# A Critical Look at Immigration’s Role in the U.S. Computer Industry

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*The views expressed here are those of the author, not the University of California.*
FOR MORE UP-TO-DATE MATERIAL SEE ANOTHER DOCUMENT, NOT THIS ONE

Note: Though the document here is more detailed, it primarily consists of material written in 1995 and 1996. It is suggested that readers use the author’s more recent paper on a related (though not identical) topic, “Debunking the Myth of a Desperate Software Labor Shortage,” at


as their primary source.

2 Executive Summary

Americans tell their children, “If you study hard, go to college, and major in a professional field, you will have a reasonable chance for a fine career.” Yet such words have a hollow ring for Cindy, a computer programmer who did all the right things and yet in 1994 found herself cast aside, unemployable, at the age of 35. (All persons identified here by only a given name or only a surname have had their names changed to protect their privacy.)

Cindy has been unable to find work as a computer programmer since being laid off by a major firm in Silicon Valley. Yet the same employers who reject her are filling their programming jobs with foreign nationals. The employers, whose public relations experts have heavily lobbied Congress against tightening of skills-based immigration policies, say that Cindy’s skills are outdated.

Sharon Gadberry, president of Transitions Management/Outplacement National notes that job ads will specify “five years of experience—they usually mean no more than that.” She explains that “Companies are trying to screen out the older workers.” A major motivation appears to be that fresh graduates are cheaper, with foreign nationals being the cheapest of all. A statistical analysis performed by the author on the 1990 Census data revealed that average salaries for foreign-born computer professionals in Silicon Valley were nearly $7,000 lower than among natives of the same age and level of education.

The industry’s claim that the issue is skills, not salary, is unwarranted. Even Bill Gates of Microsoft says that general programming talent is far more important than background with a specific software technology. (See quote in the point-by-point summary below.)

The issues here go directly to the middle class’ growing feeling that the American Dream is no longer in reach. According to a November 27, 1995 poll in the San Francisco Chronicle, a prime worry among Californians today is that there will be no jobs for their children when they grow up. How can we implore our computer science students to study hard today, knowing that they too are liable to be discarded a few years from now, like Cindy? Even the foreign nationals are victims: Assuming they gain immigrant status, as is typical, then five or 10 years from now, the same “special skills” for which they are hired today will be obsolete, and then these people too will become victims of this throwaway-worker Ponzi scheme.

A quick summary of the situation is as follows.

- The computer industry does not need to hire large numbers of foreign nationals, either for the sake of quantity or quality:
  - There is a labor surplus in the field. (Sections 5.1, 5.2.1, 10 and 14.)
  - The vast majority of major technical advances made in the industry have been made by U.S. natives, not immigrants. (Section 12.)

- The large number of foreign nationals being hired is due to these main factors:
  - Some unscrupulous employers wish to save on salary costs, and foreign nationals, in exchange for a green card, are willing to work for lower salaries. (Section 6.2.)
  - Some sincere but misguided employers have placed an unwarranted emphasis on hiring people with very highly specific skill sets, thus creating an artificial labor “shortage.” (Section 8.1.)
Some sincere employers wish to save on salary costs, by hiring mainly young new college graduates instead of mid-career people. When they run out of young domestic workers, they turn to young foreign workers, instead of to domestic mid-career people. (Section 10.)

Ethnic social networks have led to some company divisions, or in the case of small firms entire companies, hiring almost exclusively from a certain ethnic group, such as Chinese or Indian. (Section 8.4.)

In 1995 and early 1996, when Congress was considering legislation which would have tightened the laws under which U.S. employers can hire foreign nationals and sponsor them for immigration, industry lobbyists used a number of arguments in opposition. Following is a summary of those arguments, and our responses to them.1

**Industry claim:** Immigrants are vital to the American computer industry’s ability to maintain its technological edge.

Our response: The vast majority of technological advances in the computer field have been made by U.S. natives. This can be seen in rough form, for example, in the fact that of the 56 awards given for industrial innovation by the Association for Computing Machinery, only one recipient has been an immigrant. Of 115 U.S. recipients of computer-related awards given by the Institute of Electrical and Electronic Engineers, only nine of the recipients have been immigrants. We should definitely encourage and facilitate the immigration of those who have extraordinary talent, but most of the immigrants in the industry do not fall into this category.

**Industry claim:** Pages and pages of computer job ads in major newspapers prove that there is a shortage of programmers with the skills employers need. That is why employers turn to hiring foreign nationals.

Our response: Employers are over-defining these jobs, insisting that applicants have skills in X and Y and Z and W and so on. But what really counts in programming jobs is general programming talent, not experience with specific software skills. Even Bill Gates has described Microsoft hiring criteria thusly: “We’re not looking for any specific knowledge because things change so fast, and it’s easy to learn stuff. You’ve got to have an excitement about software, a certain intelligence...It’s not the specific knowledge that counts.” Studies show that programmers can become productive in a new software technology in a month or so (this is confirmed by my own personal experience, in 25 years of keeping up with technological change in the industry). Thus employers are (some deliberately, some unwittingly) creating an artificial labor “shortage.”

**Industry claim:** The shortage is so acute that we have taken to placing job adds on highway buildboards, even banners from airplanes flying over Silicon Valley.

As mentioned above, there is no shortage of professionals in the field. Employers receive huge numbers of resume’s but only a small proportion of them result in interviews. Microsoft, for instance, only hires 2% of its applicants for software positions.2 This is hardly a picture of desperation. If there were a real shortage, employers simply could not afford to be so picky.

**Industry claim:** The industry needs to hire recent graduates, shunting aside many mid-career professionals, as the recent graduates are the only ones who have up-to-date skills.

Our response: As noted above, what counts is general programming talent, not highly-specific skills. New skills can be learned quickly. Many employers like the recent graduates not for their skills, but rather because they are cheaper, with foreign nationals being even cheaper still. And whether sincere or not, industry employers who follow such a policy are operating a Ponzi scheme, since software technologies change so fast: If one hires a young graduate because he/she has specific skills, he/she will be cast aside in a few years when those same skills become obsolete.

The comments by employers regarding new graduates are tantamount to an admission of rampant age

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1Senator Alan Simpson, author of legislation to reform skills-based immigration, eventually withdrew the legislation, complaining that “I was working with the business community...to address their concerns, [but] each time we resolved one, they became more creative, more novel. [The lobbyists] distorted everything we were up to, everything.”

discrimination, as is the point made by employment agent Gadberry above. This will produce less and less incentive for young people to enter the field in the future. 

Industry claim: If a mid-career programmer cannot find a job, it is his/her own fault, for not keeping his/her skills up to date.

Take for example the C++ programming language, which is a requirement for many new jobs these days. C++ is an extension of the C language which most programmers use, and is easily learned. A programmer could take a course in C++ at a local community college, or just learn it on his/her own PC at home. But no employer would hire on this basis except for new graduates, employers insist on actual work experience in the given skill set.

Industry claim: The computer industry pays immigrants the same as it does natives.

Our response: Sun Microsystems, for instance, has heavily lobbied Congress against reform, saying that it needs to scour the world in order to hire the best and the brightest, but it seems more interested in hiring the cheapest. It has even publicly boasted that it hired 50 programmers in Russia “at bargain prices.” A statistical analysis performed by the author on the 1990 Census data revealed that average salaries for foreign-born computer professionals in Silicon Valley were nearly $7,000 lower than among natives of the same age and level of education. Even greater disparities, approaching 30% were found for engineering in general by UCLA Asian American Studies professor Paul Ong—a prominent immigrant advocate—who commented, “Companies took advantage of immigrants.” Furthermore, by concentrating on hiring young recent graduates, even employers who give equal wages to domestic and immigrant workers are saving money, since the younger workers are cheaper; when they run out of new domestic graduates, they hire new foreign graduates, ignoring the experienced domestic workers.

Industry claim: Many jobs in the industry pay very high salaries, sometimes even paying bonuses to induce workers to accept job offers. This demonstrates that the hiring of foreign nationals is not having an adverse impact on wages for domestic workers.

Our response: As noted earlier, employers are over-defining job requirements, with ads like “Must have five years of experience writing C++ code for TCP/IP applications on SPARC platforms.” The pool of programmers satisfying such conditions is of course small, thus raising salaries for those within that narrow pool. Yet as the Gates quote above illustrates, such pools are artificially narrow, since such tight job requirements are unwarranted. And as William Schroeder, CEO of Diamond Multimedia Systems has pointed out, these artificially high salaries then further increase incentives for employers to hire cheaper foreign nationals. Overall, engineering salaries have decreased relative to inflation, according to the the American Association of Engineering Societies.

Industry claim: Unemployment among computer professionals is low, thus proving the employers’ claim of a labor shortage.

Our response: People still must make a living, and thus must settle for taking whatever kind of job they can find. Many domestic computer programmers are underemployed, say working in computer customer interface jobs instead of programming, or in jobs which are completely unrelated to computers. Also, a number of them are forced to do temp work when they cannot find permanent jobs. Thus unemployment statistics are not very meaningful.

Industry claim: Half of the Ph.D.’s in computer science at American universities are going to foreign students, who are then hired by American employers after graduation and put into research positions.

Our response: Experts agree that America is over-producing Ph.D.’s, both foreign and domestic. These doctorate holders may well find jobs, but the jobs do not require Ph.D. training. Bill Gates of Microsoft does not even have a Bachelor’s degree, much less a Ph.D. I have no formal training in computer science (my Ph.D. is in mathematics), and yet I have been both a software developer in industry and a computer science researcher in academia.

Industry claim: Silicon Valley employers need to hire personnel for a project immediately, so they hire foreign nationals if they cannot find domestic workers quickly.
Our response: The employers admit that most of the foreign nationals they hire are foreign students who have recently graduated from American universities. Typically the hiring is done in the middle of a semester, so the employer needs to wait several months before the foreign national starts work. Thus the industry is contradicting its own claim.

Industry claim: Not enough domestic students are studying science and mathematics in primary and secondary school, and thus we have a shortage of trained engineers and computer programmers.

Our response: It is true that the number of new graduates in these fields has fluctuated, but we have not had a shortage. SoftPac, of Austin, Texas, found that during 1990-1993—the period of lowest production of new graduates in these fields—there were 525,000 workers trained in engineering and programming and available for work but there were only 378,000 job openings. That surplus did lead to a decline in college in enrollment in these fields, but that has now reversed; enrollment in computer science was up 40% nationwide in 1996. By the way, while mathematics is used in engineering, it is not used in computer programming.

Industry claim: Given its success, the industry must know best whom to hire. Natural market forces will result in the best people being hired.

Our response: Since most employers use the same hiring policies, a poor policy does not give any of them a competitive disadvantage. Indeed, market theory seems to fail in the computer industry. Studies have shown that programmers who are twice as productive are paid only 10% more. Intel leads the processor-chip market by far, yet its chip is widely regarded as poorly designed, as noted in Bill Gates’ famous remark that the Intel chip is “brain damaged.”

Industry claim: True, there have been some abuses of laws allowing employers to hire foreign workers, but the offenders here have been small, unknown “body shops,” not the big companies in the industry.

Our response: Sun Microsystems, which we noted above had boasted of hiring Russian programmers “at bargain prices,” is one of the most prominent companies in the industry. Hewlett-Packard, another giant in the industry, admitted under oath in court that the cheap programmers it had imported from India were of inferior quality. General Dynamics, a prominent engineering company, hired engineers from Britain whose agents described as being attractive due to the “indentured” (i.e. exploitable) nature of their visa status.

Industry claim: The industry already has strong disincentives against hiring foreign nationals, as the legal costs to obtain the visas are so high.

Our response: One can get approval from the Department of Labor to hire a foreign national on an H-1B visa for simply the price of the phone call made when one faxes in the application. More work is required for INS transactions, but economies of scale make this cost very low for the larger employers. Many of the smaller employers require the employee to pay the legal costs him/herself.

Industry claim: Company X employs a large number of immigrant engineers from country Y. This proves the need for immigrants.

Our response: This is a negative, not the positive point implied in the claim. It reflects networked hiring among an immigrant ethnicity, with the result that natives (as well as immigrants of the “wrong” ethnicity) are not being given access to these jobs.

Industry claim: Company Z was founded by an immigrant. This proves the need for immigrants in the industry.

Our response: The fact that a company was founded by an immigrant does not imply that if not for this immigrant, this sector of the industry would not exist. Again, we should facilitate the immigration of engineers of extraordinary talent, such as An Wang, founder of Wang Laboratories. But generally the immigrant entrepreneurs have not played pivotal roles in the industry’s technological development. Furthermore, if a foreign national wishes to start a company in the U.S., he/she can do so via an investor’s immigrant visa; it is not necessary to have a large quota in the skilled-immigrant visa categories for this purpose.
3 Author’s Background

Dr. Norman Matloff is a Professor of Computer Science at the University of California at Davis, where he formerly was a faculty member in the Division of Statistics. In addition, he is Graduate Admissions Coordinator for Computer Science at UCD. Dr. Matloff is also a former software developer in the Silicon Valley, and his wife continues to work there as a software engineer.

His areas of research specialization include multiprocessor hardware systems, database software security, and Chinese-language software. He is a former appointed member of IFIP Working Group 11.3, an international committee concerned with database software security, and is the author of a Prentice-Hall textbook on Intel assembly language programming.

Professor Matloff was a former Chair of the Affirmative Action Committee at UC Davis, and has long been active in work supporting minorities, particularly African-Americans and Latino-Americans, in programs such as MEP, MORE and SURPRISE.

He has been close to immigrant communities all his life. He spent part of his formative years in predominantly-Latino East Los Angeles, and his father was an immigrant from Lithuania. Professor Matloff is particularly close to the Chinese immigrant community:

His wife is an immigrant from Hong Kong; he speaks Chinese (Cantonese and Mandarin), and he and his wife are raising their daughter to be bilingual; many of their social friends are Chinese immigrants, including many who are Silicon Valley engineers; the television sets in his house are tuned to Chinese-language stations as often as to English ones, and he reads the Chinese-language press; he has extensive experience as a volunteer worker in San Francisco’s Chinatown, and has long been active in efforts to combat discrimination against Chinese-Americans (see, for example, his article in Asian Week, July 14, 1995, exposing the racially-related firing of a Chinese immigrant engineer). Dr. Lester Lee, a prominent Chinese-American and former member of the University of California Board of Regents, appointed Dr. Matloff to the Committee for Rational Relations with China in 1995.

Dr. Matloff’s 20-year immersion in the Chinese immigrant community is important to this report, because the vast majority of immigrant engineers in the Silicon Valley are of Chinese ethnicity. The preponderance of Chinese examples in this report stems from these considerations.

4 Focus and Definitions

As I wish to focus on the computer industry and particularly the Silicon Valley, I will use the term “the computer industry” to mean companies whose primary products consist of computer software and hardware. This would exclude, for example, banks, insurance companies, hospitals and so on, even though they do produce software for internal use.

The growth of the industry has been mostly in software rather than hardware. For instance, of H-1B work-visa application listings for a period in 1994 in Texas, there were 139 software positions, with titles like Software Engineer and Programmer, compared to only 30 for positions titled Electrical Engineer (some of the EE positions may also be in software). Thus, most graduates of programs in computer science, computer engineering and electrical engineering who work in technical positions in the computer industry are developing software, not hardware. Graduates of all three of these curricula tend to work in the same jobs. In most cases, it would be impossible to guess a person’s educational background knowing the type of work he/she is doing in the industry. For this reason, when discussing university curricula with names like Computer Science, Computer Engineering and Electrical Engineering, I will simply use the term “computer science” to include them all.

Again, the vast majority of technical jobs in the industry are in software. Thus this report will for the most part focus on that realm.

Programming jobs in the computer industry differ from those in banks, insurance companies and so on. Instead of the latter’s paradigm of job titles and clearly-separated functions such as System Analyst (design) and Programmer (mundane coding), in the computer industry the standard job title for a programmer is Software Engineer, and a job will usu-
ally include both design and coding responsibilities. Again, a programmer would have such a title regardless of whether he/she has a degree in engineering. For these and other reasons, analysts of the industry should avoid inferring much significance from job titles.

Similarly, claims by industry spokespeople in the Fall of 1995 that there are two kinds of programming—“research” programming and “ordinary” programming—have no basis in reality.

5 Computer Industry Hiring History

Ron Unz, a software entrepreneur who also has active political interests, has made his pro-immigration stance the centerpiece of his political strategy. He notes that more than 30 percent of the Silicon Valley’s computer professionals are foreign-born, and says the Silicon Valley’s sponsorship of foreign nationals for immigration is crucial to the industry’s technical edge. (See the San Jose Mercury News, October 27, 1995, and various articles by Unz, such as in the National Review.)

Yet even though Unz’s 30% figure is correct, his conclusion—that those immigrants in the Silicon Valley are actually needed—represents a leap in logic. To say that because a certain percentage of an industry is of a certain group hardly justifies a claim that the industry “depends” on that particular group. For instance, 40 percent of our nation’s small motels happen to be run by immigrants from India; yet no one would leap to the conclusion that without Indians there would be no motels. Instead, the hiring of foreign nationals arose in the following context.

5.1 Early and Mid-1980s

Back in the 1980s, during the infancy of the modern computer industry, there was a high-tech labor shortage. As word of this shortage reached Asia, foreign students flocked to American graduate schools. For example, at that time foreign students typically comprised 70 percent or more of the enrollments in computer science graduate programs at University of California and California State University campuses. The students hoped that after graduation they would be hired by employers in the American computer industry—and most importantly, sponsored by the employers for green cards.

Universities in the students’ home countries were treated as steppingstones for eventual immigration to the U.S. One clever Chinese ditty sung in Taiwan, referring to National Taiwan University (NTU), succinctly described the plan as (roughly):

Come, come, come,  
Come to NTU!  
Go, go, go,  
Go to the U.S. too!

No previous training in computers was required. Ms. Tan, for example, had an economics degree from NTU. Her lack of computer background was no obstacle, as many American schools offer quick computer science Master’s degrees which are especially tailored to students from other fields. For example, Professor Daniel Lewis, Chair of the Computer Engineering Department at Santa Clara University (a small but vibrant Jesuit university in the heart of the Silicon Valley) says that about half of the foreign students in their Master’s program have (both in the past and currently) come from noncomputer-related undergraduate backgrounds. (Interview with the author, May 16, 1994.) After Tan graduated, an Amer-

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4Unz ran in the 1994 Republican primary election for California governor. Though previously unknown, he still was able to attract 34% of the vote against Pete Wilson, the incumbent and eventual victor in the general election. Unz is also credited for convincing Jack Kemp and Bill Bennett, two nationally-prominent Republicans, to take strong pro-immigration stances in 1994.

5As verified by the PUMS Census data.

6In the early years, most of the foreign students were from Taiwan, but they were later joined by students from China, Hong Kong and India.
ican computer company hired her and sponsored her for immigration.

Many employers found hiring foreign nationals attractive because they were willing to work for lower pay, in exchange for being sponsored for a green card. Moreover, the presence of the foreign students in American universities alleviated employers of the need to promote computer studies among domestic students at those same schools. (Recall that American industry did successfully promote engineering studies among domestic students in order to staff the “Space Race” of the 1960s.)

5.2 Late 1980s-1997: Labor Surplus

At the time, the hiring of Ms. Tan described in the last subsection appeared to the Immigration and Naturalization Service to be in the national interest. Ms. Tan, after all, seemed to be helping the go-go American computer industry cope with an acute labor shortage. Yet though part of this shortage may have been real, a significant portion was only perceived, an industry overreaction. In the excitement of the computer revolution, numerous “startup” companies were formed, each one hoping to become the next Apple Computer-style Cinderella story of the Silicon Valley. As a result, too many companies were formed, and the industry overhired.

The inevitable effect of this was, beginning in the late 1980s, widespread bankruptcy for the smaller companies and mass layoffs for many larger companies. There now as a labor surplus, not a shortage. In other words, during the 1980s too many employment-based green cards were granted to foreign computer professionals. Instead of being necessary for the industry’s technical edge, as claimed by Unz, these workers are swelling today’s labor surplus.

One cannot pinpoint the year in which the labor surplus began, but it clearly occurred somewhere in the latter half of the decade. This was clear from the bankruptcies and layoffs, as well as from statistics. An author and specialist in the field, Janet Ruhl, believes that the supply of university graduates caught up to and surpassed demand by 1987, stating that “By 1987 an estimated 60,000 graduates were competing for some 25,000 open positions.” (The Programmer’s Survival Guide, Prentice-Hall, 1989.) Edward Yourdon, a prominent author on software development management techniques, thinks that even in 1984 there were more new university graduates in the field than there were job openings. (The Decline and Fall of the American Programmer, Prentice-Hall, 1993, p.12.)

The labor surplus which began in the late 1980s has continued to grow since that time. For example, the aforementioned Ms. Tan began in 1994 to dread threatened layoffs in the company for which she works, a well-known Silicon Valley firm. To the company’s credit, those layoffs have yet to materialize, but many programmers have little work to do, and in 1995 the firm’s CEO sent e-mail to all employees, stating that layoffs are still a distinct possibility.

Note that as pointed out by the electrical engineering trade journal Institute of Electrical and Electronic Engineers (IEEE) Spectrum (August 1993 issue), this industry change was mainly a consequence of the maturing of the industry, rather than a reflection of the economic recession of 1991-1992. (Note, by the way, that the industry hired foreign nationals in large numbers during the recession too.)

Based on Bureau of Labor Statistics data, SoftPac estimates that the software industry needed approximately 40,000 new workers in 1994. This is less than the 51,000 new computer science graduates our universities produced. Yet the number of foreign computer programmers granted work visas in 1994 exceeded 30,000. SoftPac also found that between 1990 and 1993, U.S. colleges and universities awarded two bachelor’s degrees in engineering for every engineering job opening created through net replacement.

SoftPac cautions that the value of these figures should be limited to their indication of a general trend of overproduction of computer scientists and engineers. The exact numbers themselves should not be dwelt upon, because exact analyses of employment in this area are impossible. For example, there is extensive overlap between the “programmer” and “engineer” categories used in many high-skill labor data sets. Many graduates holding computer science degrees later work in jobs categorized as en-
ning, such as “software engineer” (again, this title is the standard one for most programmers in the Silicon Valley) or “member of the technical staff,” while many of those in jobs categorized as programming hold engineering degrees, such as computer engineering and electrical engineering. One way to avoid these crossover problems is to look at the combined programmer/engineering numbers, which indicate that during 1990-1993 there were 525,000 workers trained in engineering and programming and available for work but there were only 378,000 job openings.

We noted earlier that Edward Yourdon, a prominent author on software development management techniques, thinks that even in 1984—the time at which the industry was undergoing its fastest growth in history, either in the past or since that time—there were more new university graduates in the field than there were job openings.

In addition, SoftPac notes that “the Digital Equipment Corporation has cut over 20,000 U.S. jobs since 1990, yet during the same time applied for over 1100 H-1B visas.”

During this time, many new computer science graduates found it difficult to get work, often taking several months, and even then they tended to be hired in non-technical or semitechnical positions, becoming software testers, software customer service representatives, and computer system administrators, while the foreign nationals were hired for the technical work.

The number of full-time computer jobs in the Silicon Valley decreased markedly between 1990 and 1994, with many jobs being converted to “temps,” according to Michael Peter Smith of the University of California at Davis’ Applied Behavioral Sciences Department. (Presentation to the U.S. Commission on Immigration Reform, November 16, 1995.)

Meanwhile 20,000 programmers were laid off from the defense industry. With only a modest degree of retraining, these proven software engineers could be making valuable contributions in the computer industry. Instead, the Los Angeles Times reported in 1993 that most were working in nontechnical jobs, even as security guards and pizza deliverers.

Yet computer industry employers continued to hire foreign nationals and sponsor them for immigration. At the same time, new domestic graduates were often shunted into nontechnical positions such as marketing, while the foreign nationals, typically new graduates themselves, were hired to do the technical work.

5.2.1 Trends in Enrollment in University Computer Science Curricula

In March 1997, the Information Technology Association of America (ITAA) released a report titled Help Wanted: The IT Workforce at the Dawn of a New Century. ITAA is a consortium of computer industry employers, and its president, Harris Miller, was a major lobbyist opposing the employer-based sections of the immigration-reform bills introduced in Congress in 1995. The report’s research was done by Stuart Anderson, whose analysis of salaries we critique in Section 6.2.

A major thrust of the report is a claim that insufficiently many new graduates in computer science and engineering are being produced for our national needs. ITAA bases this claim on a decline in the number of computer science graduates, from 42,000 in 1986 to 24,000 in 1994.

As I have shown above, at no time since 1980 has there been a shortage of people with degrees in computer science and engineering. The basic problem is that employers are not willing to hire people who do not have background in the latest technologies. The employers’ unwillingness in this regard is unwarranted, as I explain in detail in Section 8.1, but my point in the context of the ITAA report is that there is no shortage of “bodies.” Indeed, even the ITAA report recognizes this, quoting a December 2, 1996 Information Week article saying that “The competition for today’s hottest skills is that tough” (my emphasis).

However, given the wide circulation of the ITAA report, its point about national enrollment in computer

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7This can be seen, though somewhat indirectly, in for example: San Jose Mercury News, March 16, 1995; San Francisco Chronicle, June 14, 1993; San Francisco Chronicle, December 27, 1994; and San Jose Mercury News, May 17, 1995. This was also noted in the interview with Daniel Lewis of Santa Clara University, and of course in interviews with my own students.
science curricula should be addressed.

**Here are a few key points:**

- Throughout its report, ITAA cites statistics on jobs in the “IT [information technology] industry” and compares them to the numbers of computer science graduates. Yet many of those jobs are, by the report’s only admission, for “technicians,” which typically are done by people without a college degree.

- It is true that, at least in the early 1990s, undergraduate enrollment in computer science dropped. Yet it is interesting that even industry representatives (including ITAA) interviewed by Business Week (March 10, 1997) blamed this decline in interest in computer science among university students partly on “a glut of programmers in the mid-1980s.”

- Students do tend to choose their majors on the basis of the perceived job market in the field. Without the large numbers of foreign nationals hired in the 1980s, this glut would not have existed.

- Apparently in response to numerous newspaper articles in 1996 reporting a shortage in the computer field, national computer science enrollment in the 1996-1997 academic year was up 40%, according to the Computing Research Association.

- Even in the early-1990s years of nationally declining computer science enrollments, California enrollments were increasing. For example, here are total enrollment figures (sum of the enrollments in all courses) in the Department of Computer Science at UC Davis:

<table>
<thead>
<tr>
<th>Year</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991-1992</td>
<td>2,254</td>
</tr>
<tr>
<td>1992-1993</td>
<td>2,600</td>
</tr>
<tr>
<td>1993-1994</td>
<td>3,305</td>
</tr>
</tbody>
</table>

- Though the national numbers of new Bachelor’s degrees in engineering did fall about 15% from 1987 to 1989, the rate of production has been essentially constant since 1989, at about 65,000 per year. (*Engineers: A Quarterly Bulletin on Careers in the Profession, January 1997.*)

Note also that ITAA attributes the decline in computer science enrollment to an alleged disinterest among American children in mathematics. This is plainly false. One can hardly claim, for instance, that interest in mathematics among American declined 50% in eight years—and then suddenly increased by 40% in one year.

And much more importantly, computer programming does not use mathematics. Flip through any book on programming (C++, Java, etc.) at your local bookstore; you will not see any equations or mathematical graphs.

### 5.3 The Present Time

#### 5.3.1 There Is No Lack of “Bodies”

Numerous newspaper and magazine articles in 1996 reported a severe high-tech labor shortage. And yet as before, there actually is no shortage of workers with computer science and engineering degrees. Instead, the problem is that employers have become very picky about whom they hire. As the Electronic Engineering Times put it (June 24, 1996), “Engineering graduates are plentiful in general, but some companies are starving for specialists.” This was similar to the quote we cited earlier from Information Week (“Stretched to the Limit,” December 2, 1996):

> Federal Express Corp., lauded for its many technical innovations, still can’t attract enough skilled IT workers. The competition for today’s hottest skills is that tough.

(Here and below, emphasis is mine.)
As I will explain in detail in Section 8.1, this emphasis on specialists is unwarranted, but the point is that there is no shortage of “bodies,” i.e. no shortage of people with computer science and engineering degrees.

Another statement in the same article illustrates this particularly well:

Nearly all of the 300 CIOs surveyed by Information Week in August said they have problems finding employees with specific skills—even though only about half planned to enlarge their IS staffs this year.

(The latter half of this statement is also of interest, given the claims of a “shortage.”)

Similarly, the claims that the “shortage” is leading to high salaries, signing bonuses and other perks, again is limited only to those with specified skills. Here is a typical example (“Revolutionary Times,” Computerworld, March 31, 1997):

“We’re competing with every other [Boston] area company for people with client/server, Unix, Java, C++, Visual Basic and Windows tools skills,” says Paula Merageas, a human resources representative at Thomson Financial Services Corp.

5.3.2 The Current Job Market

The job market in 1996 can be described as follows:

- Prospects for many new graduates improved markedly, apparently in large part due to adverse publicity the industry received after Congress and the media focused attention on the widespread hiring of foreign nationals.
- Other new graduates were still being ignored or shunted into nontechnical jobs.
- Mid-career computer professionals, such as our “Cindy” mentioned early, still found it difficult to get full-time work in the industry.

The details follow.

A sharp change occurred in late 1995, in the form of a sudden increase in on-campus recruiting of new graduates. Employers now flocked to campuses that they had not visited in years. For example, a Microsoft college relations officer told me that Microsoft had decided to greatly expand its list of campuses to visit; among the new schools added to their list was my university, UC Davis (UCD).

Indeed, our UCD Career and Internship Center was suddenly deluged with calls from employers requesting interview slots for graduating seniors in the computer fields. Newspaper articles then began to appear about a sudden “boom” in job offers for the new graduates. (See for example the Washington Post, June 3, 1996.) Those students who received job offers got better offers than graduates had in the recent past—solid technical positions at good salaries.

Yet this effect on new graduates was selective. Students told me that they were not allowed to sign up for interview slots with many employers if their skills were not an exact match for the employers’ requirements. As will be discussed in detail later in this report (Section 7.4), employer overemphasis on specific skills is unreasonable and is one of the major underlying causes of underemployment and unemployment in the computer fields. And though those getting new jobs do tend to be hired for technical positions, many students were still being hired for software testing and other semitechnical and nontechnical jobs. Moreover, many schools were not included in the sudden “boom.” Take for example San Francisco State University (SFSU). When I first interviewed SFSU Computer Science Department Chair Gerald Eisner on November 14, 1995, he had confirmed a statement made to me by an SFSU student that out of hundreds of computer companies in the San Francisco Bay Area, only two (Oracle and Sybase) go to SFSU to recruit new graduates. When I re-interviewed him in June 1996, he stated that the number of computer industry employers recruiting at SFSU had not increased substantially.10

It is a safe bet that if these companies were not re-

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10Dr. Eisner did mention that employers will sometimes phone him for suggestions of students to contact for individual interviews, and that such phone calls had increased since I had talked to him in November 1995.
cruiting at some schools in their own back yard, they were not doing so in Kansas City or Tallahassee either. Indeed, in December 1996 with the Chair of the Computer Science Department of a major cornbelt-region university told me that only a small fraction of his department’s new graduates were being hired by the computer industry (the rest did get hired, but in computer applications fields such as banking); by the way, willingness to relocate was not an issue, since most of the graduates did take jobs out of state.

Another aspect is that the graduates who were now benefitting from the computer industry’s new focus on them tended to be those who had had co-ops, internships or summer jobs in the industry during their undergraduate careers. The employers are indeed correct in giving preference to such students in hiring for permanent positions, but there are not enough co-ops, etc. to meet the high demand. Yet foreign students have ready access to such jobs.

It must be kept in mind that this shift in employer attention to new graduates was just that—a shift, rather than an across-the-board increase in hiring. In other words, all indications are that there was no corresponding increase in job prospects for mid-career programmers and in fact such prospects appear to have eroded further. This shift appears to be due partly to the adverse publicity the industry received in 1995 over their hiring of foreign workers, and partly an acceleration of the trend, already in progress, to hire new graduates over experienced workers because the new graduates are cheaper. For instance, the *Electronic Engineering Times*, June 10, 1996, reported that on a survey by the National Association of Colleges and Employers which found a major trend toward hiring of new graduates instead of experienced workers, noting that “’The lower salaries [of new graduates compared to experienced workers] are probably playing a significant role in sustaining the market for new graduates,’ said University of Iowa researcher Sara Rynes.”

Again, the shift toward the new graduates made things even worse for the mid-career professionals (except those who were lucky enough to have the “right” skills set), who had already been finding it difficult to get work in the industry. For example:

- Microsoft receives approximately 120,000 re-
We will further explore the adverse impacts on mid-career professionals in detail in Section 10.

There is no doubt that the sudden increase in campus recruiting by industry employers was in part an employer reaction to the adverse publicity the industry had gotten in 1995 over the hiring of foreign nationals, particularly stemming from the introduction of an immigration-reform bill by Senator Alan Simpson which would have substantially curtailed the ability of employers to hire foreign workers and sponsor them for immigration, and from magazine and newspaper articles critical of the industry. The suddenness of the change rules out technical or economic factors, as does the lack of corresponding beneficial effect on mid-career workers.\footnote{This is not to say that more gradual technical/economic factors had not been taking place. Internet-related firms, for instance, were growing rapidly, but that growth had started a year or two earlier, well before the surge in hiring of new graduates.}

Shortly after my article on this matter appeared in the *National Review* (October 8, 1995), our UC Davis Career and Internship Center was deluged with calls from employers who wanted to book interview slots for graduating seniors. A student overheard a staff member receiving such a call, and replying, “We have been flooded with requests ever since that professor’s article came out.” The employers booked more slots than our seniors could fill, and then angrily complained to the Center staff, threatening to have a reduced recruiting presence at UCD in the future. As mentioned earlier, many of these companies, such as Microsoft, had not been recruiting at UCD in previous years. Top officials at companies such as Microsoft and Intel told me that they had been quite aware of my *National Review* piece.

The increase in campus recruiting was a very positive step, but the fact remained that job prospects were still poor for the mid-career professionals. And the same students who were getting jobs as new graduates will find identical problems 10 years from now, with employers rejecting them for jobs because their skills are now considered outdated, just as is occurring to today’s mid-career workers. The industry’s response to criticism merely shifted some of the problems, not solved them. The core problem was that we do have a labor surplus, and that the hiring of foreign nationals and sponsoring them for immigration is greatly exacerbating that surplus.

Not only is there a surplus of trained workers in the computer field, but there is also a goldmine of other talent which is being ignored. In software work what really counts is good, solid analytical ability, not formal degrees in computer science. As detailed below, many of the computer industry stars have no formal training in computer science. The tens of thousands of unemployed or underemployed Ph.D.’s in physics, mathematics and so on could be put to excellent use in the computer industry. Indeed, some have managed to find work in the computer field, though not necessarily in the computer industry. But for the most part the industry is missing an excellent opportunity to hire some top minds, if only employers were to place less obsessive emphasis on paper credentials.

Lou, for instance, is a Ph.D. in mechanical engineering but in the engineering job from which he was laid off he wrote award-winning engineering software for use on Silicon Graphics computers. After that job ended, he tried without success to get a job at Silicon Graphics, which produces software similar to what he had written.

5.4 Impact on a Minority Group: Asian-Americans

The press tends to portray competition for jobs due to immigration as a conflict between non-Caucasians and the Caucasian majority. However, it is widely recognized among specialists in immigration (including many immigrant advocates) that minority groups tend to be especially impacted.

Since many in the computer field are Asian-Americans (whether natives or naturalized citizens), that group comprises a major class of victims of current policy. Cindy, the mid-career computer professional who finds it difficult to get programming work, is Chinese-American. Lou, the former defense engineer cited above who cannot find technical work, is also Chinese-American, as are Ms. Tan (the one afraid of being laid off) and Ms. Yee (whom employers told she had too much work experience).

The harm current policy imposes on Asian-Americans becomes even more clear in light of the
situation at San Francisco State University, which has an especially large Asian-American enrollment. As stated above, out of literally hundreds of computer companies in the San Francisco Bay Area, only two (Oracle and Sybase) go to San Francisco State University to recruit new graduates. Without such easy access to hiring of foreign nationals, more companies would be forced to recruit at these schools, giving Asian-Americans and others more and better job opportunities.

6 Technical Aspects: Visas

6.1 Visa Types

The route taken by Ms. Tan and thousands of others from Asia is typical: First the person comes to the U.S. on an F-1 student visa, and then after graduation seeks a job with an American employer who then sponsors him/her for a green card.

During the interim period during which the employee waits in the immigration queue (which depends on how many nationals from that particular country are in the queue), he/she either works under Practical Training status (an extension of the F-1 student visa) or under an H-1B temporary work visa.

This situation, which I will refer to as the “university steppingstone” route, is in contrast to that in which an American employer directly imports a worker from a foreign country under an H-1B temporary visa. (It should be noted that for many companies the H-1B visa is “temporary” in name only, according to Intel’s chair Gordon Moore.12 It too is a steppingstone to sponsorship for permanent residence by the employer.)

The “direct import” situation has received considerable press in recent years, but it should be noted that most foreign-born professionals working in the computer industry have used the “university steppingstone” route. While both routes tend to produce problems in terms of displacement of American workers, it is important to understand this distinction.

The author’s primary interest is in those who follow the university steppingstone route, and most of the statements made in this report concern that group.

6.2 Obtaining Visas: Easy and Cheap

On the surface, it would appear that there are some disincentives against employers hiring foreign nationals. The law requires documentation that no American worker could be found to fill the job in question, and the services of an attorney are generally used, thus creating an expense.

The actuality, though, is that there are no serious disincentives. When a software manager wants to hire a foreign national, he typically will not be involved in the visa process at all; the process will be handled by the company’s personnel department. Thus there are no disincentives for the software manager.

The personnel department doesn’t find the process difficult either. The documentation that it must submit to the Department of Labor (DOL) is not given careful scrutiny. SoftPac of Austin, Texas notes that:

The Houston Chronicle analyzed three years of foreign labor applications that employers submitted to the Labor Department and found that Texas employers convinced the department 99% of the time that there were no qualified U.S. workers to take the jobs. According to a 1991 report by the Labor Department’s inspector general, the vast majority of immigrants are permitted to enter the U.S. without considering their impact on the American job market. Companies will tailor requirements to such an extent that only the foreigner they wish to hire can meet them. A Department of Labor official told the Houston Chronicle that “the Labor Department doesn’t have the personnel to check the accuracy of employer’s statements to support their decision not to hire a U.S. worker.” Additionally, the Board of Alien Labor Certification Appeals often overrules regional offices when they contend that U.S. applicants are qualified. According to the officer, “When an employer says no, its no.”

In May of 1996, the federal Department of Labor re-
leased a report, *The Department of Labor's Foreign Labor Certification Programs: The System is Broken and Needs to be Fixed.* A press release on the report summarized, “[W]hile DOL is doing all it can within its authority, the foreign labor programs we audited do not protect U.S. workers’ jobs or wages from foreign labor because neither program meets its legislative intent. Moreover, DOL’s role under the current program design amounts to little more than a paper shuffle for the PLC program and a rubber stamping of applications for the LCA program. As a result, annual expenditures of approximately $50 million for DOL’s foreign programs do little to ‘add value’ to the process. If such programs are to continue, we believe changes must be made to ensure that U.S. workers’ jobs are protected and that their wage levels are not eroded by foreign labor. However, DOL should be removed from the process unless a more meaningful role is defined.”

Significantly, the DOL report also found that although employers are in theory supposed to make a widespread search for domestic workers before offering a job to a foreign national, this requirement is not working either. In cases in which state employment agencies referred domestic workers to jobs for which employers had applied to hire a foreign national, only 0.08% of the domestic workers—less than one in one thousand—were hired.

The expenses for an attorney do not present a disincentive either. The only expense involved with obtaining approval from the Department of Labor for an H-1B visa is the price of the telephone call needed to fax in the application. Obtaining approval for INS transactions is more involved, but the process has become so routine that the expenses are minimal these days. And often the employer will ask the foreign national to pay the legal expenses him/herself.

7 Employer Motivation for Hiring Foreign Nationals: Salary and Other Cost Savings

7.1 Overview

Mr. Ivanov immigrated to the U.S. from Russia in 1980. In 1994 he had a rather startling experience when he interviewed for a position with a software firm in New York.

First, Ivanov was surprised to find that almost all of the company’s technical staff were from either Russia or India. He was even more taken aback when the employer, expressing interest in hiring Ivanov, began to explain how the company would sponsor Ivanov for immigration. When Ivanov replied that he was already a naturalized U.S. citizen, he was told that the company was no longer interested in him.

Ms. Yang came to the U.S. as a student from China. After graduation, she was hired and sponsored for immigration by a Silicon Valley computer firm. She then noticed that the company rejected any job applicant who already had citizen or permanent resident status. The company works its programmers 10 hours per day, with no overtime pay or compensating time off, at low salaries.

Many computer professionals have similar stories to tell, claiming that employers hire foreign nationals out of a desire for cheap, compliant labor.

Employers who wish to offer positions to foreign nationals are in theory supposed to demonstrate to the Department of Labor (DOL) that they are paying the prevailing wage. However, due to the wide variation in salaries in the computer field, it is difficult for non-computer specialists in the DOL to determine whether an offered salary is too low.

There can be no doubt that salary is a major issue with employers. Prominent software development expert Edward Yourdon points out that “...it takes very little capital to get started [in the software business]; indeed, the largest cost is the labor involved, which is why the issue of salaries is so important.” (*The Rise and Resurrection of the American Programmer*, Yourdon Press, Prentice-Hall, 1996, p.4.)

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14 Some of this is described in David North’s *Soothing the Establishment: the Impact of Foreign-Born Scientists and Engineers on America*, (University Press of America, 1995, p.52.)
One of the first questions asked in an interview is the salary level the applicant expects. Indeed, this will typically be asked in a telephone pre-interview, with the answer being a major factor in determining whether the applicant will be invited to interview in person. Thus even employers who do not necessarily plan at the outset to hire a foreign national may end up doing so simply because the latter is the lowest bidder. Indeed, a high-salaried applicant is likely to not even get an interview. Clearly, then, salary is a major employer concern.

Note too that this also means that the low initial salary a foreign national is willing to take in exchange for a green card then tends to propagate even after he/she receives the card. Each time this person applies for a job in the future, the employer will first ask what his/her current salary is. UCLA Asian-American Studies professor Paul Ong found that it takes the immigrants 20 to 25 years to catch up. (The State of Asian Pacific America, Paul Ong (ed.), LEAP Asian Pacific American Public Policy Institute and UCLA Asian American Studies Center, 1994, p.179.)

Note that even if all employers were to offer the same salaries to foreign nationals as to domestic workers, the simple law of supply and demand would imply that overall wages would be lower than what they would have been without the presence of the foreign nationals; a labor surplus in a given profession reduces salaries.

It is important to note that hiring managers may hire foreign nationals to save costs even without any explicit directive from upper management to do so. Hiring managers know that they will be rebuked if they hire too many people at higher salary levels. Thus they have considerable incentives to hire foreign nationals who will accept lower salaries, as well as incentives to hire new or recent graduates, turning to new foreign graduates when they run out of new domestic graduates (and shunning domestic mid-career people).

7.2 Studies of Immigrant and Native Salaries and Employment

7.2.1 Multivariate Studies Based on Census Data

To assess the role of salary in the hiring of foreign nationals, I ran a statistical regression analysis on the 1990 Census data. The data consisted of all professionals who listed their occupations as Programmer, Computer Scientist or Electrical Engineer, and whose workplace was in or near the Silicon Valley. (This consisted of Santa Clara, Alameda and San Mateo Counties.)

An individual was excluded if he/she worked less than 48 weeks in 1989, or had less than a Bachelor’s degree. In all, the data set consisted of 1,551 individuals. The predictor variables were Age (a proxy for years of experience), Foreign-Born status (1 if foreign-born, 0 if native), and Education (1 for Bachelor’s, 2 for Master’s, 3 for Ph.D.).

Note that in this manner we were adjusting for both years of experience and education. Exclusion of the Education variable, for instance, would have resulted in a misleading analysis, as the higher number of holders of graduate degrees among the foreign-born (recall the “university steppingstone” phenomenon) would make it look like they are better-paid than they actually are.

On the other hand, we would not want to count as “foreign-born” people who immigrated via nonemployment means when they were children, and thus have no interest in taking lower salaries in exchange for a green card that they do not need. Accordingly, I only included immigrants who entered the U.S. in the five years prior to the date of the Census.

The resulting regression equation was:

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15% PUMS sample.

16 As noted earlier, all three of these occupational categories tend to be associated with the same kind of work. However, different individuals may enter different occupations when completing the Census form, even if they do the same work. For example, someone with an electrical engineering degree may list his/her occupation as Electrical Engineering even though he/she is doing programming, merely because of his/her educational background.
Salary = 657 Age - 6744 Foreign Born + 6135 Education + 19187

In other words, if one fixes years of experience and level of education, the immigrant engineers were on the average paid nearly $7,000 less in salary than the natives. This differential is nearly 15% of the $50,000 average salary found in the data set.

Moreover, presumably there are a number of sincere employers in the mix who do pay immigrants wages equal to those of natives. Thus the average differential among the employers who pay lower wages to immigrants would be much higher than the $6,744 figure.

Regression models comprise the standard tool for analysis of salary data, but to get additional perspective I subsequently ran another analysis on this same data set, in this case using a direct tabulation rather than applying a regression model. This tabulation was again limited to the Silicon Valley, but this time I added the further constraints that the worker has a Master’s degree (and does not have a Ph.D.), and that the worker is at most 32 years old. For the foreign-born, I included the worker if his entry to the U.S. had been no more than eight years earlier. I then simply computed mean salaries for all native and all foreign-born. The results were:

native: $51,480
foreign-born: $42,845

UCLA Asian American Studies professor Paul Ong, together with Evelyn Blumenberg, performed detailed studies on the 1990 Census data. After adjusting for a host of factors such as experience, education, English proficiency, and so on, they found that “Recent immigrants in engineering earn about one-third less than their U.S.-born [Asian-American] counterparts.” They note that other researchers have found that “Foreign scientists and engineers may be willing to accept lower salaries in order to obtain full-time employment in the U.S., a prerequisite for permanent residency.”

In the *Electronic Engineering Times*, July 18, 1994, Ong comments on his study, saying “Companies took advantage of immigrants.”

7.2.2 Problems with Other Studies

Some other studies comparing immigrant and native salaries in science and engineering have been published or referenced since congressional attention was brought to the issue in 1995.

For instance, the July 1995 issue of *Engineers*, a publication of the Engineering Workforce Commission of the American Association of Engineering Societies (AAES, which includes IEEE), stated (p.5): “[Base salaries in] software engineering companies showed especially severe declines, [because that job sector] may be flooded with prospective applicants.” Their data for salaries (in constant dollars, i.e. adjusted for inflation) show a steady downward trend in salaries from 1986 to 1995, with an erosion of about 10% during that period.

On the other hand, Stuart Anderson of the pro-immigration Cato Institute conducted a study for Empower America (EA), titled *Employment-Based Immigration and High Technology*, in which Anderson uses unpublished National Science Foundation data to assert that the immigrants are actually paid more on average than the natives.

The fact is that both of these studies must be viewed with the utmost of caution, because they do not correct for important variables. The reader is urged to keep in mind that the analyses of salary issues can be very misleading unless proper controls are made for variables such as:

- geography
- type of work
- occupational field
- type of employer (e.g. industrial vs. academic)

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18Ong and Blumenberg also discuss the possible effect of another factor, concerning whether the engineer has an American education. This is discussed below in connected with the Stuart Anderson analyses.
• type of study (e.g. Census vs. self-respondent survey)
• level of education
• age
• length of time in the U.S.

Neither the AAES nor the EA study controlled for geographical variations in salary, which is a major factor. A 1995 publication by High Technology Careers, titled Future Outlook, shows salary variations of 15-20% among the four states Arizona, California, Colorado and Texas, and in certain subfields the variation is even greater than that. This is an especially important point for immigrant programmers and engineers, as they tend to seek jobs in high-cost-of-living areas such as the Silicon Valley, which have accordingly higher salaries.

Neither study controlled for type of employer, again a major factor. Proportionally fewer immigrant Ph.D.’s take jobs in academia, which are lower-paid than jobs in industry.

Furthermore, self-respondent surveys are quite unreliable for this kind of analysis, especially because many immigrant engineers come from cultures in which survey response rates are low. There may well be a greater propensity for low-salaried immigrant engineers to not bother returning a survey form. Both the AAES and EA studies were based on self-respondent surveys.

The length of time in the U.S. is a major variable. Programmers who are foreign nationals on H-1B work visas and are being sponsored for green cards by their employers are essentially immobile, unable to switch jobs, because they do not want to start the green-card process all over again with a new employer. Thus their employers can exploit them, giving them fewer and smaller raises in salary than what comparable U.S. citizen/permanent resident workers get.

The type of work is another crucial variable. The employers themselves admit that the H-1Bs are hired because they have certain “hot skills,” say the Java programming language. Java commands a premium in salary. But an employer can hire an H-1B with Java skills for a salary which is low for Java people but higher than those of “ordinary” programmers. This creates a major distortion under which it seems like the H-1Bs are being paid well, when in fact they are being cheated.

The EA study did at least adjust for level of education and age, but it lumped together science and engineering salaries, a major flaw since engineering salaries tend to be substantially higher. Since the immigrants in technical fields are overwhelmingly concentrated in engineering rather than science, this again is a major problem.

Though David North’s Soothing the Establishment: the Impact of Foreign-Born Scientists and Engineers on America, (University Press of America, 1995) has quite a bit of valuable information, its wage analyses tend to suffer from the same problems cited above.

Stuart Anderson, author of the EA report, subsequently published an article, “The Wage and Employment Impact of Immigrant Scientists and Engineers in High Technology,” in the Fall 1996 issue of International Educator. This magazine is published by the National Association of Foreign Student Advisers (NAFSA), which had heavily lobbied against 1995-1996 congressional proposals aimed at curbing the use of American university graduate programs as steppingstones to immigration. Anderson’s article contained largely the same material as in his EA report, but had a significant update in that it addressed the work of Ong and Blumenberg which I have cited above.

Anderson cites the Ong/Blumenberg finding from Census data that foreign-born Asian engineers in the U.S. had wages approximately 33% lower than their American-born counterparts. However, he then notes that Ong and Blumenberg point to another study, this one on data from the Survey on Natural and Social Scientists and Engineers, which found that “…those with a foreign education earn about 10 percent less

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19 The study by Ong and Blumenberg mentioned above found differences of approximately 15%.
19 See for example the North reference cited below, p.64.
21 See Section 14.2 for more information on NAFSA lobbying activities.
22 Anderson had taken a look at this article after I had urged him to do so at a conference on immigration held at Stanford University in October 1996.
than those with a U.S. education. There are no differences in wages between the U.S.-born and foreign-born employees with a U.S. education after controlling for other factors” (quote from the Ong and Blumenberg reference cited above).

Anderson then concludes from this that “what Ong and Blumenberg found [that the foreign-born workers were paid 33% less than the natives] does not have to do with ‘cheap’ immigrant labor but with how U.S. employers evaluate the relative importance of U.S. education.” But of course this conclusion does not follow at all—even if all the foreign-born workers were lacking a U.S. education (which is not the case at all), the 10% salary differential due to this lack certainly cannot explain the 33% overall salary gap found by Ong and Blumenberg.23 And note again that Ong himself described the results of his studies by saying “Companies took advantage of immigrants.”

By the way, even that 10% figure is inflated. The reason for this is that the statistical regression analysis, in examining those with an American education, is picking up many foreign-born workers who immigrated as children with their families. These workers of course already have their immigration status settled, and thus are not subject to exploitation by employers—unlike those who come to the U.S. under foreign-student visas hoping that employers will later sponsor them for green cards, and who are thus willing to work for lower wages in exchange for the green cards. The “American Education” variable, by

mixing these two different groups, is producing an overestimate of the effect. Instead of measuring the value of an American education, this variable is measuring the value of having a green card.

Another way in which salary data can be misleading is that due to an overemphasis on paper credentials, there has been an increase in salaries for some types of experienced programmers. By insisting on hiring, say, a programmer who has experience with TCP/IP network protocols, C++ programming and Motif windows—and again, we will show later why this is unreasonable and indeed harmful to the industry—an employer is looking at such a narrow pool that he of course must pay a premium salary. (This in turn leads to further hiring of cheaper foreign nationals.)

An article in the San Jose Mercury News on February 16, 1997 described this multilithic nature of salaries in the industry in the case of temporary programmers:

Those with “hot” job skills prosper, winning higher incomes...[while others] are consigned to low wages...

It should be noted that salary data would not reflect other adverse impacts of foreign-national workers on domestic workers. As discussed in Section 5.1, a major recent trend in the industry has been a shift toward hiring new or recent graduates instead of established people, because the younger people have lower salary levels. An employer with this motivation would turn to hiring cheaper young foreign nationals when he runs out of cheaper young domestic workers to hire—instead of turning to more expensive mid-career people. In this case the mid-career people’s employability is reduced by the presence of the foreign nationals, even if the employer pays the young foreign nationals identical salaries to those paid to the young domestic workers.

Possibly the most misleading type of study is that which analyses unemployment rates. Such rates underestimate the problem, because those who are laid off must, after all, take some kind of job. Often the jobs which laid-off engineers must settle for carry a reduction in salary, and involve responsibilities which do not utilize the person’s talents. Laid-off program-
mers, for example, must often take jobs in program testing instead of software development, or in interfacing with customers. Cindy, the laid-off programmer described in our opening section, finally had to take a job completely out of her field, doing noncomputer work for an investment firm. Thus analyses of unemployment rates among programmers and engineers carry essentially no meaning.

7.3 Comments by, and Actions of, Specific Employers Regarding Salary Savings

During the Fall of 1995, many industry spokespeople denied that low salaries were the factor in the hiring of foreign nationals, claiming that the foreign workers are simply more talented. Sun Microsystems vice president Ken Alvarez claimed that then-pending congressional legislation “is going to kill us,” by blocking Sun’s ability to hire “the best talent in the world.” Yet Sun itself has boasted of, for example, hiring 50 programmers in Russia at “bargain prices,” according to the Los Angeles Times (November 15, 1993, and also July 15, 1996).

Falcon International, a General Dynamics subcontractor, even brazenly referred to the foreign-national employees as being highly attractive because they are “indentured” to the employer.24

Joseph Costello, CEO of Cadence Design Systems, a leading CAD software firm, has stated that when Cadence was considering setting up a development branch in India, a bullet item in a slide presentation on the proposal listed “salary savings” as an inducement for the move.25 Costello quickly added that he had rejected cost as a criterion. However, though he and two other Silicon Valley CEOs on the panel (Dado Banatao of S3 and Phil White of Informix) claimed that their only criterion for setting up foreign development branches was the existence of “pools of talent,” it certainly is no coincidence that the sites they chose were all in low-wage countries.

Salary is indeed a factor in the hiring of foreign nationals. This was even conceded by William Schroeder, chief executive officer at Diamond Multimedia Systems. According to the Wall Street Journal (October 9, 1995), “Mr. Schroeder says that since skilled people can demand a premium salary in the U.S., it is understandable that employers will seek lower-cost alternatives abroad.”

Microsoft CEO Bill Gates, who has been lobbying Congress to retain the ability to hire foreign nationals, is notorious for hating to pay high salaries. (See Microsoft Secrets: How the World’s Most Powerful Software Company Creates Technology, Shapes Markets, and Manages People, by Michael A. Cusumano and Richard W. Selby, 1995, and the Los Angeles Times, February 26, 1996.) In the past, he solved that problem by paying low salaries while offering stock options to compensate, but now that the Microsoft stock price has stabilized, this is not a solution. Wall Street Journal reporter G. Pascal Zachary, writing in the industry online trade journal Upside (“The Once and Future Microsoft.” April 1995), says that

These raw [Microsoft] recruits are grouing about the company’s thin stock packages and woeful starting salaries, which are as much as a quarter less than those offered by competitors. The low salaries are

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24 This statement was made in Falcon’s document, “Falcon International’s Proposal to Supply International Labor for General Dynamics’s Convair Division,” August 2, 1989. This document was used as an exhibit in the Department of Justice’s prosecution of General Dynamics, and was obtained under the Freedom of Information Act by SoftPac.

25 Panel discussion at a conference on immigration, Hoover Institution, Stanford University, October 18, 1996.
a perverse consequence of Microsoft’s obscenely high profits; it earns an extraordinary 25 cents on every dollar in revenue. But as Microsoft’s stock price stagnates and the chances of parlaying options into multimillions vastly diminishes, Gates is increasingly meeting his profit targets on the backs of his workers.

It is possible that this is the reason Gates now is so vociferous in demanding that Congress not reform laws under which foreign nationals are hired.

Gates is also famous for making his programmers work 80 hours a week or more (with no overtime pay), making his effective salary scale half of those of “normal” companies. According to Cusumano, in a recent year Microsoft made only one offer to 50 new Massachusetts Institute of Technology graduates who interviewed with the firm. In spite of Gates’ previous claim that his main criterion in hiring is “smart people” (a criterion which presumably most MIT graduates which satisfy), it would seem that what he really wants is people who convince the interviewers they are willing to work 80 hours per week without overtime pay.

TJ Rodgers, the CEO of chip manufacturer Cypress Semiconductor, has been quite outspoken in opposing tightening up the laws under which skilled foreign nationals can be hired. In early 1996, he stated that he has 230 positions which he could not fill, and thus must resort to hiring foreign nationals. In response to Rodgers’ statement, I received the following e-mail message. The sender has a BSEE and was just finishing his MSCS at the time he sent the message (March 1996). He was interviewing for jobs, and had several excellent offers in hand, mostly for hardware-design positions. He made the following remark about Cypress:

‘T.J. Rodgers’ company Cypress did not bother to interview me after my friend at Cypress submitted my resume’. If Rodgers claims he can’t fill 230 positions then I don’t have any sympathy for his company. If hiring managers don’t even bother to contact applicants—then it is the company’s unassertive recruiting that causes positions to stay open—not the status of the market. The federal government has the courtesy to respond to applicants in writing, unlike Cypress. The general impression is that applicants can only assume from Cypress is nonresponsive or nonhiring. After learning how my MSEE friend is compensated at Cypress, any market-wise person should be unsurprised that Cypress has difficulty filling positions.”

In an interview with the San Francisco Chronicle (March 7, 1996), Rodgers even claimed that he cannot find people to fill even his positions as administrative assistants, at high salaries. “Our choice would be to hire everyone from San Jose [where Cypress is located], but they are simply not available.” This of course is disingenuous; if Rodgers is indeed paying high salaries, he would be flooded with applications for jobs as administrative assistants if he were to cast his net wider than San Jose.

The employer’s sponsorship of a foreign national for a visa (either an immigrant visa or a temporary work visa) provides real leverage over the employee. For instance, as mentioned earlier, Falcon International, a General Dynamics subcontractor, even brazenly referred to the foreign-national employees as being highly attractive because they are “indentured” to the employer.

Falcon was referring to foreign nationals holding H-1B temporary work visas. For those who are sponsored by the employer for green cards, i.e. immigrant status, the situation is similar; the worker’s “indentured” status continues during the time the employee waits in the immigration queue, a process lasting as long as three years.

Industry claims of getting “the best and the brightest”—as opposed to the cheapest—ring hollow in light of an incident recounted by Mary Dumont, a Palo Alto attorney representing Californians for Population Stabilization in a lawsuit against Hewlett-Packard’s hiring of Indian engineers via the Tata Corporation. Dumont describes the judge’s questioning of a Hewlett-Packard representative. When the judge asked about the quality of the imported Indian workers relative to natives from, say, the nearby University of California at Berkeley, the Hewlett-Packard representative conceded that the UC graduates were better.
7.4 Immigration Policy As a Government Subsidy to Employers

Current policy on skilled immigration amounts to a monetary subsidy given to employers by the federal government, in several senses:

- Many employers pay lower wages to foreign nationals.
- Many employers save on salary costs by hiring young new (or recent) graduates. When they run out of young domestic workers, they turn to the young foreign workers.
- Hiring foreign workers saves employers the costs of retraining employees. When the employers run out of domestic workers having a specific skill set, they hire foreign nationals with these skills.

The employers themselves demanded this subsidy, when they pressured Congress to expand yearly quotas for skilled immigrants in the 1990 Immigration Act. This of course is richly ironic, given the outspoken free-marketeer views expressed by so many Silicon Valley employers.

8 Employer Motivation for Hiring Foreign Nationals: Overemphasis on Paper Credentials

Some employers, oblivious to the mountains of resume’s which they receive, will complain that they cannot find people to fill their open positions. The problem is that the employers are greatly overspecifying qualifications for the positions. As we will see here, in so doing the employers are not only making it harder to fill the positions, but also are harming the productivity of their companies; a worker’s raw analytical talents are much more important to productivity than the artificially specified job qualifications.

This overemphasis on paper credentials often leads to an employer hiring a foreign national, saying that an American could not be found with specialized skills, or graduate degrees, needed for the job. Our Ms. Yang cited earlier, for example, was hired ostensibly for her skills in the OS/2 operating system. This is often merely a pretext. Ms. Yang, for instance, says her skills in that area were actually superficial, and others with such skills were rejected if they held citizen or permanent resident status.

*Employer requirements that a worker have a graduate degree or specialized skills are unwarranted in the vast majority of cases.* For example, there are virtually no jobs in the computer industry which need a Master’s or Ph.D.

8.1 Unwarranted Emphasis on Graduate Training

One way to see that employers are usually unwarranted in claiming that their jobs require graduate training is to note that there is enormous variation in computer science graduate curricula from one school to another. In other words, there is no such thing, for instance, as “generic Master’s degree technical skills.” Thus a job ad which requires a generic Master’s degree cannot have any real meaning in terms of specific skills. While graduate study may provide one with a “culture” which enhances one’s general analytical abilities, a Master’s degree does not provide any specific technical knowledge needed for the vast majority of jobs in the field.

Indeed, many of the field’s most successful people do not even have a Bachelor’s degree in the computer area, let alone a graduate degree. Microsoft founder and CEO Bill Gates had no formal computer training, as is the case for Apple Computer co-founders Steve Jobs and Steve Wosniak. Lawrence Ellison, founder and CEO of the database software giant Oracle Corporation, does not have a Bachelor’s degree either.

John Gilmore, a self-taught programmer with no college education, was one of the key early software developers for Sun Microsystems, now an industry leader in computer workstations. Microsoft had also been heavily recruiting him at the time he joined Sun. *(San Francisco Examiner, August 17, 1995.)*

There are many similar cases among rank-and-file
A closeup view of the lack of need for graduate training in computer science may be obtained via *Showstopper!*, by *Wall Street Journal* reporter G. Pascal Zachary (The Free Press, 1995). The book is a chronicle of the development of Windows NT at Microsoft, one of the largest, most complex software projects ever undertaken in the industry. Very few of the major programmers described in the book have a graduate degree—or even an undergraduate degree—in computer science. It is worth listing the programmers whose background is given in the book (if not a U.S. native, this is noted):

Johanne Caron—Canadian-born, Master’s degree in computer science
David Cutler—Bachelor’s degree in engineering
Mitchell Duncan—Bachelor’s degree in electrical engineering
Moshe Dunie—Israeli-born, Bachelor’s degree in engineering
Mike Glass—“attended six colleges in nine years”
Patrick Haluptzok—Bachelor’s degree, hired “not because I knew how to program, which I didn’t, but because they believed in hiring smart people who’d then learn to program”
Jim Horne—Canadian-born, “a physics student who had taught himself programming”
Gary Kimura—Ph.D. in computer science
Mark Lucovsky—Bachelor’s degree, field not stated
Jonathan Manheim—college dropout
Paul Maritz—South African-born, no formal training in computer science

Again, note that these are Microsoft’s top programmers, working on Microsoft’s most innovative, most ambitious project. Yet most did not have graduate training in computer science. (Note too that most also were not immigrants.) Moreover, those who did have graduate degrees were doing the same work as those who lacked such degrees; their graduate degrees were incidental. Like Gates, many of these top programmers had no formal training in computer science at all.

New York University’s Alan Gottlieb, one of the field’s top researchers in computer hardware, comes from a mathematics background, not computer science. Though I have been a software developer in industry and later became a computer science professor and researcher, all my degrees are also in mathematics; I too have no formal training in computer science. And Ron Unz, the multi-millionaire software entrepreneur who praises the presence of foreign students in American computer science graduate programs, is himself a self-taught programmer.

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26The fact that so many good programmers are self-taught does not mean that universities should not offer undergraduate curricula in computer science. Instead, the point relevant to the discussion here is that whether a programmer is self-taught or has a formal degree in computer science, in either case he/she is using undergraduate-level skills. The vast majority of jobs in the industry do not use graduate-level material.
Another way to see this point is to look at employment of electrical engineers. During the 1980s software became dominant among jobs in the computer industry (e.g., see IEEE Spectrum, August 1993), so many graduates of electrical engineering programs took jobs as programmers. Yet most of them had very little formal training in software, typically only two or three beginning courses. Indeed, many of the foreign nationals hired and sponsored for immigration by American software developers also have electrical engineering degrees, with limited formal background in software.

Professor John Ousterhout of the Computer Science Division at the University of California at Berkeley has also stated that having a sharp mind is more important than having formal training.27

A programmer at a non-profit cancer research center notes, “The [foreign programmers] were originally hired because management was impressed with their MScS [Master’s in computer science] degrees and high GPA’s etc. It’s really all bunk…it doesn’t mean that they were any better…In eight years of work experience, I can’t say that they’re any better as a group than the citizen programmers.”

One manager in a well-known Silicon Valley firm once startled the immigrant programmers in his group by blurtng out, “You all have Master’s degrees, while I was a C student who only got a Bachelor’s degree. How come I have more insight than you do?”

The July 11, 1995 edition of the Wall Street Journal carried an article claiming that hiring foreign-national professionals is vital to the nation’s high-tech industries. The article’s central example was that of Symmetrix, an Austin, Texas designer of automated electronic test equipment, which has hired foreign students who complete American Master’s programs. Yet in an interview with the author (July 20, 1995), Symmetrix CEO Paul Hiller said, “A Master’s degree is not really needed. What counts most is the person himself; is he bright?”

I also interviewed Amit Kamra of Information Systems Transition Services in Dallas, who had placed an ad on the Internet for foreign programmers holding H-1B visas.28 Kamra said, “We don’t look much at education…A graduate degree won’t tell me that this person is an exceptional programmer. Education doesn’t tell me about this guy’s brain. Analytical ability is what counts, being able to do problem solving. It is not so much a matter of working hard as working smart.”

In a Stanford University panel discussion at a conference on immigration,29 CEO Dado Banatao of the PC graphics board firm S3 insisted that a Master’s degree is absolutely essential to his company’s work. When I asked him after the session whether this assertion extended to S3’s development branch in India, he said that it did. I replied that he should check this, but he said that he didn’t have to, and added, “I know my people.” And yet a check of the Indian branch’s World Wide Web job page showed that each of the technical jobs listed gave “BS or MS” as a requirement, that is, applications from workers holding only Bachelor’s degrees were welcome.

Another Stanford event which is interesting in this regard was the roundtable discussion organized by the Stanford Computer Industry Project (SCIP) on February 19, 1997, on employer needs in the current software labor market. SCIP had investigated the market widely, interviewing many computer-industry hiring managers, combing industry trade papers such as Computerworld for information, and so on. They assembled this information into a World Wide Web site for the participants (industry CEOs and managers, academics, venture capitalists, etc.) to peruse in preparation for the roundtable discussion. Entire assemblage of information of the industry’s needs in the labor market, there was quite a bit of material on employer desires to hire programmers with background in specific software technologies,30—but not even one mention of a “need” for graduate degrees.

As mentioned earlier, most of the jobs in the industry today are in software, not hardware. As pointed out earlier, one does not even need an undergrad-

28 August 24, 1995. By the way, Kamra explained that the only reason he had mentioned H-1B in the ad was that the firm had recently decided to expand their applicant pool to include H-1B’s. He emphasized that the company welcomes applications from qualified U.S. citizens and permanent residents.
29 Hoover Institution, October 18, 1996.
30 See Section 8.1 below.
ate degree, let alone graduate training, to be a good software designer. Chip design, on the other hand, does of course require a knowledge of electronic principles. However, once again, an undergraduate training in these principles is quite sufficient. Perry Lorenz, an electrical engineer at National Semiconductor Corp., is a good example of this. Lorenz has only a Bachelor’s degree, and before going to National Semiconductor, had no work experience designing chips. Yet he has become a top designer in the company. As in the case of software, Lorenz says that good hardware design is a matter of intellectual talent, not graduate training. He notes that his colleague Bob Widlar, who was such a phenomenal designer that when he retired National was said to have paid him not to work for anyone else, also had no graduate degree.

8.2 Unwarranted Emphasis on Specific Skills

Similar comments apply to refute employer claims (some of them pretexts, others sincere) that they need to hire people with background in specific software technologies, such as was the case with the aforementioned Ms. Yang’s familiarity with the OS/2 operating system. Any competent programmer can become productive in most software technologies quickly, say in a month or so. This is borne out by formal studies, as well as on my own experience in more than 25 years of adapting as the software field has evolved, and is the consensus of the many people whom I have talked to in the industry. A typical example is that Lawrence Richards of SoftPac, when given an assignment as a software contractor to learn Motif windows programming, became reasonably proficient in three weeks.

Ms. Yee, whom we have mentioned earlier, works for a well-known Silicon Valley software producer. There is a wide range of ability among the workers in her division, but in 1990 they all learned to program in Microsoft Windows within a month.

This point on the quickness with which new software technologies are learned can be seen in data on factors affecting completion time for software development projects, cited in one of the central works on software engineering, Software Engineering: Economics, by Barry Boehm (Prentice-Hall, 1981, p.530). Those data indicate that programmers reach perhaps 80% of their full productivity level by one month, and full productivity by the next time period studied, four months.

Amit Kamra, the head of Information Systems Transition Services mentioned earlier, said that the firm needed to hire foreign nationals in order to get people with needed experience in specific software technologies. Kamra said that the company could not afford to hire someone who would have to learn the given technology on the job, say Microsoft Windows programming. But when I asked him how long it would take for a good programmer to become productive in Windows if he/she did not know this technology beforehand, he answered, “[Up] to two weeks, maybe all the way up to a month and a half to become truly productive.” I asked why they did not hire such people, given the shortness of such time periods, to which Kamra replied, “Well, we could, and we did so once with good results [he then gave the details]...But well, during those two weeks [of learning] the project is slowed down a bit, especially since others on the project would have to help the new person."

It is interesting in this regard that when Rich Allen of Texas Instruments (TI) was interviewed for an article on the hiring of foreign nationals in the computer industry, with a possible implication being that TI hires foreign nationals instead of retraining existing workers, he emphasized that said that his company provides two to four weeks of training per year to employees—well within the one-month figure I am using as a guideline here for learning a new skill. And Allen’s figures were consistent with those for companies cited by Computerworld as being most willing to retrain existing employees (March 31, 1997).

Even software entrepreneur Tony Vickers (who subsequently became a spokesperson for the Information Technology Association of America, an industry lobbying organization), in testifying in support of the notion that the computer industry needs to hire large numbers of foreign nationals (Commission on Immigration Reform hearing, San Francisco, November 16, 1995), conceded that new software technologies

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31 Oakland Tribune, March 14, 1996.
can be acquired in a month or so.

Lawrence Richards of SoftPac, a former programmer, noted

Employers are also using the system to eliminate any costs to themselves involved in training. Their requirements for exact skill matches have reached absurd dimensions. For instance, rather than advertise for someone with knowledge of the database language SQL, they will insist on experience on a specific database package that uses that language. Thus someone experienced in Informix will be disqualified from a job programming in Oracle or Sybase, even though the differences among these packages may be minor and could be learned within a month. I, myself have two years experience programming in Motif, yet many employers will require a year or more experience in using PowerBuilder for a job, even though this program was designed to make it easier to generate Motif programs. This requirement for exact skill matches is also further evidence of the over-supply of software engineers.

From a national-interest point of view, it makes no sense for an employer to relegate an American worker to underemployment or unemployment, in “disposable” fashion, just to save a month.

Nor does it make sense to add an extra person to a surplus-plagued labor force, for a 30-year career (if the foreign national is sponsored for immigration), just to save a month. Mr. Peng, for instance, originally worked in Shanghai for a San Francisco-based American software company. The company found it difficult to direct his work from afar, so it sponsored him to immigrate to the U.S. Subsequently, though, the business failed, and he is now a permanent fixture in the labor market at large.

The point that what counts is talent, not background with specific software technologies, has been made most clearly by Bill Gates, CEO of Microsoft. Gates has stated that he prefers to hire sharp minds, not people with specific technical skills or advanced degrees. Asked by the *Wall Street Journal*, “What would be your profile of the ideal Microsoft recruit?”, Gates answered,

“We’re not looking for any specific knowledge because things change so fast, and it’s easy to learn stuff. You’ve got to have an excitement about software, a certain intelligence...It’s not the specific knowledge that counts.”

Interestingly Gates’ comment above directly clashes with a December 3, 1993 letter to DOL, in which Microsoft attorney Ira Rubinstein claimed that software industry employers hire foreign nationals because there are “too few Americans with advanced or even undergraduate degrees in science and engineering, or because [the foreign workers have specific skills needed for the industry] to remain technologically competitive.”

Indeed, Gates’ comment also clashes with his own words later on, when the issue of hiring foreign nationals became a major topic of congressional interest in 1995: Gates and other computer industry executives wrote a letter on September 12 to Congress, saying, “The continual emergence of new technologies creates shortages of, and worldwide competition for, specialized engineers who are trained to implement those technologies.”

The fact is that Gates’ original remarks—“We’re not looking for any specific knowledge because things change so fast, and it’s easy to learn stuff”—were the ones that accurately described Gates’ philosophy. Indeed, Jim McCarthy, one of Gates’ software development managers at Microsoft, points out in his book, *Dynamics of Software Development* (Microsoft Press, 1995, p.168),

The biggest mistake I see managers make as they hire people for software development teams is that they overvalue a particular technology. To verify this tendency, all you have to do is look at the want ads: ‘Wanted: foobar programmers. Experience with whatsit required.’ Obviously, conversance with a given technology is a

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wonderful attribute in a candidate, but in the final analysis it’s an extra, not mandatory. After all, most software development technologies have a half-life of about one year.

Industry analyst Michael Cusumano writes that “academic researchers and practitioners alike...[believe that] writing software is and may forever remain more like an art or craft,” as opposed to a technical skill which can be taught. Again, having “smart people” is what counts.

Gil Amelio is the former CEO of National Semiconductor, who in 1996 was hired to “rescue” Apple Computer. He has written a book on management of high-tech firms, Profit from Experience (with William Simon, Von Nostrand Reinhold, 1996). In listing hiring criteria, he gives first priority to Strong Personal/Ethical Qualities, and second priority to Brightness (pp.71-72). For the latter, Amelio says, “This is not a question of education but of native abilities...natural curiosity, inquisitiveness, the ability to catch on quickly.” He then brings up Experience as a (relative non-)criterion, saying, “This is the first thing most people look for—which may be one of the chief reasons so many get hired who don’t work out.”

And Gates’ point that one can learn the new technology on the job, during the given project, is illustrated further in the remarks made by the aforementioned Paul Hiller, the Symmetrix CEO featured in the Wall Street Journal article on industry hiring of foreign nationals. Hiller told the author that he too had to train the foreign nationals whom he had hired.

Some in the computer industry claim that they hire foreign nationals because American universities are not giving the proper training to their computer science and engineering students, whereas foreign universities do train their students well. (See for example TJ Rodgers, CEO of Cypress Semiconductor, CNN interview, September 14, 1995, and Lance Nagel, industry representative, presentation to the U.S. Commission on Immigration Reform, November 16, 1995.) Such a claim is immediately seen to be absurd, when it is noted that the schools in Asia from which the foreign students graduate almost universally use American textbooks. Moreover, the claim does not jibe with the industry’s actions. In all my years of teaching computer science at UC Davis (starting in 1980), no one from industry has ever complained about our curriculum; on the contrary, in our well-attended annual Industrial Affiliates Conference, industry people have been very positive about our programs. Professor Edward Feigenbaum of the Stanford University Computer Science Department and an expert on the Japanese computer industry says, “Few if any authoritative Japanese are satisfied with the quality of the computer science and information science departments at Japan’s universities. In the United States, I have never heard a single software industry executive claim to be unhappy with the output of the computer science departments of U.S. universities.” (The Future of Software, ed. by Derek Leebaert, MIT Press, 1995, p.222.)

In discussing the issue that talent is far more important than paper credentials, perhaps the most telling evidence of all comes from studies of programmer productivity. A good account of this is given, for example, in Peopleware: Productive Projects and Teams, by Tom DeMarco and Timothy Lister (Dorset House Publishing Co., 1987, pp.44ff). These studies show a dramatic 10-to-1 variation in programmer productivity, by virtually any criterion—time to finish a product, number of errors, and so on. In other words, the best programmers work 10 times faster, produce 10 times fewer errors, and so on, than the worst ones.34 In other words, once again raw analytical talent, not paper credentials, is what really counts.

Edward Yourdon makes this point again and again. (The Decline and Fall of the American Programmer, Prentice-Hall, 1993, p.54.) For example, he quotes one software manager: “The most important ingredient...is hiring smart people...Very little else matters in my opinion.”

And good managers do know how to identify the smart people. The book by Microsoft manager Jim McCarthy cited above has some excellent material on how to do this (pp.166-168). So does the DeMarco and Lister reference.

34The ratio of the best to the median is 2.5, as is the ratio of the above-median programmers to the below-median ones.
8.3 The Pernicious Effects of Automated Resume’ Scanning

One little-known consequence of the labor surplus in the industry is that many employers now receive so many resume’s that they can now afford to indulge in the ultimate in lazy hiring—many now use machines which automatically scan resume’s for desired key words.

An article in the October 1996 edition of the IEEE’s newsletter, The Institute, describes the problem well:

...job descriptions are becoming much more specific, driven by keywords instead of human contact.

“In the past, recruiters would talk to people individually and have a better idea what was going on, and could often convince a company to hire an engineer and bring them up to speed,” [industry analyst] Erickson, said. “The situation now is a recruiter plugging in words on a search engine and coming up with people.”

Mike, a hiring manager at Cadence Design Systems, told me in the fall of 1995 that he could not fill several open positions. He said that although he had specified skill sets for these jobs, he would be happy to be more flexible. However, he was not even getting any resume’s from Human Resources, which was automatically rejecting any resume’ that was not a perfect match.

In what amounts to a 1990s variation on What Color Is Your Parachute?, an article in the San Jose Mercury News, May 17, 1995, was even devoted to advising job seekers as to which typefonts to use in their resume’s, in order to maximize machine readability.

As DeMarco and Lister show, talent is the overriding factor in productivity. Thus resume’-scanning, by screening for extraneous factors such as Master’s degrees or specialized skills instead of screening on talent, is resulting in a situation in which employers are often not hiring the best workers available.

8.4 Effects on Salaries

As noted earlier, overemphasis on paper credentials is one of the reasons for the large variation in salaries in the field. The pool of programmers satisfying the many conditions in a job ad is of course small, thus raising salaries for those within that narrow pool, while at the same time reducing wages and employment opportunities for those not in such a pool.

By insisting on hiring, say, a programmer who has experience with TCP/IP network protocols, C++ programming and Motif windows—and again, we showed earlier why this is unreasonable and indeed harmful to the industry—an employer is looking at such a narrow pool that he of course must pay a premium salary.

This in turn leads to further hiring of cheaper foreign nationals. As noted earlier, according to the Wall Street Journal (October 9, 1995), “[Diamond Multimedia Systems CEO William] Schroeder says that since skilled people can demand a premium salary in the U.S., it is understandable that employers will seek lower-cost alternatives abroad.”

9 Employer Motivation for Hiring Foreign Nationals: Ethnicity-Based Networked Hiring Among Immigrants

Other factors also work to produce the high proportion of immigrants in the industry, such as network hiring within an ethnic group. This has often been cited by immigration economists in analyses of low-skilled labor markets, but it arises with high-tech jobs as well. One often sees Silicon Valley companies in which certain divisions are almost entirely Chinese. Many Chinese engineers in the Silicon Valley will spend the majority of a typical day speaking Mandarin, not English.

At the company where Ms. Yee works, for instance, most of the software engineers in her division are Chinese immigrants from Taiwan. Most hiring is done via word of mouth, so the Chinese immigrant social network ensures that the group will continue to be Chinese, with non-Chinese not even being aware
of openings. This mirrors *La Opinion* labor writer Richard Rothstein’s finding at the low-skilled level that “Once such powerful networks are established, policy is impotent to break them.”

Ms. Yee admits that she herself has been a beneficiary of this practice. Both in the case of this company and of the company at which she worked previously, she secured her job through the Chinese social network.

The company may be the loser in this process. The one time that Ms. Yee did suggest a U.S. native, Mr. Smith, for a position in the group, Smith was deemed below-standard by all the Chinese who interviewed him. Ironically, the day was saved for Smith by another immigrant, this one from India, who was impressed by him and insisted that he be hired. Smith has turned out to be a star, one of the top few engineers in the Silicon Valley branch of the company.

Melanie Erasmus points out that “at Cadence Design Systems, a software company, foreign-born Chinese-American engineers may represent as many as 80 percent of the technical staff.”

The practice of ethnic-network hiring has become so refined that the Chinese Software Professionals Organization even holds its own job fairs in Silicon Valley, separate from the ones given by Westech.

In small or medium-sized companies run by immigrants, it is common to find that virtually the entire technical staff, and even top managers, consists of immigrants of the same ethnicity as the boss. For example, Everex, one of the companies immigration advocate Ron Unz has cited as founded by immigrants—Steve Hui, the founder, is from Hong Kong—had (prior to going into Chapter 11 status) virtually all of its technical staff comprised of immigrants from Hong Kong and the neighboring Cantonese-speaking area in southern China. Pauline Lo Alker, herself a Chinese immigrant and Silicon Valley CEO, notes that “There is a high tendency to surround themselves with people they are comfortable with.” (*New York Times*, January 14, 1992.)

It is common knowledge that those of other ethnicities (including immigrants of other nationalities) need not apply. *This is important, as a large portion of employer-sponsored green cards come from the smaller and medium-sized companies.*

On July 19, 1995 I interviewed Isaiah Choo, manager of the El Cerrito Computer Company (San Francisco Bay Area), whose classified ad for a software engineer I had seen in the July 15 edition of the Chinese-language *Sing Tao Daily*. When I asked in which newspapers Choo had placed an ad, he replied that the only other paper was also Chinese-language, the *World Journal*. He admitted, “Yes, we are looking for a Chinese programmer...No, it is not because of language. We don’t care what language the programmer speaks as long as they get along. Well, I’m just following the instructions of the Taiwanese owner.”

On August 22, 1995, Xin Ye of New Era Technologies posted a programming job advertisement in soc.culture.china, a newsgroup on the Internet read by many students from China studying at U.S. universities. But the ad was not posted to the newsgroup read by the general public for job postings, misc.jobs.offered (most of whose job listings are for positions as programmers); apparently Xin Ye too wanted to hire only a “Chinese programmer.”

But even more importantly, Xin Ye’s ad shows that the company especially targets foreign students who are seeking an employer to sponsor them for immigration: “If you have just graduated from school but think you can be a quick learner or have significant coding experience in school, we would be glad to...

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35 *Dissent*, Fall 1993. By the way, though Silicon Valley networking does of course occur with other ethnicities than the Chinese, it is interesting that UCLA sociologist Roger Waldinger has in his study of low-skilled workers in New York also found networking to be particularly prevalent among the Chinese. (*New York Newsday*, June 26, 1995.)


37 In many California elementary and high schools, Chinese immigrant parents have even set up their own Chinese Parent-Teacher Associations (PTAs). In other words, a given school will have both a Chinese PTA and a mainstream PTA.

38 *Sing Tao* and *World Journal* are the two widest-circulation Chinese-language newspapers in the U.S.

39 Limiting a job ad to Chinese newspapers is only one of many ways to subvert the DOL/INS requirement that a job be advertised. For example, the *Kansas City Star* (July 16, 1995) reports “...many Americans may never even see the ads. Michele Buttelman, an advertising executive with the *Los Angeles Times*, said some employers on the West Coast often camouflage the advertisements by having them placed under the wrong heading in the newspaper or published on holidays.”
consider your experience. We hope you have [a] temporary working visa (practical training, H-1B temporary visa) so you can start with [the] project. We’ll take care of the visa issue after a short period of service.”

Note that this company is quite willing to take a new graduate with no paper credentials. But if this company follows the typical pattern for the industry for sponsoring foreign nationals for green cards, the company will hire the person first as an H-1B and then later when applying for a green card for him/her will claim to the INS that this employee has “unique qualifications which American applicants lacked”—referring to skills the employee acquired from the employer during that “short period of service”!

A Ph.D. dissertation by Edward Jang-Woo Park\(^40\) has some rather detailed analyses of the role of ethnic-network hiring in Silicon Valley. (It should be noted that Park’s focus tends to be more on manufacturing jobs than in engineering, but the situation is similar.) Here are some excerpts:

> [Page 90:]...in 1984 National Semiconductor employed 2,000 Filipino manufacturing workers...In the same year, 4,000 Vietnamese workers dominated the manufacturing force at Hewlett-Packard. Other large firms have similar patterns of ethnic concentration...such as Advanced Micro Devices (Filipinos), Televideo (Koreans) and Intel (Southeast Asians)...

> [Page 93:]...After being told to “hire mostly Koreans,” she has advertised job openings in the [Caucasian-owned] firm only through the San Francisco edition of the Korea Times...

> [Page 162:]...Ken [a CEO] feels “rather embarrassed to admit that with the exception of two administrative assistants (both are white women), all of the employees of MCS are not just Chinese, but Cantonese...

The Chinese Software Professionals Organization

\(^{40}\)Asian Americans in Silicon Valley: Race and Ethnicity in the Postindustrial Economy, Department of Ethnic Studies, UC Berkeley, 1992.

10 Employer Motivation for Hiring Foreign Nationals: Miscellaneous

In recent years a few major employers have begun to cite a new reason for hiring foreign nationals. They say that in order to produce software for foreign markets, they need to have workers who are familiar with the cultures in those countries. One industry lobbyist, speaking on background, said, “Say we are producing software for China. We need a native of China, in order to know how to design the icons [cute pictures on the screen, on which the user clicks the mouse] appropriately in a Chinese cultural context.” But only a small portion of the foreign nationals being hired work on international software, and if a company needs cultural advice on icons, they can hire a native of the culture for an hour or two of consultation.

When hiring of foreign nationals became a major issue with Congress in 1995, computer industry employers claimed that they hired the foreign nationals because they need to hire personnel for a project immediately, because project delays are quite costly and risk the company’s losing market share. (Electronic Engineering Times, October 2, 1995.) Yet at the same time they stated that most of the foreign nationals they hire are foreign students who have recently graduated from American universities. These two claims are starkly at odds with each other: Typically hiring of a student is done in the middle of the student’s final semester before graduation, so the employer needs to wait a couple of months before the foreign national starts work. Thus, the employer is not hiring the foreign national to begin work “immediately” as claimed.

Moreover, during those months, an existing domestic worker could learn the given technology instead, as shown in Section 8.1. Furthermore, what is most crucial in avoiding delays in completing a project is to hire smart people; after the smart person picks up the necessary technology, he/she will be the one who
best insures timely completion of the project, while the dullard who is experienced in the given technology will actually retard progress in the project (this too is documented in Section 8.1).

11 Impact on Mid-Career Engineers and Programmers

11.1 Those Over 30 Need Not Apply

Traditionally, in choosing a technical profession such as computers or engineering, one looked forward to a lifetime of learning new technologies. Today’s computer industry is not allowing its professionals this opportunity.

During the lobbying in which the computer industry engaged in 1995 and 1996, they admitted to a policy which is tantamount to rampant age discrimination. For example, here is an excerpt from “Immigration Issue Divides US Computer Industry,” IEEE Computer, February 1996:

[Intel human resources policy manager Eva Jack told Computerworld magazine that] computer technologies become obsolete so quickly that often only recent university graduates, many of whom are foreign nationals, possess needed skills.

The aforementioned Rich Allen of Texas Instruments described engineering technologies as changing so fast that skills have a “half life” of only three years.

Lars Poulsen, head of RNS, a network router firm in Santa Barbara, said that he aims for a median length of experience of five to seven years among his engineers. (Interview with the author, June 24, 1996.)

This trend was even noticed in the March 29, 1997 issue of The Economist, with a statement similar to Intel’s:

Age and experience, which elsewhere get people promoted, are no help in the [Silicon Valley]; on the contrary, there is a distinct bias in favour of youth. Nowadays the average software-engineering qualification becomes obsolete in around five years, so a student fresh out of college may be more valuable to a company than a 40-year-old.

FACE Intel (Former and Current Employees of Intel) states that

...until late 1996 70% of all new hires were required to be New College Graduates (NCG). While the older or disabled employees were being targeted and terminated, the majority being hired were younger and less costly. After our complaints were filed and reviewed by Intel, the new target, we believe, was reduced to 50%. Incidentally, the acronym NCG has been replaced by RCG i.e. Recent College Graduate!!!!!

How did we begin all this? On May 22, 1996 at the annual Intel stockholders meeting, we asked Intel executives at the meeting why a majority of FACEI (AXEI at the time) members were over the age of 40. And why Intel is trying to increase profitability at the expense of the older employees by a mandated 70% of new hires being NCG’s...

Craig Barrett, Intel’s Chief Operating Officer, replied to the downsizing question with, “The half-life of an engineer, software, hardware engineer is only a few years...” One can infer by his remarks that those employees who were perceived as beyond the “useful life” at Intel have been targeted for termination. This example shows the philosophy held by Intel’s executive staff per our opinion.

Silicon Valley employment agent Maryann Rousseau noted, “We’re taking many more new graduates, because of the low salary...”

A hiring manager in a Silicon Valley firm is a former UC Davis student and was unusually frank in my conversation with him on this topic:

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41 Interview with the author, July 1, 1996.
Well, I want to state that this is in my opinion not a good policy, but the top management in our company has directed us to focus our hiring on new or recent graduates only. These are people who have no family and can work long hours. Yes, salary is a major factor; that’s what it boils down to. You work the young ones for five years and then replace them. I have objected to this, because I believe that many of our projects are being hurt by the fact that everyone is so inexperienced.

(Having programmers work long hours is another way employers save money. A programmer who works 60 hours per week is in effect doing the work of 1.5 people for one person’s salary.)

The impact of these statements on continued employment prospects for engineers and programmers is grave: In earlier sections, we have stressed that talent, not specific skills, should be the prime criterion for employment, and that employers are hurting themselves with policies which place undue emphasis on highly-specific skills. Thus there is no technical basis for comments like that of Eva Jack, and Jack’s comment amounts to an admission of rampant age discrimination in the industry. This in turn raises extremely serious societal concerns. One must ask, given this policy of the industry, what possible incentive would young people have to go into the computer field? Several of my undergraduate computer science students have mentioned to me that their parents had been laid off from engineering jobs, and that they were wondering if they should continue to major in a high-tech field.

The “bottom line” once again centers on salary. Every employment agent and technical recruiter I interviewed mentioned that mid-career people are generally unattractive due to their high salaries. As I have pointed out before, new graduates are attractive because they are cheaper, with new foreign-national graduates being the cheapest of all. Even sincere employers who pay foreign nationals the same wages as domestics will save money by hiring new graduates, and when they run out of domestic new graduates they will turn to new foreign-national graduates instead of to mid-career domestics.

Ms. Yee, a mid-career worker whom we described earlier, does have a job but when she looked for another one with a shorter commute, a number of employers told her that they are concentrating on hiring people with three years of experience or less. This of course echoes the comment of Sharon Gadberry, president of Transitions Management/Outplacement National, who noted that job ads will specify “five years of experience—they usually mean no more than that...Companies are trying to screen out the older workers [often to save on salary].”

An IEEE survey found that job security to be a major concern among its members, with 84% citing this as either “important” or “very important.”

Another mid-career engineer notes:

If a programmer with 15-20 years experience is laid off, he is usually in trouble. (I should point out that this has never happened to me, but I have seen it happen over the years to others)...Per company policy, they will typically get a raise of 4% a year which can put them at the high end of their salary grade after a few years, definitely by the time they reach mid-career...As it is easy to hire people with 1-5 years experience at a lower salary, these mid-career engineers are very vulnerable.”

Prominent software development guru Edward Yourdon comments, “...a lot of [mid-career] programmers have disappeared—I’ve visited organizations that used to have 100 software people developing and maintaining software for mainframe systems, and then returned two years later to find that the staff had been reduced to a dozen younger and less expensive people.” (The Rise and Resurrection of the American Programmer, Yourdon Press, Prentice-Hall, 1996, p.10.) He then notes (p.11) that a major trend (in the computer applications realm) has been to replace mid-career workers with “cheap, young C++ programmers.”

The difficulties mid-career programmers face in seeking employment have led to the publication of self-help books such as:

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43Ms. Gadberry was quoted in the San Jose Mercury News, September 4, 1995.
It is significant that Simon has two such books in this list. In the preface to the second book, he explains that at the time he wrote the first one,

...even though a great deal of material about surviving and thriving in the turbulent times of the early 1990s was included, the emphasis on career rejuvenation had not been present (perhaps because as bad as things were beginning to get with respect to career prospects in the 1990-1991 time frame when I was writing that book, things have gotten a whole lot worse since then).

The foreign nationals, who are today hired and sponsored for immigration because of their “special skills,” will typically suffer the same fate. The same skills that they are now hired for originally will be obsolete several years from now, and these foreign-born-but-now-naturalized-American workers will find it hard to get work in the industry.

In other words, industry employers, both those who want to save money and those who sincerely believe that specific skills are needed, are operating a Ponzi scheme, luring more and more workers who will be used for a few years and then discarded, producing an ever-worsening labor surplus of both native and foreign-born workers, who are underemployed at best, and in many cases unemployed.

Clearly, the employers’ desire to hire younger, cheaper workers is a problem in its own right, separate from the question of hiring foreign nationals.

But if the foreign nationals were not available for hire, the employers would be forced to turn to the mid-career workers they are now shunting aside. As Kim Lee, of the Network Connections employment agency in the Silicon Valley remarked to me on June 26, 1996, “In 1988 the employers would have retrained [mid-career] people but they’re not desperate enough to do so today”; clearly the availability of foreign workers is making it easy to ignore the experienced domestic workers.

11.2 The Myth of Retraining for Mid-Career Professionals

For the most part, industry employers are not providing retraining, and are not hiring mid-career professionals even if they get retrained on their own.

11.2.1 Most Employers Are Not Willing to Retrain

After Senator Alan Simpson introduced his 1995 bill to tighten up our policy on high-tech hiring of foreign nationals, and Secretary of Labor Robert Reich stated that the problem was that employers are not retraining existing professionals, industry officials protested that they do spend vast sums of money on retraining. For instance, Rich Allen of Texas Instruments said that his company provides 40 to 80 hours of training per year to employees.\(^44\)

However, most employers are not providing retraining for many of their programmers. The highest estimate I have seen of the percentage of computer programmers whose employers provide retraining is 20 to 25% (Computerworld Salary and Job Satisfaction Survey, reprinted from Computerworld, May 27 and September 2, 1996.)

And even these figures are for existing employees. Almost no employers are willing to hire a programmer and allow him/her to retrain on the job.

Recall, for instance, employment agent Kim Lee’s statement above: “In 1988 the employers would have retrained [mid-career] people but they’re not desperate enough to do so today.” The point was made quite

\(^{44}\)Oakland Tribune, March 14, 1996.
forcefully by Susan Miller, a computer industry employment agent who says that 90% of the workers she places are foreign nationals. (Interview with the author, June 26, 1996.) Pointing out frankly that her own high income as an employment agent depends largely on the fact that the industry is not providing retraining for existing employees, she nevertheless feels that

It’s a very closed industry in that respect [retraining]. The trap the industry falls into is that they don’t spend time retraining. It would be much more cost-effective for them to retrain the employees they already have; by not retraining they are driving salaries way up, since so few people have the “right” skill sets. The employers haven’t been smart. They have been very closed-minded, with blinders. If I could change one thing about the industry, that would be it.

Andrew Gaynor, another employment agent, called the industry “very short-sighted” in this regard.45

Days after a lobbyist for a major Silicon Valley electronics firm had told national media about the large sums of money the firm spends annually on training, I discussed this with a high-level official in the company. Speaking to me on background, he at first repeated the large figures his firm spends on training. Yet, when pressed he conceded that the company mainly provides training for its technicians, not its engineers or programmers.

One of the rare training programs for laid-off engineers attracted 15 times more applicants than the program could accept (San Jose Mercury News, January 9, 1996), even though the program had had no advertising at all. (Personal communication from Jay Pinson.) Clearly, this would not be occurring if employers themselves were providing retraining.

Some employers protest, quite correctly, that if they do provide retraining to an employee, after completing the skills upgrade, the employee will leave the job in favor of another employer who will offer a higher salary. But this again is due to the fact that employers are willing to pay such a premium for background in special skills in the first place—a premium which is, as I have said, unwarranted. (Section 8.1.)

11.2.2 Catch-22 for Workers Who Retrain on Their Own

Stuart Anderson, an analyst with the libertarian Cato Institute (which supports open borders, completely free immigration), has written a study in support of industry employers. He believes that the problems of mid-career professionals in finding work in the industry are the workers’ own fault, saying “It’s up to the American worker to make himself marketable to the industry.” (Oakland Tribune, March 14, 1996.) Yet this is diametrically opposite of reality:

In general, one cannot simply take a class and then be attractive to employers, who want actual work experience in the technology. For instance, a June 3, 1996 article in the Washington Post noted that a “hot” programming language now is C++. Courses in this language are available at any community college, but most employers would not even consider hiring someone on that basis.46 Maryann Rousseau, also a computer industry employment agent, noted47 “Taking a course is just not going to work for a senior person, given his salary.”

For that matter, a course is not needed for learning purposes anyway. A worker could learn to program in C++ on his own, practicing on his own PC at home, but again, in the case of senior job applicants, employers will insist on actual work experience with that technology. This worker’s application for a job requiring C++ skills would be rejected out of hand.

In other words, for established programmers, the only way to upgrade one’s skills is job experience, which produces the classic “Catch-22” problem de-

45Interview with the author, July 1, 1996.
46The Washington Post article cited above describes the situation of Kim Mackey, who “was frustrated by her [high-tech] employers’ reluctance to give her more opportunities to [use her new programming skills acquired at a local college]...‘I don’t think it’s so much a shortage of people,’ Mackey said. ‘The industry needs to start looking from within.’” Mackey’s situation is of course different, but it does illustrate the point that self-retraining will usually not get one a job in this field.
47Interview with the author, July 1, 1996.
scribe in the San Jose Mercury News:48

Eric Montague, is a 44 year-old software engineer...A programmer since 1978, most of his experience has been on giant main-frame computers made by Tandem Corp. But most jobs these days involve programming in other languages, used on workstations and personal computers. Without experience in those languages, Montague can’t get a contracting job. Without a job, he can’t get experience.

One possible strategy for mid-career programmers is to try to join projects at one’s current place of work which employ newer software technologies. But clearly this involves quite a bit of luck. First, one must be in the right place at the right time: Your employer starts such a new project, and you have just finished an old project (using old technology) and thus are free to work on the new one. Moreover, even such a fortuitous combination of circumstances may well not suffice, as Alan Simon describes well in his book mentioned earlier, Downsized But Not Out: How to Get Your Next Computer Job:

[You can volunteer] for new pilot development programs—ones which utilize newer, more interesting (and more marketable in terms of your skills base) technology—but...it’s more likely that the new kids in town, perhaps new college graduates, [will be] assigned to these high-profile efforts, even though they probably earn significantly less money at present than you...

Some employment agents whom I interviewed stated that the only possible strategy for mid-career workers would be to make frequent job changes. Say a programmer is currently using a technology X which is beginning to lose its marketability, but wishes to acquire skills in a new technology Y. Under this strategy, he would try to find a job which uses both X and Y. He will then hope that he is lucky enough that (a) such a job exists, and (b) the number of applicants who know both X and Y is small enough that the employer will be willing to allow him to learn Y on the job.

Such a strategy is certainly worth a try, but it is fraught with problems. Andrew Gaynor, the employment agent cited earlier, finds that “If you get an 80% [skill-set] fit, you probably hire the person, but not if it’s 50% or 60%.”49 Moreover, such a strategy would have to be employed about every two years or so to keep up with technology changes, so there are limits to how many times the strategy could be employed. The programmer, because of salary increases, becomes less and less attractive to employers relative to new graduates. Worse, employment agent Maryann Rousseau noted, “The current [1996] job market [in which many jobs are available for those with desirable skill sets] will go away in two years, and there will be layoffs. Then someone who frequently changed jobs in the past will be considered a job hopper and thus unattractive.”

12 Quality of the Immigrant Professionals: Generally Mediocre

Industry lobbyists opposing congressional reform proposals in 1995 claimed that the foreign nationals they hire are the world’s “best and brightest.” However, this is generally not the case at all. The actual situation is as follows:

A small proportion of the immigrant programmers and engineers have indeed been of exceptionally high talent. We should indeed “roll out the red carpet” for such people, putting their immigration procedures on a fast track. I personally have urged employers (including my own department at UC Davis) to hire a number of exceptionally talented computer scientists from China, India and so on.

But in general, the immigrant computer professionals have been of average technical ability at best. In fact, many have been of well below-average quality. These low-quality individuals have actually harmed the industry.

48February 17, 1997.

49Interview with the author, July 1, 1996.
Since the industry lobbyists have made quality a central issue in their efforts to oppose congressional reform proposals, I will address this issue in substantial detail, with two main points:

(a) The vast majority of major technical advances in the computer field have been made by U.S. natives, not immigrants.

(b) A disproportionate number of the immigrant programmers have been technically weak, adversely impacting the productivity of their employers.

In other words, not only has immigration not been key to the industry’s technical advancement [item (a) above], but arguably the overly-casual hiring of foreign nationals has actually hurt the industry [item (b)].

12.1 The Industry’s Major Technological Innovations Have Not Come from Immigrants

It is true that a few immigrant computer professionals have achieved prominence in their fields. For instance, An Wang, founder of Wang Laboratories, was a major contributor to early core memory technology. Again, our nation benefits greatly when employers bring truly exceptional foreign talents to the U.S., and this should be continued. But it is incorrect to attribute the major technological advances of the industry to immigrants. The vast majority of such advances have been made by U.S. natives.

This can be seen in rough form, for example, in the awards given for industrial innovation by the Association for Computing Machinery (ACM), the nation’s main computer science professional society. Of the 39 recipients of the ACM Software System Awards, only one has been an immigrant. Of the 17 recipients of the Eckert-Mauchly Award, given for advances in computer hardware, none has been an immigrant. In other words, of the 56 top innovators in the computer industry (as viewed by the ACM), only one is an immigrant.

There is of course some degree of subjectivity in these awards. But the same pattern is exhibited repeatedly in the awards given by numerous organizations: in 17 pages of awards listed in the Computer Industry 1994-95 Almanac, the vast majority of recipients are U.S. natives. For example, of 115 U.S. recipients of computer-related IEEE awards, only nine have been immigrants.

Similarly, one can consider the names mentioned in the index of Michael Malone’s The Microprocessor: A Biography (Springer-Verlag, 1995), a history of the computer chip industry. Excluding people in functions such as marketing, i.e. restricting attention only to engineers and scientists, there are 89 names. Of these, only 10 are immigrants (though another five live abroad).

I also conducted an informal poll among computer science and electrical engineering faculty at UC Davis. Interestingly, nearly half of those UCD faculty who chose to respond are themselves foreign-born. Yet of the 29 people in the U.S. they listed as top innovators, only two are immigrants.51

A Wall Street Journal article (March 13, 1996) quotes Scott Brown of Novell on foreign programmers (whom he manages overseas): “[They] are very competent and work extremely hard, but they’re missing some creative zest that’s difficult to capture.”

After hearing industry lobbyists emphasize that they hire foreign nationals in order to get the world’s “best and brightest,” many people are quite surprised by the award statistics presented above. Given that about one-third of Silicon Valley engineers and programmers are foreign-born, for instance, how could there be so few top innovators among them? The answer to this question turns out to be cultural: Most of the immigrants in the Silicon Valley are from East Asian cultures which emphasize rote-memory learning, which stifles creativity. In Appendix 16 I discuss

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50By E. and K. Julliussen, pub. by Computer Industry Almanac, Inc., Glenbrook, NV.

51It has been suggested that numbers of patents might be good measures of immigrant engineering talent. But patents in the computer field are generally awarded to members of a project. The main participants in the project will have their names on the patent, even if the basic ideas stemmed mainly from only one person. Thus holding a patent is often a matter of “being in the right place at the right time,” rather than being indicative of the holder’s having special talent. Accordingly, the proportion of immigrant patent holders roughly mirrors—though is still less than—the proportion of immigrant engineers in the field.
the details of this, so that the relative lack of immigrants in the innovation awards lists will make sense.

12.2 Many Have Been of Poor Quality

Many of the immigrant programmers in the U.S. are not only not of top quality, but actually weaker than average. Even Arthur Hu, a Chinese-American programmer and former columnist for *Asian Week* who bitterly opposes congressional efforts to tighten up conditions under which computer industry employers can hire foreign nationals, has conceded this point. Hu has stated in the Center for Immigration Studies electronic discussion group IMPOLICY that “[the immigrant programmers are] not as bright as the best Americans,” and that “In my experience, people from Taiwan and India who make less and get worse jobs simply aren’t as good [as their American coworkers].” (November 29 and 30, 1995.)

Recall that a Hewlett-Packard representative admitted under oath in a court proceeding that the Indian programmers he was importing were not as good as those from, say, the nearby University of California at Berkeley.

Again, there are cultural reasons for this weakness, discussed at length in Appendix 16.

One might naively presume that the weak people hired (whether immigrant or native) would soon be discovered, after they actually began work, and be forced out of the industry. On the contrary, many are actually entrenched in the industry, if they have the skill set which is currently popular, for three reasons:

First, due to a fear of lawsuits Silicon Valley employers will almost never fire a programmer for poor performance.\(^{52}\) Similarly, when one employer asks a job applicant for a reference, the employer will not insist that the reference be the applicant’s supervisor. Thus many applicants will use friendly co-workers as references. In addition, again because of fear of lawsuits, many employers simply refuse to act as a reference, other than confirming dates of employment.

Second, the phenomenon of networked hiring works to keep the weak immigrant workers employable as well, if they are of an ethnicity which has an active social network.

One might also think that an applicant who has the “right” paper credentials but who is weak intellectually will be exposed during the resulting interview, but in practice it does not work out this way. As noted by DeMarco and Lister in the *Peopleware* reference cited earlier, “It would be ludicrous to think of hiring a juggler without first seeing him perform. That’s just common sense. Yet when you set out to hire an engineer or a designer or a programmer or a group manager, the rules of common sense are suspended. You don’t ask to see a design or a program or anything. In fact, the interview is just talk.”

In recent years many employers have taken to testing applicants during an interview (this was considered gauche in the past), but even then the questions tend to be superficial, as a real test of understanding would involve having the applicant work on a real problem (i.e. “perform,” using the juggler metaphor) for a day or two, which of course is infeasible.

As a result, if a weak programmer has the right combination of specific skills demanded by an employer for a given job, he/she is apt to be hired. *In short, the main factor which determines a mid-career programmer employability is his skill set, not his talent.*

*Employers who hire weak people (again, whether immigrant or native) primarily because they have experience in the desired skill set are shooting themselves in the foot.* In another DeMarco book, *Controlling Software Projects*, the author says,

\[^{52}\text{This is true nationally too. See *The Decline and Fall of the American Programmer*, Prentice-Hall, 1993, p.56.}\]
penalized employers for their poor hiring techniques. Virtually all employers overemphasize paper credentials instead of talent, so that market competition results in bidding up the salaries of those with highly-specific skill sets instead of those of the more talented workers. DeMarco and Lister found that on the average, programmers who were twice as productive were paid only 10% more.

(And the market does not penalize poor products either. For example the Intel processor chips are, by consensus of everyone including Intel, not well designed—Bill Gates called them “brain damaged”—yet Intel is by far the market leader.)

Industry companies would be more productive if they were to hire on the basis of talent rather than skill sets. The companies’ products would come to market earlier, with fewer bugs and more innovative features, etc., as described above.

Ordinarily the issue of whether private employers are hiring the best talent would be beyond the government’s purview, but that is not the case here. On the contrary, Congress established the H-1B and employment-based green card programs at the request of employers. These programs are in fact federal subsidies to the industry, especially in view of the salary savings enjoyed by the employers. Thus Congress has a legitimate interest in investigating signs (e.g. those presented throughout Section 7.4 of this report) that the programs are reducing, rather than enhancing, the quality of work performed by the industry.

13 Immigrant Entrepreneurs in the Computer Industry

Some lobbyists opposing reform of skills-based immigration laws in 1995 extolled the virtues of immigrant entrepreneurs in the computer industry. Such claims have been quite distorted in various ways. For brevity, I will focus on the most commonly cited example, Intel, the market leader in CPU chips (central processing units) for personal computers. The Intel situation has been grossly distorted by the lobbyists.

The Intel CPU chip has not been indispensable to the PC industry. Back in 1981 when IBM needed to select a CPU chip for its new PCs, IBM had many alternatives to its choice of Intel as a CPU supplier. There was nothing technically special about Intel—whichever CPU chip IBM chose would have become the market leader, just because of the power of the IBM name at that time. Indeed, the Intel chip not only was not indispensable to the industry, its selection by IBM for the PC has actually hurt the industry. The consensus throughout the industry is that the Intel chip was badly designed. The IBM engineers in Boca Raton, Florida who designed the original PC favored a competing chip by Motorola, and both the Motorola chip and the one produced by National Semiconductor were technically superior to Intel’s. As mentioned earlier, Bill Gates has called the Intel chip “brain-damaged,” citing the fact that the Intel chip’s handling of memory access was extremely cumbersome to write software for. As a result, enormous amounts of programmer productivity have been wasted, resulting in development delays and high software costs, though these problems were for the most part resolved once the 32-bit chips were developed in the early 1990s.

Thus the Intel chip was not essential to the PC, and arguably the PC would have been better without it. By the way, Intel should not be portrayed an immigrant entrepreneurial story in the first place. CEO Andy Grove did indeed immigrate to the U.S. as a refugee from Hungary (note: not as a skills-based immigrant), but he was not one of Intel’s founders. Gordon Moore and Robert Noyce founded the company, though it is true that Grove did go to work for Moore and Noyce at a very early stage. Moreover, Grove’s entire career at Intel has been in manage-

ment. He had already been in management at his previous employer, Fairchild, rather than in direct technical work. It is misleading to imply that Intel’s success is due to his technical input. Instead, as Michael Malone puts it, “Whereas Noyce was the diplomat and industry hero and Moore the technical genius, Grove was the man who could do what it takes to make his company successful. (The Microprocessor: A Biography, by Michael Malone, Springer-Verlag, 1995.)

To be sure, some immigrant-founded computer companies have made some technological contributions, as mentioned before for the case of An Wang’s Wang Laboratories. Again, we should facilitate the immigration of engineers of extraordinary talent, such as Wang. But generally the immigrant entrepreneurs have not played pivotal roles in the industry’s technological development.

Asian-American activists have recently been claiming that 300 out of 800 companies in Silicon Valley are headed by people of Asian ancestry. The source of this claim is an article by Edwin Park. Yet Park’s citation, an article by Andrew Pollack in the January 14, 1997 edition of the New York Times, does not contain this statistic. In any case, Park does mention that many of these Asian companies are in the manufacturing segment of the market, not technological development, and more importantly, the 300/800 fraction, if correct, is

### 14 The Role of Foreign Students in American Computer Science Ph.D. Programs

14.1 U.S. Overproduction of Ph.D.’s

Much has been made by supporters of immigration of the fact that a hefty percentage of Ph.D. degrees in science and engineering granted by American universities are awarded to foreign students, many of whom become immigrants after graduation. What this ignores is that these students are not needed. On the contrary, our universities are producing too many Ph.D.’s, causing a glut on the labor market.

As noted earlier, virtually no jobs in the computer industry require graduate training. And although in academia a Ph.D. is of course needed for faculty positions at Ph.D.-granting universities, that job market has become extremely tight. For example, the UC Davis Computer Science Department received 460 applications for faculty positions during the 1994-1995 academic year—for only three openings.

Sadly, in the late 1980s Congress was very much misled by a National Science Foundation (NSF) report which claimed a looming nationwide shortage of scientists and engineers. This resulted, for example, in Congress increasing the skilled-labor quota, in the 1990 Immigration Act.

The NSF now concedes that its projection was incorrect (Sacramento Bee, March 27, 1994), and policy makers are just recently discovering that large numbers of Ph.D.’s are either unemployed or underemployed. A recent report by William F. Massy of Stanford University and Charles A. Goldman of the RAND Corp., The Production and Utilization of Science and Engineering Doctorates in the United States, studies the problem in great detail.

Indeed, Massy and Goldman point out that production of Ph.D.’s in science and engineering is geared not to labor market needs, but rather to the “needs” of university faculty to produce Ph.D.’s! A faculty member’s rise in the ranks will depend to a great degree on how much federal and private grant funds he/she is able to attract, and how many Ph.D. students he/she produces (the funds are used to provide financial support to the students). Massy and Goldman quote a chair of a major Computer Sci-

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59 I have brought this to Professor Park’s attention. As of May 16, 1997, he was not sure where he got the statistic, and will check.


ence Department as saying that he sets the enrollment level for his department’s graduate program by simply multiplying a per-faculty quota for Ph.D.’s by the number of faculty in the department; this is standard practice.

Intel has been one of the most vociferous Silicon Valley companies to insist that it hires foreign nationals because Intel finds a shortage of domestic engineers with graduate degrees. Thus it is instructive to look at the field of greatest interest to chip manufacturers such as Intel—electrical engineering. Quite contrary to Intel’s claim, Massy and Goldman find that we are overproducing electrical engineering Ph.D.’s by 44%. The August 1, 1994 issue of Electronic Engineering Times, in reporting its latest salary and employment survey, noted, “...there is a glut of technically trained Ph.D.’s. Though it seems hard to believe that companies would avoid hiring well-trained engineers with doctorates, Ph.D.’s tell us that they’re seen as overqualified and overpriced on the 1994 job market.” A San Jose Mercury News story of June 22, 1995 mentioned Sanford Dickert, a Stanford University Ph.D. student, who “drew up two resume’s, one touting him as a doctoral candidate in electrical engineering, the other simply listing his undergraduate degree in electrical engineering from Purdue University. The second got more responses.” Paul Hiller, the Symmetrix CEO whom we mentioned earlier and who hires mainly electrical engineers, told the author that he too views a Ph.D. as a negative.

So much for electrical engineering; what about computer science? Massy and Goldman estimate only a small degree of overproduction of Ph.D.’s in computer science, in the sense of unemployment rates. Computer science Ph.D.’s are still able to find jobs.62 But that does not address the main point, which is that while a Ph.D. may be employed, he/she is in almost all cases doing work which does not need a Ph.D. In fact the Computing Research Association’s statement circulated on the Internet, responding to the original report by Massy and Goldman, even quotes Chief Technology Officer Forrest Baskett of Silicon Graphics as saying that in spite of the considerable number of doctorates hired by his company, his company’s jobs do not require a Ph.D.63 He, as with others, says that what he really wants is sharp minds.

Overproduction of computer science Ph.D.’s was a major theme in an article by Professor Anthony Ralston of the State University of New York at Buffalo in the Communications of the Association for Computing Machinery (March 1996), the ACM’s flagship professional journal. Ralston writes:

[In the coming years] we are almost certain to continue to produce more—probably far more—Ph.D.’s in computer science than will be able to find the kinds of research jobs which attracted them to seek doctorates in the first place, and perhaps more than will be able to find jobs at all. Many of us are, in fact, accepting students under false pretenses...

Ralston goes on the say that the Ph.D.’s may still be hired for computing jobs that do not need a Ph.D., but countered, “But does this justify the cost—to taxpayers, to government, to the students themselves—when the attainment of a Ph.D. adds little to the abilities of the candidates to do [these] jobs?”64

The increase in on-campus recruiting by industry employers in 1996 has led to a 25% decrease in applications for graduate programs in computer science.65 Thus, because a central part of the job of university faculty is to bring in federal research grants which pay the salaries of Ph.D. students, the ironic result of the increased attention employers have paid to new domestic Bachelor’s degree holders will be that the universities will now bring in even more foreign graduate students.

The industry lobbyists opposing congressional reform of laws governing the hiring of foreign nationals have repeatedly claimed that a major reason why

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63E-mail broadcast to all major academic computer science department chairs by Professor Ed Lazowska, University of Washington, July 28, 1995.

64Ralston’s point about the taxpayers refers to the vast sums spent by the federal government for the research projects on which the Ph.D. students work.

employers hire foreign nationals is that the employers need to hire people with graduate degrees. I have already detailed why this claim is incorrect in Section 8, and as we have seen here in this section, the nation actually is producing too many Ph.D.’s as it is.

Moreover, the industry has never acted on its claims to need graduate work in its employees. I have been Graduate Admissions Coordinator for Computer Science at UC Davis since 1983, and have served for a number of years on our Computer Science Undergraduate Curriculum Committee. Our department has excellent contacts with the computer industry, including a yearly Industrial Affiliates conference which is quite well-attended. Yet in all that time, never once has anyone from industry urged me to get more domestic students to attend graduate school. The industry’s claim to hire foreign nationals because insufficient domestic students pursue graduate study simply does not jibe with the industry’s own actions.

In 1995 there was much discussion of the fact that most foreign Ph.D. students are supported by federal and state funds. This is correct. However, it obscures the main point, which is that we are producing too many Ph.D.’s in the first place; the fact that many of them are foreign students is secondary.

14.2 Quality of the Foreign Graduate Students in Computer Science

In the debate on immigration reform in 1995, the claims was often made that the foreign students who come to the U.S. for graduate study are the top students in their home countries. This claim is false. Though there are indeed some truly outstanding foreign students, most of them in a handful of world-class schools such as UC Berkeley and Stanford University, most are not in this category.

When a foreign national applies for a U.S. student visa, there is of course no requirement that the student be especially talented. He/she merely needs to have been admitted to some U.S. school, and again there is no requirement that that school be particularly selective in its admissions policies. On the contrary, since without foreign students the graduate programs for many U.S. universities would collapse, or at least be forced into severe scaling down, the schools have no incentive to have high standards in their admissions policies.

David North’s Soothing the Establishment: the Impact of Foreign-Born Scientists and Engineers on America, (University Press of America, 1995, p.43) contains some data on Graduate Record Examination (GRE) scores among applicants to graduate school in 1993. Let us examine the scores among engineering students. The mean for the foreign students was approximately 3% higher than for U.S. citizens on the Quantitative Test, but the foreign students scored about 10% lower than the citizens on the Analytical Test. The Quantitative Test score difference is small and of little interest anyway, since the test’s coverage does not extend beyond the high-school level; this limitation has long been a frustration to graduate admissions officers in engineering. On the other hand, we at UC Davis have found the GRE Analytical Test to be a strong predictor of success in our computer science graduate program (among both domestic and foreign students).

Thus the claim that the foreign graduate students are in general better than the domestic ones is not borne out.

14.3 Foreign Student Motivation for Graduate Study

One often hears that the presence of so many Asian foreign students in U.S. computer science graduate programs is due to the fact that Asians have high respect for education. This is true to a limited degree, but the overriding factor is typically that they are using these programs as steppingstones to immigration. By contrast, Asian-Americans (at least first-generation ones) also value education highly, and yet their numbers in those same computer science graduate programs are low, in spite of their high enrollments in computer science at the undergraduate level. The major factor underlying this difference is that the Asian-Americans already have U.S. citizenship or green cards; a graduate education has no im-

66See Section 14.3 below.
67The Educational Testing Service originally had a plan to offer a new version of the Quantitative Test designed for students in engineering and the physical sciences, but later abandoned it.
migration value for them, so they tend not to pursue a graduate degree.

UCLA Asian-American Studies professor Paul Ong, along with Evelyn Blumenberg, note that although graduate degrees do not bring enough extra salary to make the degrees a good investment for domestic students, for foreign students the degrees represent tickets to immigration: "...the low rate of [monetary] return [i.e. extra salary] for advanced degrees within the U.S. labor market...is not a disincentive for Asian foreign students. Indeed, receiving such a degree can offer a high rate of return because it increases the probability of working in the U.S. for these individuals." (The State of Asian Pacific America, Paul Ong (ed.), LEAP Asian Pacific American Public Policy Institute and UCLA Asian American Studies Center, 1994. p.175.)

And even the Asian foreign students who had originally stated their intention to pursue a Ph.D. often stop at a Master’s. In the last few years our Ph.D. program in computer science at UC Davis has had ten students drop out. All ten were foreign students, who quit once they found Silicon Valley employers who would hire them and sponsor them for immigration. The students’ basic goal was to secure a green card, rather than to get a graduate education.

Many American schools exploit this goal of the foreign students, as the schools need the “bodies,” in order to meet their own goals of Ph.D. production, and in order to populate the schools’ graduate courses. The universities are aware of the “immigration stepping-stone” nature of the attraction of graduate study for the foreign students, and indeed the foreign-student adviser offices at many universities (both private and public) dispense advice on immigration procedures to foreign students. In November 1995, the first version of Senator Alan Simpson’s bill S1394 was released, containing a provision requiring foreign students to return to their home countries for three years. The National Association of Foreign Student Advisers immediately launched a lobbying campaign against the bill, saying (correctly) that the foreign students simply would not come to school in the U.S. if this provision of the bill were enacted.  

14.4 The System As a Natural Breeding Ground for Cynicism

Current law involving the hiring of foreign nationals is fraught with forces encouraging—often in fact even requiring—cynical behavior by all parties involved. To illustrate this, consider the typical milestones which will occur for a foreign student in computer science:

- When a student in a foreign country goes to a U.S. consulate in that country to apply for a student visa to the U.S., he must sign a form stating his only intention in the U.S. is education, and that he does not intend to stay in the U.S. permanently. Since most foreign students in computer science come to the U.S. with the intention of staying permanently, the System is requiring the student to tell a lie, in his very first interaction with the U.S. government.

- At the same time, the officials in that U.S. consulate are charged with the responsibility of determining whether applicants for student visas do intend to stay in the U.S. permanently. The officials know that, statistically speaking, most of the students have such an intention, but it is impossible to determine this in individual cases. As one consular official put it, “Sec. 214(b) of the Immigration and Nationality Act [in effect] requires that the consular officials have the ability to look into the hearts and minds” of the applicants, an absurdity. So, as an official certifies applicant after applicant as being free of this intention, he knows the whole process is a sham.

- When a student finishes his study in a U.S. university and finds a job with an American employer, he typically will work first under the Practical Training provision of the F-1 student visa. The Practical Training program was established with the goal of complementing a foreign student’s theoretical coursework with industrial experience before returning to his home country. But of course what the Practical Training program has evolved to instead is a holding pattern which tides the student over until the employer’s petition for his green card is approved by the INS.

In order to get the student’s Practical Training application approved, the university (typically the student’s faculty adviser) must write a letter stating how the practical work experience the student gains from the employer will be helpful to the student when he returns to his home country. The universities, of course, are aware of the fact that the student will not be returning home, making the letter, at best, an exercise in hypocrisy.

- At some point the employer will begin the paperwork to petition to the INS for the student’s green card. To do so, the employer will have to take out newspaper ads to advertise the position, all the while knowing that the ads are meaningless, since the employer has already hired the student for the job in question. This cynical act is typically made even more cynical by the fact that the ad is actually tailored around the student’s qualifications, making it virtually impossible for anyone but the student to “qualify” for the job.

In other words, all parties involved, even if they would prefer to act sincerely and openly, are virtually forced by the System into acts of dishonesty.

It should be noted that in this cozy relationship, everyone has powerful incentives to “go with the flow”:

- The students will acquire their immigrant status, which is their main goal.
- The universities will get “bodies” to populate their graduate courses and enable the schools to get lucrative federal research grants.
- The employers will get cheap labor.

It is thus not surprising that these same three groups comprised the major players in the lobbying against congressional proposals for reform of laws governing the hiring of foreign nationals: the students, the universities and the employers. And the lobbying itself displayed the cynical behavior fostered by the System, such as:

- In the short space of just two weeks, a handful of students from China, calling itself the Association for Chinese Community Affairs (itself a cynical act, as the name connotes Chinese-Americans, as opposed to Chinese foreign nationals), collected 15,000 signatures for a petition from the Internet, with the vast majority of the signatories being foreign students. The petition was presented to numerous congressional offices. The Chinese student campaign against the Simpson bill continued to be organized on the Internet after that, including by a highly active group of students from China at UCLA. The latter group’s World Wide Web site advised Chinese students to lie when calling Senator’s offices, saying that the students should let the staffers assume that the students are U.S. citizens: “Senators simply are not supposed to check upon your visa status, even [if] you’re an F-1 [foreign-student visa] student...Do not worry about your [foreign student] status. Yes, you are counted as voting citizens because they never bother to ask the status. Therefore, in fact, your voiced opinion is really an American Citizen’s opinion from their point of view because they cannot tell the difference.”

- As mentioned earlier, the National Association of Foreign Student Advisers launched a campaign against the Simpson bill. Their point was perhaps more honest, but just as cynical, saying that the foreign students will not come to the U.S. for education if they are not allowed to immigrate, thus recognizing the fact that the goal of the students is green cards, not education.

- As also mentioned earlier, the computer industry organized an extremely heavy attack on the Simpson bill, not at all bargaining in good faith, prompting Simpson to say, as we noted earlier, “I was working with the business community...to address their concerns, [but] each time we resolved one, they became more creative,
more novel. [The lobbyists] distorted everything we were up to, everything.” (San Jose Mercury News, March 8, 1996.)

15 The Possibility of Overseas Software Factories

Supporters of the current immigration policy on skilled immigrants claim that if American employers are not allowed to hire immigrant computer professionals at low wages in the U.S., the employers will ship the work to foreign countries. It is true that some companies are experimenting with this, but this is not likely to become the major mode of operation of the industry. The misunderstandings caused by long-distance communication, the problems of highly-disparate time zones and so on can result in major headaches, unmet deadlines and a general loss of productivity.

And it must be kept in mind that a project does not end when the product has been released to the customers. The product must constantly be updated, as bugs are discovered and users demand more features. Thus the problems associated with long-distance software development are continuing, not temporary.

Recall our example of Mr. Peng, who originally worked in Shanghai for a San Francisco-based American software company. In the end, that long-distance operation did not work, so the company had to bring him to the U.S.

The two top leading researchers in computer architecture write about Intel’s 8087 “math chip” which accompanied the early Intel CPUs (and was later incorporated into them):

The Intel 8087 was implemented in Israel, and 7500 miles and 10 time zones made communication difficult with Intel’s headquarters in California. According to Palmer and Morse [1984], “Unfortunately no one tried to write a software stack manager until after the 8087 was built, and by then it was too late; what was too complicated to [make efficient] in hardware turned out to be even worse in software…”...As Kahan [1990] says: “Consequently [language compilers produce inefficient code], degrading the chip’s performance by typically 50%...”

Such problems were also mentioned to the author in 1995 by Symmetrix CEO Paul Hiller, who is engaged in a joint venture with a company in India. He said that the problems of long-distance communication had really impeded progress on the project. He added, “You really need to be able to talk [about the project] face to face.”

This point is made quite forcefully in UC Berkeley Professor AnnaLee Saxenian’s study of the computer industry, Regional Advantage (Harvard University Press, 1994, pp.156ff). For example, she quotes Tom Furlong, former manager of Digital Equipment Corporation’s workstation group in Palo Alto as saying, “Physical proximity is important to just about everything we do...The level of communication is much higher when you can see each other regularly. You never work on the same level if you do it by telephone and airplane...An engineering team simply cannot work with another engineering team that is three thousand miles away, unless the task is incredibly explicit and well defined—which they rarely are.”

Professor Saxenian writes, “Other executives noted that proximity was essential for the detailed and often continuous engineering adjustments required in making complex electronics products. In the words of the president of a [computer] power supply manufacturer that moved part of its manufacturing from Hong Kong to Silicon Valley in the late 1980s to be closer to a major customer: ‘I don’t care how well the specifications are written on paper, they are always subject to misinterpretation. The only way to solve this is to have a customer’s engineers right here. There is no good way to do it if you are more than fifty miles away.’”

In an interview with the San Jose Mercury News (March 9, 1997), Scott Cook, co-founder and chairman of Intuit Inc. said:
We have 15 locations around the globe, including nine in the US. And with only one exception they’re humming. For the last 6 months Bill Campbell (Intuit’s chief executive) and I have been just 2 miles from our new corporate campus. We’ll move there when new space opens up next year. We have e-mail, Picturetel, and more. Yet I’ll tell you it stinks. We miss the feel of the people, the managing by walking about, the quick decision in the hall, the subtle sense about how managers are handling their job, the serendipitous encounter than saves two people weeks of working in different directions, the technicolor feedback that helps managers coach their people. Both Bill and I are opening up satellite offices in Intuit’s (current) campus.

Great businesses excel most in their informal processes and culture, not in their official documents—RFPs, financial statements, budgets—and formal meetings. Video is great for formal stuff, lousy for informal. What are you going to do—have a video robot that simulates walking about by roaming into peoples’ offices?

In the same article, Bill Gates said,

For a company like Microsoft, it’s worth a real premium for us to have very strong collaboration. We have found projects that make sense to do other places, in Israel, in Tokyo for example. But it makes sense for the bulk of our operations to be in one location and for the foreseeable future we’re going to stick with that.

We will spend what is necessary to have most of our development groups at our headquarters and have them meeting face-to-face every day. We want to make sure there is a place where customers can come in and talk to us in person and make sure the products fit together in the right way.

Edward Yourdon, quotes software consultant Carol Colvin: “Despite increased communications via

satellite...I have yet to see a project where specs could be delivered and the programmers code in isolation and deliver a useful product.” (The Decline and Fall of the American Programmer, Prentice-Hall, 1993, p14.) And it is significant that Yourdon, who expressed some disagreement with Colvin at that time, has now changed his mind. In his new book, The Rise and Resurrection of the American Programmer, Yourdon Press, Prentice-Hall, 1996, p.9, he says, “...there is constant interaction between the end user and the software developers...It’s difficult enough managing this kind of interactive development when the users are located right next door to the software developers; it’s much more difficult when the developers are on the other side of the world...So, effective offshore programming is undoubtedly more difficult than I originally suggested.”

A Wall Street Journal article (March 13, 1996), quotes Derek Leebaert, who is working with programmers in Serbia: “We’re still at the stage where you need a trusted manager on site, in the foreign country. That’s a very limiting factor.”

Michael Cusumano reports that ITT Corporation’s efforts to promote “software reusability” (in which modules developed for use in one piece of software could be used in others) were impeded by the international nature of the company: “Reusability became a technical and cultural issue because...ITT had [software] developers spread out around the world, hindering communication across projects.”

In this regard it is worth noting that most large programs are composed of many modules, with different modules often written by different individuals or groups. Yourdon (p.186) notes that Bell Labs found that 40% of its software bugs arose from incorrect interfaces between modules. Given that interpersonal or intergroup interface is already this error-prone within a small geographical region, one again can see how such problems would be compounded in an international setting.

Problems of worker continuity must also be considered. Say you are manager of a company shipping department, and your inventory-control software suddenly develops a bug. If the only person who really knows the program’s innards did the work

71Reference cited earlier, p.99.
in India and now cannot be located, you will be in a very serious fix indeed. In a related remark, Stephen McClellan writes that “American computer customers will for a long time undoubtedly have serious reservations about buying vital computer products from a source 6000 miles away.”

In the October 9, 1995 Wall Street Journal article mentioned in a previous section, reports that William Schroeder, chief executive officer at Diamond Multimedia Systems says “There is a ‘natural limit’ to how many skilled jobs can be moved abroad because of the costs of communication and other factors.”

In many senses, software plays just as vital a role in our economy as does oil. Thus a dependence on imported software would be just as risky as we have found our dependence on imported oil to be.

16 Conclusions and Recommendations

The most important point is that immigrants are not needed for the success of our national computer industry: The industry has not depended on immigrants for its technical edge. Most of the immigrants in the industry have been of average technical abilities. The vast majority of the major technical advances in the industry have been made by U.S. natives. American universities are producing more domestic graduates than the field needs (including both the computer industry itself and “application” industries such as banks). Employer claims that the graduate degrees or special skills of the foreign nationals are needed for productivity are unwarranted.

In addition to not being a help to the industry, large scale immigration has arguably hurt both the industry and its workers: Hiring of foreign nationals has led to both unemployment and underemployment of U.S. native professionals, and has also contributed to rampant age discrimination in the industry, by the industry’s own admission. The presence of foreign nationals has swelled the labor surplus, contributing to the counterproductive practice of automated resume’ scanning, and dissuading many of the brightest native students from majoring in computer science; employers are shooting themselves in the foot, often failing to hire the best talent.

Current skilled immigration policy amounts to a major financial subsidy to the self-described free-marketeer Silicon Valley employers. Many employers who hire foreign nationals, perhaps most, are motivated by a desire to save money. Foreign nationals are willing to take a lower salary in exchange for being sponsored for a green card; young new graduates have lower salaries, and the foreign nationals expand the pool of young workers; and employers who run out of domestic workers possessing a given skill set can hire foreign nationals with those skills, thus avoiding the expense of retraining.

Even Stanford University law professor Bill Ong Hing, a strident immigrant-rights advocate, has criticized current policy on hiring of foreign computer professionals as being unresponsive to various societal needs.

Universities across the country are spending hundreds of millions of dollars to train students for the computer industry. Most people would agree that this is a reasonable, even vital, investment in our nation’s future. But that investment will yield a return only if our graduates are allowed to put their learning to use. Current immigration policy—both for employment-based green cards and for H-1B visas—is impeding that goal.

The following actions should be taken:

- Sponsorship for immigration of genuinely outstanding scientists and engineers should be continued. However, these people should be clearly talented. For example, the mere co-authorship of research papers should not by itself be evidence of talent.

- The routine granting of green cards to foreign computer professionals on the basis of graduate degrees or “special skills” should be ceased. Employment-based green cards should be granted only if there is a shortage of people with general skills. In particular, employment-based green cards should be granted to computer programmers only if there is a shortage

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72 Reference cited earlier.

73 Asian Week, April 29, 1994.
of people with general programming skills, not because there is a shortage of programmers with five years of experience writing C++ code for TCP/IP applications on SPARC computers.

- The granting of H-1B temporary work visas to computer professionals in foreign countries should be reformed along the same lines. H-1B’s should be issued only if there is a general shortage of programmers, rather than a contrived shortage as described above.

A Cultural Impediments to Innovation and Insight Among the Immigrants

After hearing industry lobbyists emphasize that they hire foreign nationals in order to get the world’s “best and brightest,” many people are quite surprised by the award statistics in Section 12. Given that about one-third of Silicon Valley engineers and programmers are foreign-born, for instance, how could there be so few top innovators among them?

The answer to this question turns out to be cultural: Most of the immigrants in the Silicon Valley are from East Asian cultures which emphasize rote-memory learning, which stifles creativity. In this appendix I will discuss the details of this, so that the relative lack of immigrants in the innovation awards lists will make sense. In the Silicon Valley the term immigrant is virtually synonymous with the word Chinese, as the vast majority of immigrant professionals there are ethnic Chinese. Indeed, the author’s analysis of the 1990 Census data shows that of computer professionals in the Silicon Valley who had immigrated in the five years prior to the Census, 76% were Chinese.74 This has led to immigration commentator Francis Fukuyama’s claim that the computer industry depends particularly on ethnic Chinese for its technical edge.75 In other words, a discussion of the quality of immigrant computer professionals is largely a discussion of the quality of the Chinese. Thus I will spend some time here discussing some Chinese cultural traits which, quite counter to Fukuyama’s claim that the Chinese bring the industry a technical edge, actually tend to result in reduced levels of technical abilities among the Chinese computer professionals, relative to those of other groups.

On the plus side, the Confucian ethic produces diligent, compliant attitudes which many employers value in their Chinese employees. However, that same Confucian ethic actually tends to make those employees’ technical abilities weaker than those of other ethnicities, not stronger. The rote-memory approach to learning in Chinese, Japanese and other East Asian cultures76 tends to produce workers who

- are not innovative
- are not good at problem solving
- need excessive amounts of supervisory help

This is again reflected in the ACM awards for industrial innovation. Of the 56 award winners, there are no foreign-born Chinese.77

Similarly, in spite of the large numbers of Chinese foreign students in U.S. computer science Ph.D. programs,78 and in spite of the fact that the Chinese students tend to have high Graduate Record Examination scores and get good grades, of the 35 ACM awards for outstanding Ph.D. dissertations, one Chinese-American.79

Note also that the Chinese dominance among the foreign-born in the industry is changing, in that in 1997 Indians outnumbered Chinese by a 5-to-1 ratio among holders of the H-1B work visa.

74This includes people from China, Hong Kong and Taiwan. Upon hearing this statistic in the Fall of 1995, some industry lobbyists dismissed it as transitory, the result of the Chinese Student Protection Act, which granted permanent residence to tens of thousands of Chinese nationals. But this was incorrect; the act was passed in 1992 and was not implemented until 1993, several years after the collection of the 1990 Census data which I have used here. In fact, as noted earlier, the largest Chinese subgroup in the Silicon Valley consists of those from Taiwan, not China, as the Taiwanese influx began before those from China and Hong Kong.

75National Review, May 1, 1995.

76The comments on Asian educational systems here of course do not apply to Americans of Asian ancestry who are born (or at least raised) in the U.S.

77There is one Chinese-American.

78For example, consider the 460 applications the UC Davis Computer Science Department received for faculty positions (which of course require a Ph.D.) in 1994-1995. Chinese (from China, Taiwan and Hong Kong) comprised the largest ethnicity, with 84 applicants. The next-largest group was Indians, with 60 applicants.
none of the recipients has been of Chinese ethnicity.\textsuperscript{79} Again, virtually no jobs in the computing field require graduate work, but the point is that this complete lack of Chinese winners of the dissertation award sheds further light on the complete lack of Chinese among the industrial innovation award recipients: the rote-memory approach to learning—called \textit{tian yazi}, “stuff the duck” in Chinese—simply is not conducive to technical innovation.\textsuperscript{80}

(Some readers may wonder if the ACM is simply biased against Asians. But this concern is quickly dismissed by noting that although there have been no Chinese recipients of the ACM dissertation award, five recipients of the awards have been from India. The overall breakdown of recipients is: U.S. native 25; India 5; Europe and Israel 5.)

Of the 89 computer-chip innovators discussed in the Malone reference cited earlier, only one is Chinese. Of the 29 names cited by UC Davis computer science and electrical engineering faculty, none is Chinese.

Physicist Chen Ning Yang at SUNY Stony Brook went into the problem in great detail in his television interview with Bill Moyers (available in book form in \textit{Bill Moyers: A World of Ideas}, Doubleday, 1989):

“...kids trained in the Orient tend to be too [intellectually] timid...This attitude prevents them from jumping over hurdles to make important contributions. We see this very clearly among our graduate students. The graduate students from the Orient are quieter and more willing to work, and they make very good grades, but they are somewhat restrained from making imaginative leaps...This too timid attitude is a handicap later in life when they want to be more creative or more imaginative...The Chinese system tends to channel the students too much...You have blinders over your eyes...You’re not told to think for yourself...More than one graduate student from China and Taiwan has come to me and said, ‘Professor Yang, I find it very strange that I was the best in my class in examinations, but now I’m doing research work, and I find that these American students are much livelier, much better than I am.’”

It must be noted that Yang is speaking generally, not about individual cases (he, of course, is an exception to his own rule). One of the most insightful graduate students I have worked with, Raymond Wai-Man Lo, was from Hong Kong. But Yang’s general observations match those of many educators, including me, who work with Asian students.\textsuperscript{81}

Professor Benjamin Duke, who has taught at universities in Japan for 25 years, notes the problem frequently in \textit{The Japanese School}, Praeger, 1986, such as in pp.204ff: “Throughout Japan’s modern history she has made few original contributions in any endeavor except for the Japanese arts...It is often pointed out [by Japanese] that Japan has produced only four Nobel Prize winners compared to 126 awards to Americans and more than 200 to Europeans.” A Japanese, Hisao Yamada writes, “Our [Japanese] children are drilled and our school system is imbued with...uniformity...Deviation from the standard is [barely allowed]. Creativity is punished.”\textsuperscript{82} Yamada adds, alluding to the role Confucian obedience to authority plays in this process, “The question ‘why’ is not interpreted as a healthy sign of curiosity—it is a personal offense toward the integrity of the teacher.”

\textit{This is important, because computer programming is inherently a creative activity.} If, say, we were to assign each of 10 programmers to write a program to perform the same task, we would get 10 very different programs.

Robert Glass describes the creative nature of programming in the preface of his book \textit{Software Creativity} (Prentice-Hall software engineering series, 1995), writing from the perspective “That software construction is primarily a problem-solving activity; that all problem-solving requires creativity; that

\textsuperscript{79}By contrast, there are many papers in computer science research journals by Chinese graduate students, co-authored with their research professors. The student will be an author (typically the first-listed author) even if the research professor, not the student, was the main creative source for the project. This is very different from the ACM dissertation awards, in which the research professor must make the case that the ideas and insights in the research came primarily from the student, not the professor.

\textsuperscript{80}The data above are as of 1995. The year 1997 brought the first Chinese winner, Xiaoyuan Tu of the University of Toronto.

\textsuperscript{81}Yang is not a fan of the Europeans either. He places European culture as being halfway between the American and East Asian cultures, in terms of developing the creative impulse.

\textsuperscript{82}This is from Yamada’s article “Breaking the Mold,” in \textit{The Discipline of Curiosity}, Jenny Groen, Eefke Smit and Juurd Eijsvoogel, eds., Elsevier Science, 1990.
software problem-solving is deeply complex, perhaps more deeply complex than any other such activity; that, therefore, software problem-solving requires the ultimate in creativity.”

Thus lack of creativity in a programmer is a serious impediment to his work. As a result, Japan’s celebrated success in manufacturing (automobiles, consumer electronics, memory chip production) has not carried over to the software industry, which is a different entity entirely. In The Coming Computer Industry Shakeout (Wiley, 1984, p.120), Stephen Mc Clellan writes, “The Japanese are trying. They are building software factories and employing thousands of programmers. But that approach seems to lack the creative dimension that software development requires. Japan’s skills of adaptation [shown in the manufacturing industries listed above] seem to be of little help when it comes to software.” This effort failed, and Professor Edward Feigenbaum of the Stanford University Computer Science Department and an expert on the Japanese computer industry reports that, “In January 1993, Tokyo officially declared software a ‘distressed’ industry.” (The Future of Software, ed. by Derek Leeaert, MIT Press, 1995, p.216.)

More recently, Anthony Clapes, observed that, “Creativity, in the sense of individual expression, is said not to be valued in Japanese society. Programming, however, is a form of self-expression.” Clapes then recalls the famous Japanese proverb, “The nail which sticks out gets hammered down,” and reports that “Many commentators have attributed the inability of Japan to achieve prominence in the software industry to [this] notion.”

Such remarks were also made by Charles Ferguson and Charles Morris in Computer Wars (Times Books, New York, 1993), who observed that Japan’s failure to make inroads in the computer industry has come in spite of enormous efforts by the Japanese government to develop that industry. The Taiwan government has also tried to develop a “Chinese Silicon Valley” in the city of Hsinchu, and again, other than in manufacturing, the government efforts have not had much success. Even Steve Hsieh, the director of the Taiwan government project, says “We are extremely efficient manufacturers, and we are becoming good developers. But we are not yet researchers.”

As noted earlier, an absolutely key trait for success in the computer professions is good problem-solving ability. Virtually all aspects of software and hardware development are fundamentally acts of problem solving. This is true not only for the initial development stage, as in Robert Glass’ remarks cited above, but also in other aspects, particularly the debugging process.

Yet the rote-memory approach to learning in East Asian cultures produce marked weakness in problem solving. This was noted by Professor Duke, for instance in mathematics: “Seldom does the [Japanese] mathematics teacher go beyond the concepts required for the [nationwide standardized] examination...the application of mathematics to unique situations requiring imaginative or original thinking is rare indeed.”

Similar comments comparing the problem-solving abilities of Hong Kong and Canadian students appeared in the Financial Post (Canada), November 5, 1994: “Students coming from the Hong Kong system often have trouble with the freer Canadian style of education. ‘They do well in rote memory, but they don’t have much experience in applying what they learn,’ [school principal] Gillies says. ‘Canadian children are better problem-solvers.’”

Esther Lee Yao, a Chinese-American professor of education, writes that Asian immigrant children “work efficiently in a well-structured, quiet learning environment in which definite goals have been established for them. They seldom...dare to challenge their instructors...Older children, who are accustomed to structured and passive learning conditions, rather than the American educational approach, which requires critical and divergent thinking, may perform well in rote memorization and mathematics operations but may do poorly in creative writing and analytical commentary.”


84 The Economist, March 9, 1996.


The reader may wonder how this jibes with the fact that in the last 10 years, a number of winners of the high school-level Westinghouse Science Talent Search have been Chinese immigrants.
In addition, the Confucian respect for authority and the rote-memory approach to learning impedes independent thinking. Supervisors in both industry and academia have told me that they feel that a disproportionate number of Chinese need to be given excessively detailed directions in their work, and are not self-starters.

It is significant that the general consensus within the company where Ms. Yee works is that of the company’s several sites, the most productive one is located in a state with few immigrant engineers, while the least productive sites have many immigrants. This may partly explain the DeMarco and Lister finding in their book *Peopleware* that programmers who work together tend to be of similar talents, either similarly low or similarly high.

These problems have been so great that the South Korean government has recently been working on completely overhauling its educational system, according to Woo Sung Han of the *Korea Times*. Such an overhaul has also been reported by *60 Minutes* in the case of Japan, and some work in that direction has been done in China as well.\(^{86}\) It remains to be seen what the effects of this will be 15 or 20 years from now. Since the major problems are rooted in Confucian culture rather than in the educational system itself, change in student attitudes may be difficult to achieve.

Although we must indeed praise these kids for their ambition and dedication, the fact is that the contest is not a measure of “the best and the brightest” of high school science students. Instead, the contest has become more a matter of going to the right high school, and arranging for the right university professor for guidance.

Out of thousands of high schools across the nation, the same four or five high schools dominate the list of winners every year. These schools offer special three-year “Westinghouse programs,” and have honed strategy for winning the contest “down to a science” (pun intended). And the student projects which form the main criterion for the award are far from being independent work; instead, they are done under the direction of well-chosen university researchers. (See for instance *Newsday*, January 24, 1994, and *Newsday*, March 13, 1991.)

The San Francisco Bay Area, where there are no high schools with “Westinghouse programs,” usually does not produce students (Chinese or otherwise) who do well in the Westinghouse contest, in spite of the fact that the region contains large numbers of professional, middle-class Chinese immigrant parents, many of them engineers in the Silicon Valley.

Writing in the March 9, 1997 issue of the *San Jose Mercury News*, J. Myron Atkin reported, “While each country is fighting its own demons as it tries to improve its schools, it may be particularly instructive to look at what disturbs the Japanese [about education] and what they are trying to do about it... countries that serves as the president’s model. The Japanese are deeply concerned with what they see as a lack of creativity in their society and with the deteriorating quality of their physical environment. Both issues lead to much hand-wringing in the public press and among educational policymakers.”

Professor Harold Stevenson of the University of Michigan, who has made some classroom visits to some East Asian schools, believes that such an overhaul is unnecessary, dismissing the rote-memory image of East Asian education as something that “was going on in Asian classrooms 50 years ago.” But this does not jibe with the experiences of those who actually teach Asian students, as we have seen above, nor does it jibe with the East Asian governments’ own findings which have led to their educational overhauls. One of the problems here may be that the teachers whose classrooms Stevenson visited (and those visited in a 1996 OECD study) were making special efforts to look “modern” for him, especially since government efforts at overhaul had already begun.