- We current have an average of 5% unfilled positions
- Which means over 25,000 openings nationwide for S/390 professionals.

These figures are well in proportion with the Department of Commerce's assessment of 2.1 million IT professionals as of the end of 1998. Furthermore, looking at the probable effect of retirements on the S/390 workforce we may conclude that:

- About 100,000 of these professionals will retire in the next 5-10 years
- About 250,000 will retire in the next 20 years
- Thus we will lose a average of over 12,000 per year on top of the existing 25,000+ openings.

These positions must be filled from somewhere and it is clear that companies are not going to be able to hire professionals from one another very much longer.

Perceived Quality of Computer Science Graduates

"There's no question that if you don't have people properly trained for the future, it will affect our economy. If the need for IT workers isn't addressed, it could have a sizable impact on our economy because information technology, such as e-commerce, is playing such a tremendous part in our economic explosion." – Secretary of Commerce William Daley, in an interview with *InformationWeek*, June, 1999.

"More than one Corporate Partner complained about the poor job our education system is doing to fill the skills gap. Higher education cranks out computer science majors but does a 'lousy job'

filling the need for information management professionals." – John Dodge, writing in *PC Week* about meetings with their Corporate Advisory Board, May, 1999.

There is an ongoing debate among educational institutions in the U.S. as to whether universities and colleges are (or should be) preparing students for employment in the workforce, or providing them with a firm educational base on which they can build or develop specific knowledge and skills after graduation. Certainly the latter is the traditional view of academic institutions, and many flatly reject a proposition that they should be teaching specific skills. Just as clearly, most corporate executives do not feel that graduates are entering the work force with applicable training and education. The situation with S/390 professionals is clearly aggravated given the lack of S/390-oriented education today.

The *S/390 Needs and Competencies Survey* reflected the perspective of PC Week's Corporate Partners when the respondents were asked to characterize today's university or college CS/MIS graduate. By far the dominant characterization was "Totally desktop or UNIX focused, don't understand enterprise environment" (80% first choice, 20% second choice of respondents). The second choice was "Good theoretical background, little practical experience" (36% first choice, 64% second choice of respondents).

Describe Today's CIS/MIS Graduate	1st	2nd	3rd	4th	5th
Good theoretical background, little practical experience	8	14	0	0	0
Totally desktop or UNIX focused, don't understand enterprise environment	24	6	0	0	0
Excellent skills, practical focus, exactly what we need	0	0	0	5	0
Broadly based, good background upon which I can build the skills I need	2	5	7	0	0
Other	1	0	0	0	0

Figure 6: Source S/390 Needs and Competencies Survey

Supporting this perception is a wide range of comments made by the respondents, the common thread of which was that graduates coming out of school simply had no awareness or comprehension of either the S/390 environment or, more broadly, an understanding and awareness of the enterprise production computing environment. The interviews repeatedly identified this lack of knowledge as the fundamental reason why it takes so long for graduates to become effective in an enterprise environment, even more than a lack of specific languages or skill sets.

It is certainly true that for the most part students in MIS and CS curricula today are not exposed to S/390 and often have never even heard of the platform except in references to "legacy " or "obsolete" computing technologies. While a fair number of schools have S/390s in their administrative centers, almost none teach any S/390-related material, and it appears that equally few provide any framework for the understanding and appreciation of large-scale enterprise computing environments. This is perhaps not surprising. Computer Science education has certainly evolved towards principles and theory, and it uses and teaches the most widespread technologies. For their part, when students have a choice (that is, electives or adjunct courses) they will choose what they perceive to be the most widely-applicable (or most popular) subjects. Without a lot of groundwork, positioning and achieving "mind share" among the student community, courses in S/390-related topics can be a difficult "sell" even in the few places where they are available.

Societal Change

While graduates of computer science courses are probably receiving better preparation today than they did twenty-five years ago, they are no better prepared and perhaps less well prepared for employment in S/390 professions than they were in 1975. Even then, however, the first computer science graduates were widely seen as requiring a lot of on-the-job training and education before they became effective (the classic observation was that new hires all seemed to expect to write compilers). What has really changed is the attitude of employers. Until recently, many employers, especially the larger ones, liked to hire graduates with potential. They understood that graduates would be prepared to develop specific skills and knowledge and were prepared to invest in that development. In turn, they expected valuable employees would remain with the company for a long time.

Over the last several years, a variety of economic and social forces have created a very different employment climate. Rather than looking for potential, companies seek new hires with the specific skill sets and knowledge that they need. This tendency is reinforced by the movement to use contractors rather than hire full-time employees. Companies no longer expect employees to remain for a long time and are generally unwilling to invest a lot of time and resources in training their employees to become productive.

"Many companies are demanding IT people that are an exact fit with their job descriptions," according to Kelly Carnes, assistant secretary designate for the Department of Commerce. "These companies need to train and retrain individuals and help to equip them with the combination of IT skills that they're looking for."

At the same time, the Department of Commerce report points out that strong disincentives exist for businesses and the IT industry to invest money and time in training America's IT workforce. Workers who receive training become more marketable after acquiring "hot" combinations of technology skills, such as Internet, ERP, and application development. These employees command higher salaries and are often lured away by competing companies.

Lack of S/390 Education

There is almost no S/390 or large-scale commercial computing education offered by universities and colleges in the United States today – or indeed worldwide. There are a smattering of COBOL or Assembler courses, usually offered in junior colleges; even then, they are often not taught on a S/390 but on a PC-based package or an emulator. But a serious search for institutions who actually offer a focus on S/390 (as part of the *S/390 Needs and Competencies Survey*) turned up only such two universities. (We did find several schools who had offered S/390 courses but which had stopped.) Generally, we found that didn't offer S/390 courses for four reasons: (a) lack of demand; (b) lack of qualified teachers; (c) no access to S/390 as a teaching platform; (d) lack of awareness on the part of faculty.

Lack of demand is usually related to adjunct or elective courses – if not enough students take a course it isn't cost effective for the institution to offer it, whereas with required courses this is not

an issue. The lack of qualified teachers is harder to address. Since most schools stopped featuring S/390 in their education offerings years ago, it is nearly impossible to find faculty who know anything about the platform or its characteristics, and generally teachers will teach what they know. The almost total lack of S/390 computers (as compared to UNIX or Windows machines) in academic institutions (except for the systems which remain in administrative computing centers) means that there is usually no direct way to learn about S/390 and little perceived reason to do so. Finally, faculty generally having no background themselves in S/390 don't see the point or the need in the first place, and so are unlikely to initiate or support any moves to develop such education in and of themselves.

REMEDIES: A CALL TO ACTION

There is a shortfall in information technology professionals, and the problem is worse with respect to S/390 professionals. S/390 use is increasing; there are a substantial number of job openings and every reason to believe that the number will rise dramatically over the next several years. From the perspective of companies employing S/390 professionals, university and college graduates are ill-prepared. Companies are increasingly unwilling to put the time and resources into developing new hires but want to hire the already-capable. Few educational institutions are prepared to or able to offer S/390 courses and even they struggle to find qualified faculty to teach these courses. Students are not offered this material and unless they understand the value of it would probably not take such courses unless they were required.

Yet if an answer is not found such that new S/390 professionals become available, the implications are serious, not only to the organizations using S/390 today, but to the institutions, societies and governments dependent upon S/390-based systems.

What Needs to Be Done

1. Businesses, companies and institutions who use S/390s and rely on them must actively get involved, communicate their needs to universities and colleges, demand action and help build programs to address the problem.
2. Educational institutions must incorporate and communicate a greater awareness of the large-scale enterprise computing environment to their students. Even though many graduates may not wind up working in S/390 positions, an understanding of the issues and disciplines involved in developing and supporting large-scale, highly-available, mission-critical systems and applications will make them more attractive to their prospective employers and better able to analyze application requirements and project future scaling needs.
3. There is a widespread need (certainly in the S/390 arena but actually across most information technology programming fields) for graduates to have better developed practical programming skills. This is not an issue of which language, but of software engineering principles: of actually writing, debugging and correctly running significant programs; and of software development as a shared art.
4. Some means must be found to package and offer specific topics such as Assembler or Object-Oriented COBOL, Systems architecture, CICS and so forth to students even if they are more "training" than "education". Clearly such courses can be developed and offered at educational institutions given sufficient demand and a willingness on the part of the institutions. Having said that, the institutions will need resources, such as some form of S/390 upon which to build the courses, the means to acquire or train the faculty to develop and teach the courses and willing students to take the courses. Partnerships between specific companies and specific institutions will clearly play a part in this, as may grant-supported donations of equipment and software from IBM and perhaps other vendors.

5. Somebody has to "teach the teachers", or find a source of new teachers. This is a different proposition from teaching the students and will require a very different focus and a different approach. Especially where a commercial computing focus is taken to heart and S/390 related or based courses are made part of a core curriculum, the faculty developing those curricula must be conversant with the subjects. Some form of collegium or institute is necessary where academic professionals can learn these topics – and where they can return for brush-up courses as the technologies evolve.

6. In a social climate increasingly demanding that graduates come out of the schools (or at least into employment) with the needed knowledge and skills, methods must be found for students, graduates and already-employed professionals to take courses and programs outside of their regular employment. Even if these courses or programs are not part of a regular curriculum, linkages between Computer Science departments and educational or training vehicles, possibly outside of the university or college, could be established to incorporate these as part of degree programs and make them more attractive (and available) to students, as well as to those outside the university structure.

7. The concepts of S/390 Professional Certification and possibly a Certificate Program should be examined. While Certificate Programs are frequently castigated as turning out "six week wonders" with no real breadth or understanding, any avenue which might assist in developing professionals with needed skills must be reviewed. A S/390 Professional Certification, with requirements agreed upon between IBM and industry, would serve both to focus attention on real requirements and needs and could provide a vehicle to interest more educational institutions in becoming involved. More importantly, it would eliminate some of the guesswork in trying to determine the skill level of new employees and provide more information on which to base internal training programs.

Who Must Solve the Problem

As suggested at the beginning of this paper, the easy answer is "everybody" – corporations, universities and IBM, its partners and its competitors. It is undoubtedly true that "everybody" will have to be involved in developing and implementing answers to the problem. But the big question is how to move forward.

Secretary of Commerce Daley has suggested in his interview with InformationWeek that "much of our educational system is not producing the highly trained individuals to do the jobs of the future. The big mistake of five, 10 years ago, was that a lot of people in academia didn't see what was going on in the business world, the dramatic changes that were taking place that were going to necessitate skilled people. I don't think it was necessarily industry's job to be pushing the educational system. The educational system and government – federal, state, and local – should have seen what was going on in their communities and where the needs were going to be, and should have responded to that."

Mr. Daley may be right that it isn't necessarily industry's job, but it is clear that the educational system will not respond to the need for S/390 professionals by itself, nor is it clear that

governmental involvement will help – after all, many schools in the United States are in part tax-supported. In any case it is nearly impossible for schools to directly respond to industry requests for specific skills, since by the time a curriculum is modified to fit the specific need, the need has changed.

The bottom line is that business and industry will have to take the lead at least as far as S/390 education is concerned. The educational system won't respond on its own – it is trying to address overall issues of which this is one part. IBM can and should help and support initiatives. But businesses and other S/390 users have the basic, essential need for qualified personnel and have many of the necessary resources to assist in developing those personnel. They must partner with academia to invest in their own future.

BEGINNINGS

There have been some attempts to deal with the lack of S/390 professionals and there are some hopeful signs, but much more needs to be done. A few schools still offer or are starting to offer S/390 education. Businesses are beginning to work with selected universities and colleges to influence curricula and produce graduates with more relevant skills and education. And IBM has instituted programs to help and support liaisons with business and academia.

Businesses Heeding the Call

Corporate Universities and exchange programs are becoming more widely established as a replacement for traditional training programs. Large companies such as Disney and Motorola have built their own university systems while others are establishing "virtual campuses" based on distance learning and the internet. Bell Atlantic developed a program called Next Step which is offered by 25 community colleges in the northeast to Bell Atlantic employees. The program offers technicians a custom-made curriculum developed by Bell Atlantic and its unions which offers an associate degree in Applied Science.

United HealthCare and United Technologies jointly enlisted Rensselaer Polytechnic Institute to train their combined workforce of 200,000 (in all fields) using distance learning. RPI now delivers degree programs from Boston University, Carnegie Mellon, Stanford and MIT to specified UHC sites, and arranges non degree seminars, technical courses and training in management and education for both companies.

The Department of Commerce *Digital Work Force* report cites many IT vendors and businesses who have partnered with educational institutions to encourage IT talent and credits these partnerships with the increase in computer science degrees granted over the last few years. From 1995 to 1998, enrollments in computer science and computer engineering rose 104%. Enrollments in bachelor degree programs rose 108% in the same period, while enrollments in masters degree programs rose 106% and in PhD programs 71%.

These are not specifically S/390-related, of course, but they do show the increased awareness and activity of American business in its willingness to deal with the IT resource shortage.

Forty-three percent (43%) of the respondents to the *S/390 Needs and Competencies Survey* indicated that their organization had any existing co-op or internship program (of any type at all) with a local college or university (or, if they were a college or university, had a program with a local business).

Less than 20% knew of any college or university offering S/390-related courses (and in some cases their information was out of date), but 55% would be willing to work with a local college or university specifically if they were interested in developing some S/390 course content or internship program.

The IBM/Northern Illinois University S/390 Emerging Markets Program

Three years ago, IBM and Northern Illinois University (NIU) established a pilot summer residency program for professors and lecturers from universities in areas such as the Far East, Eastern Europe and Africa. Many of NIU's core computer science courses are based on S/390 (see the section on NIU later in this paper). The goal of the program is to provide visiting academics with the NIU course structures, pedagogical approach and teaching materials. After completing the residency program, they could then adapt the NIU material as appropriate to integrate S/390 content and focus into their own universities' computer science curricula. The academics attend the 8-week summer residency at NIU for two successive years. So far more than 75 scholars from China, India, South Africa, Russia and Poland have attended the NIU program and the establishment of S/390-focused education is well underway in several of these countries.

The IBM S/390 University Program

This program was established by IBM this year to address training and educational shortfalls in computer science education, specifically in the areas of S/390. IBM recognizes that while the problem is pervasive, it will have to be resolved on a business by business and university by university basis. Moreover, IBM is firmly convinced that businesses must take the lead in establishing these relationships, as they have the biggest need and are the ultimate consumers for the universities. The goal is to form a consortium made up of independent teams of universities and businesses who together agree to become part of the program.

The business/university teams will build course content appropriate to the needs of each team, but will also contribute to joint course development and delivery and make some portion of the course material available in a repository to which all other partnership teams have access. The intent is to develop a shared library of S/390 course materials possibly including standard books (or references to the books), instructors' guides and notes, test banks and exhibits which could be used directly or serve as the basis for an individual school's extension of its own curriculum.

IBM anticipates that interested businesses and universities will propose a partnership team to IBM based on the program description and requirements. If the team meets the criteria for participation they would be invited to join the consortium. Beyond the basic requirements, IBM expects each team to negotiate among themselves to meet their unique needs and educational requirements. Each team will be encouraged to both draw from and contribute to the course repository and participate in periodic symposia or meetings between the consortium members.

Universities and Colleges Offering S/390-focused Education

In the course of researching this white paper we spent a good bit of time looking for universities and colleges which actually offered some form of S/390 education in order to understand the issues which they encounter and their educational models. The three institutions we focused on were Dutchess Community College (Poughkeepsie, New York); Northern Illinois University (DeKalb, Illinois); and the University of Nebraska at Omaha (Omaha, Nebraska).

Dutchess Community College, in Poughkeepsie, New York, is a two-year institution offering AS and AAS degrees. They have about 2,500 students, and as with most community colleges the majority of the students are part-time. Dutchess has a small P/390 running VM and VSE which they use for their S/390 courses. They also have an R/390 on which they expect to run OS/390. Dutchess offers two different two-year programs. The CPS (Computer Science) program leads to an AS degree offered by the Math Department. The CIS (Computers and Information Sciences) program leads to an AAS degree, intending to make the graduate employable immediately, but about 50% of CIS students transfer to the CPS program.

Their core, required courses are S/390 based: COBOL, CICS, SQL, VSAM, DB2, 390 Assembler, all specifically S/390 or taught from a S/390 perspective and with S/390 based exercises. Students have about 15 elective credits in topics such as networking, C++, Java, Web Authoring and Visual Basic. Dutchess has a small resident faculty of three in IS, but relies heavily on adjunct instructors who are not educators per se but are employed by local businesses; about a third of their adjuncts are IBM employees. They feel that this access to adjunct instructors is essential to their program and doubt if a community college without access to such resources from local businesses would be able to succeed at a similar endeavor.

Dutchess has a relatively small number of enrollments and graduations; as with all community colleges a fair number of their students either don't graduate or transfer to another institution. This year they graduated 30 students in the CPS/CIS programs, although that is high and their usual number is somewhat lower. They have a high dropout rate which is not related to the quality of the program but the difficulties faced by the average community college student.

Dutchess' primary concern is to make sure that their students acquire hireable skills which significantly improve their worth in the marketplace. To this extent they are very sensitive to the needs of their students' employers. As against that Dutchess is very aware that the specific needs of the employers can be short-lived; frequently shorter-lived than a program would be once conceived, implemented and students taken through it. This is an ongoing source of frustration and is closely tied to the "skills" versus "education" issue. In a nutshell, nobody expects a graduate from a two-year program to have an education; at most they have a lower-division preparation for upper division work in a 4-year institution. Those students in AAS programs are frankly in skills-development programs although they are enriched with some liberal arts and remedial education as possible.

They are proud of the success of their graduates. Most graduates have been employed as programmers with starting salaries in the middle to upper 30s. Dutchess feels they demonstrate that a properly designed and implemented community college program can produce graduates well-grounded in application programming and that community colleges can and should be an important part of any broad-based approach to improving the availability of "affordable" S/390 and other professionals.

Northern Illinois University is a Doctoral Institution and is much more the traditional model of resident undergraduates going through a 4-year or graduate curriculum. They have over 24,000 students and their computer science department teaches over 2,000 students a year, making it one

of the nation's largest. Northern Illinois's off-campus educational programs are all Master or Doctoral and the computer science department offers their Master's program at two remote locations. They award about 60 Masters in computer science each year. The computer science department is nationally recruited, with more than 250 firms nationwide coming to the NIU campus to recruit their students. NIU also has very large internship program with over 150 companies participating.

Northern Illinois has an unusual computer science program in two aspects. First, while it offers many of the usual computer science curricula courses (languages, theory of operating systems, architectures and so forth) many of its core (required) computer science courses are based on S/390. This came about because the program was originally established on this way, but has continued because of a well-established working relationship with the administrative computing center which has helped to ensure that the S/390 is available for student work; synchronizes versioning of software to match current course content; and the like.

The other unique aspect of Northern's curriculum is a pedagogical approach which they term "principles through practice". Rather than teaching theory and perhaps exposing students slightly to practical examples, Northern emphasizes actual and successful program design, development and testing. It uses S/390 Assembler as a required base course so students will become familiar with computer architecture. Northern teaches the theory of operating systems but roots actual student work in OS/390 as well as UNIX and Windows. Northern teaches S/390 systems programming and systems engineering skills. Similar examples can be found throughout their curriculum.

Northern's students generally have multiple job offers well before they leave school (in fact students leaving before graduation because of job offers is an increasing problem), and they tend to command a 20-35% salary premium over graduates from other Computer Science programs. By no means do all of Northern's graduates go to S/390 installations, but regardless of the environment they seem esteemed for their ability to quickly learn specific things and to have an excellent grasp of fundamentals.

Northern has a much larger faculty than the other schools but also is having trouble finding new faculty with S/390 knowledge and experience. They recently interviewed about 100 PhDs in computer science for a new position without finding one with any S/390 background or knowledge.

The University of Nebraska at Omaha is a subsidiary campus of the primary campus at Lincoln. It has about 11,000 students and currently has no on-campus residences although some are being constructed. Its focus is not primarily on traditional multi-year undergraduates. UNOmaha has a new institution called the College of Information Sciences and Technology (CIST) combining its former Computer Science and Computer Information Science programs.

The unique thing about UNOmaha is a local group of several very large employers in Omaha who are also community-minded and willing to invest in and support university programs to help the development of students and offerings to existing employees. Nebraska does not have a lot of full-scale universities or colleges to attract business dollars, so UNOmaha has a comparatively

large "piece of the action". As a consequence UNOmaha has been able to attract a substantial amount of money from local businesses to build their new facility and to invest in the new CIST program.

A few years ago IBM donated a S/390 to the Lincoln campus; very recently it donated a S/390 to the Omaha campus. CIST in Omaha has embarked on a program to develop S/390-based courses and to add a commercial computing "focus" or perspective to its core CS/CIS curricula. At this time they have revamped an existing COBOL course to use OO COBOL on the S/390 and have completed their first semester of a new High Level Assembler course. Other courses will follow as they are developed over the next one to two years.

A constraint is that there are only three faculty available to develop and teach the courses and in fact only one is active in developing them. As with other schools, availability of trained faculty interested and willing to teach S/390 courses is a major issue and UNOmaha expects to use adjunct instructors from the major companies "investing" in their CIST program for some of these courses.

A high percentage (about 50%) of students at UNOmaha are already in the workforce in some capacity and are taking courses to extend their education or to retrain; most CS courses in fact start at 4:30 in the afternoon or in the evening to make it easier for working students to attend them. The S/390 focused courses will be adjunct courses (somewhat like electives) rather than part of the core curriculum and their success will depend in part on how many students decide to take them. At this time nobody knows how successful that will be. They also intend to instill a stronger S/390 and commercial computing emphasis in their existing CS/MIS core curriculum both to attract students and to give all students a better understanding of alternative types of computing and the issues involved.

ABOUT THE S/390 NEEDS AND COMPETENCIES SURVEY

This paper references *The S/390 Needs and Competencies Survey*, conducted by DCTA, Inc. in the second quarter of 1999. The survey, to be published in its complete form later this year, resulted from the discovery that while there is a wealth of anecdotal evidence among S/390 users as to the growing lack of S/390 expertise, there is very little quantifiable information. The survey was thus designed to gather information on this issue, together with related issues such as company plans for S/390 usage in the future, and offered questions about about the following:

- General information about the company (size, number of employees and IT employees, industry, and so forth)
- Distribution of workload by platform type today, new applications, and total in 2005
- Significant new applications or business solutions and the platform chosen for implementation
- How platform decisions are made for new applications
- Number of IT professionals by platform type and broad job groupings
- Openings in these fields
- Projected rise or fall in number of openings and why
- How hard it is to find IT professionals by platform type and why
- How long it takes for a new employee to become productive by platform type
- Specific skills desired for new S/390 application developers and systems professionals
- Specific S/390 skill shortages (not always the same as those desired for new hires)
- How S/390 education is provided to new hires
- Where new S/390 personnel come from
- How new Computer Science graduates are perceived in terms of adequately prepared
- Relationships between companies and educational institutions such as internship programs; perceived value; willingness to work with local schools on S/390 education and why
- Known educational institutions providing S/390 education
- Comments on how educational institutions might better prepare students for employment

This was an extremely in-depth survey requiring a considerable amount of time to complete. The goal was to survey a small but representative number of S/390-using organizations. Some interviews were conducted in person or by telephone. Additionally, SHARE Inc.¹ distributed the survey to its membership, as many of its member companies are S/390 users and consequently have a significant interest in the findings. In all, 43 S/390-using companies, universities and organizations responded to the complete survey, ranging from comparatively small organizations to companies with revenues in excess of \$30 billion and IT budgets of over \$1 billion.

The survey instrument may be found at <http://www.dcta.com/publications/> and the entire survey report will be published on the DCTA website when released this fall.

¹ SHARE Inc. is an association of over 2,300 member companies and organizations including over half of the Fortune 500. Most SHARE members have S/390 servers as a core part of their enterprise computing environments. More information about SHARE may be found at <http://www.share.org>.

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