

## BUILDING A COMPETITIVE WORKFORCE: Immigration and the U.S. Manufacturing Sector

by David L. Bartlett, Ph.D.\*

### EXECUTIVE SUMMARY

Shortages of skilled labor constitute the foremost challenge confronting U.S. manufacturers who face growing competition from manufacturers in Asia, Eastern Europe, and elsewhere. Demand for professionals with university degrees is rising as manufacturing becomes increasingly high tech. But the U.S. educational system is not producing enough highly educated native-born manufacturing workers to meet this growing demand. Moreover, the pending retirements of Baby Boom generation workers will further constrain the growth of the manufacturing labor force. Bridging this gap between the supply and demand for skilled workers requires new investments in the U.S. educational system and the formulation of immigration policies that respond to the labor needs of the U.S. economy. Yet current immigration policies, especially since 9/11, have made it more difficult for highly skilled professionals from abroad to enter the United States.

Among the findings of this report:

- In 2005, 90 percent of manufacturers surveyed by the National Association of Manufacturers (NAM) reported “moderate to severe” shortages of skilled production workers, while 65 percent indicated “moderate to severe” shortages of scientists and engineers.
- In order to hedge against worker shortages, and in response to mounting global competition, American manufacturers are

boosting investments in industrial automation, robotics, and other labor-saving equipment that requires a high level of skill to operate. These developments are raising demand for highly educated manufacturing workers.

- Even during the 2000-02 recession, during which 2.8 million manufacturing jobs disappeared, high-salaried positions for machinists, tool and die makers, and welders went unfilled owing to a paucity of qualified applicants. NAM estimates that U.S. manufacturers will face a deficit of 10 million skilled workers by 2020 if these trends go unchecked.
- In 2004, immigrants represented large shares of advanced-degree holders in technology-intensive manufacturing industries: machinery (65.4 percent), measurement/control instruments (48.2 percent), electronic components (44.6 percent), computers/peripherals (44.4 percent), communications equipment (39.8 percent), and medical equipment (37.3 percent).
- Between 2001 and 2004, the number of foreign-born workers with advanced degrees rose in 7 industries (machinery, electronic components, aircraft, computers/peripherals, measurement/control instruments, motor vehicles, and aerospace) and declined in 3 (pharmaceuticals, communication equipment, and medical equipment).

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## THE HUMAN CAPITAL CRISIS IN U.S. MANUFACTURING

In its *2005 Skills Gap Report*, the National Association of Manufacturers (NAM) presents a sobering assessment of the human capital challenges facing U.S. manufacturers:

- 90 percent of surveyed manufacturers reported “moderate to severe” shortages of skilled production workers.
- 65 percent indicated “moderate to severe” shortages of scientists and engineers.
- 54 percent reported that current shortages of qualified workers are creating a “moderate to high” negative impact on their ability to service customers.

Looking forward, the NAM survey offers few signs of relief from manufacturing labor shortages. About 80 percent of respondents anticipate shortages of skilled workers in the next three years, while 74 percent indicated that sustaining a “high-performance workforce” constitutes their foremost challenge in coming years.<sup>1</sup>

To hedge against worker shortages, American manufacturers are boosting investments in industrial automation, robotics, and other labor-saving equipment that requires a high level of skill to operate. Meanwhile, mounting global competition is heightening pressure on U.S. manufacturers to implement advanced process technologies: “smart systems,” testing/measuring instruments, reconfigurable tools, modeling/simulation equipment, and solid free-form fabrication.<sup>2</sup>

These developments are raising demand for highly educated manufacturing workers. NAM estimates that over 40 percent of American factory jobs will require post-secondary

education by 2012.<sup>3</sup> Demand for professionals with university degrees (industrial engineers, software programmers, chemists, physicists, environmental technicians, computer specialists, etc.) also is rising as U.S. manufacturers—who traditionally have relied on employees with high-school diplomas or associate degrees—move into nanotechnology, biotechnology, and other high-tech emerging markets.<sup>4</sup>

At the same time, demographic and economic factors are constraining the supply of native-born manufacturing employees possessing these skills. Retirements of Baby Boom generation workers—a trend already underway and expected to peak in 2012—are depleting the ranks of experienced equipment operators in the U.S. manufacturing sector. The science and engineering (S&E) labor force is also declining: 26 percent of S&E workers in the United States are over 50, and growing numbers of these individuals will retire in the next two decades.<sup>5</sup>

The U.S. educational system is not producing enough highly educated native-born manufacturing workers to replenish the supply. The rate of growth in the number of S&E college graduates exceeds that of the overall U.S. labor force, which is projected to grow by just 1.1 percent annually through 2010. But production of scientists and engineers with university degrees in the United States lags behind growth in S&E occupations.<sup>6</sup> Meanwhile, lagging output of technical/vocational schools—compounded by unfavorable views of manufacturing held by many young Americans—leaves gaps in skilled production jobs vacated by retiring workers. Even during the 2000-02 recession, during which 2.8 million manufacturing jobs disappeared, high-salaried positions for machinists, tool and die makers, and welders went unfilled owing to a paucity of qualified applicants. NAM estimates

<sup>1</sup> National Association of Manufacturers, *2005 Skills Gap Report—A Survey of the American Manufacturing Workforce*, December 2005, p. 4-8. See also Timothy Aepfel, “Firms New Grail: Skilled Workers,” *Wall Street Journal*, November 22, 2005, p. A2.

<sup>2</sup> National Council for Advanced Manufacturing, *Report on Industry Views Towards Categories of Innovative and Potentially Disruptive Advanced Manufacturing Technologies*, April 2005.

<sup>3</sup> National Association of Manufacturers, *The Looming Workforce Crisis: Preparing American Workers for 21st Century Competition*, August 2005, p. 3.

<sup>4</sup> National Association of Manufacturers, *Keeping America Competitive: How a Talent Shortage Threatens U.S. Manufacturing*, April 2003, p. 13-18.

<sup>5</sup> National Association of Manufacturers, *The Looming Workforce Crisis*, p. 3. A new study by the U.S. Federal Reserve projects a decline in the national labor participation rate from its postwar peak of 67.3 percent in 2000 to 64 percent in 2015, reflecting the loss of some 77 million Baby Boomers from the workforce. See Stephanie Aaronson, et al., *The Recent Decline In Labor Force Participation and its Implications for Potential Labor Supply*, Division of Research and Statistics, Board of Governors of the Federal Reserve System, March 2006.

<sup>6</sup> Manufacturing Institute, *Facts About Modern Manufacturing*, September 2003, p. 9; National Science Foundation, *Science & Engineering Indicators 2004*, May 2004, “Overview”, p. 9-10.

that U.S. manufacturers will face a deficit of 10 million skilled workers by 2020 if these trends go unchecked.<sup>7</sup>

Gains in manufacturing productivity, which grew at double the rate of overall U.S. productivity in the 1990s and reached 4.5 percent in 2001, have softened the impact of the declining supply of qualified workers.<sup>8</sup> But the erosion of the math and science skills of young Americans relative to their international counterparts—a phenomenon amply documented in recent empirical studies<sup>9</sup>—raises doubts about the sustainability of that productivity growth.

The growing gap between the supply and demand for skilled employees leaves U.S. manufacturers with two options: (1) relocating production to foreign countries possessing human capital assets in short supply in the domestic labor market, and (2) importing skilled foreign workers. Following a decline from 2000 to 2003, outbound U.S. foreign direct investment (FDI), which is the acquisition by U.S. companies of existing foreign companies and/or the formation of new foreign subsidiaries, reached \$230 billion in 2004.<sup>10</sup> Moreover, a growing share of American FDI is destined for manufacturing. The manufacturing share of outward FDI from the United States approached 70 percent in China and Malaysia and surpassed 50 percent in South Korea, Germany, Italy, and Singapore.<sup>11</sup>

However, while the availability and quality of local labor is an important driver of manufacturing-related FDI, U.S. companies looking to establish foreign affiliates consider a wide range of factors when undertaking offshore production: size, growth rate, and purchasing power of the host economy; availability of qualified local partners; access to high-quality suppliers and distributors; depth of the local financial market; robustness of infrastructure; legal, regulatory, and institutional environment; political and economic stability; and links to downstream “original equipment manufacturers”

(OEMs)—manufacturers that source parts and components for assembly into finished products sold under their own brand names. Accordingly, the shortage of qualified domestic workers does not itself constitute a decisive factor in outbound FDI by American manufacturers. Furthermore, small- and mid-sized manufacturers—which encounter special challenges in the bidding for skilled workers in many parts of the United States—still face high hurdles when contemplating foreign operations. As a result, bringing in skilled foreign-born workers is a less costly and risky alternative than FDI for many American manufacturers.

## FOREIGN-BORN WORKERS IN THE U.S. LABOR FORCE

According to the 2004 American Community Survey, foreign-born workers represented about 15 percent of the U.S. labor force {Figure 1}. The highest foreign-born shares (20 percent) were found among workers in construction and arts/entertainment/hospitality/food services. The smallest foreign-born share of workers (8 percent) was in public administration. Foreign-born workers accounted for 17 percent of the manufacturing labor force.<sup>12</sup>

Among foreign-born workers as a whole, 14.4 percent were employed in manufacturing in 2004—the second largest share after education/health care/social services (16.2 percent). However, there were significant differences between recent immigrants (those who arrived in the United States since 2000) and the general foreign-born population. The share of new immigrants employed in manufacturing (12.8 percent) was smaller than for immigrants as a whole. Larger shares of recent immigrants worked in arts/entertainment/hospitality/food services (16.6 percent), construction (15.5 percent), and education/health care/social services (13.1 percent) {Figure 2}.<sup>13</sup> This result is unsurprising in view of

<sup>7</sup> Phyllis Eisen, *Today's Manufacturing Layoffs Mask a Looming Shortage of Skilled Workers in the U.S.*, National Association of Manufacturers, August 2003, p. 1.

<sup>8</sup> Manufacturing Institute, *Facts About Modern Manufacturing*, p. 9-10.

<sup>9</sup> See for example the comprehensive report of the National Academy of Sciences, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, October 2005.

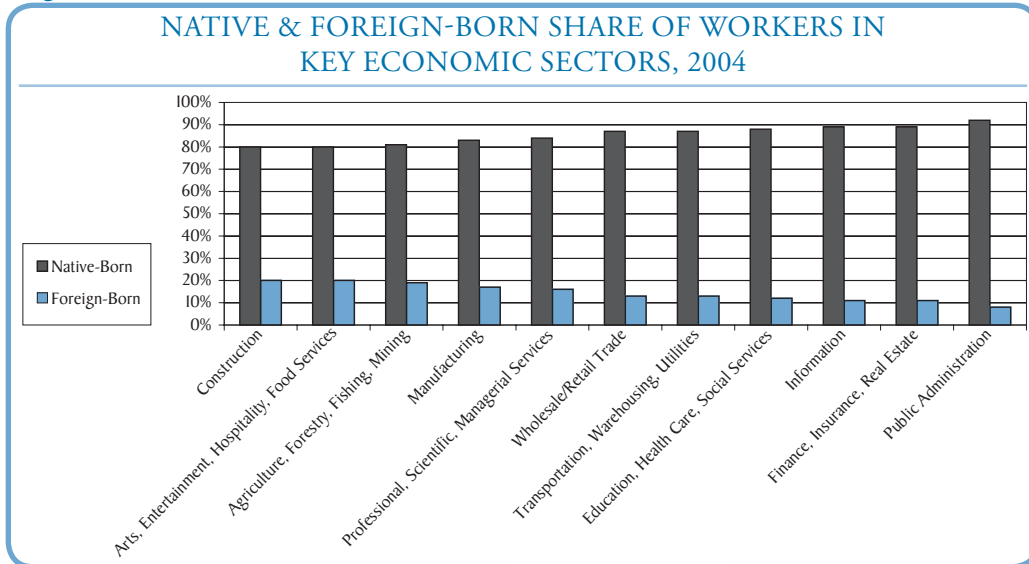
<sup>10</sup> United Nations Conference on Trade and Development, *World Investment Report 2005: Transnational Corporations and the Internationalization of R & D*. New York & Geneva: United Nations, p. 303.

<sup>11</sup> United Nations Conference on Trade and Development, *FDI Country Profile: United States*. New York & Geneva: United Nations, September 19, 2005, p. 44-45.

<sup>12</sup> U.S. Census Bureau, 2004 American Community Survey, Subject Table S0602: Selected Characteristics of the Native and Foreign-Born Populations.

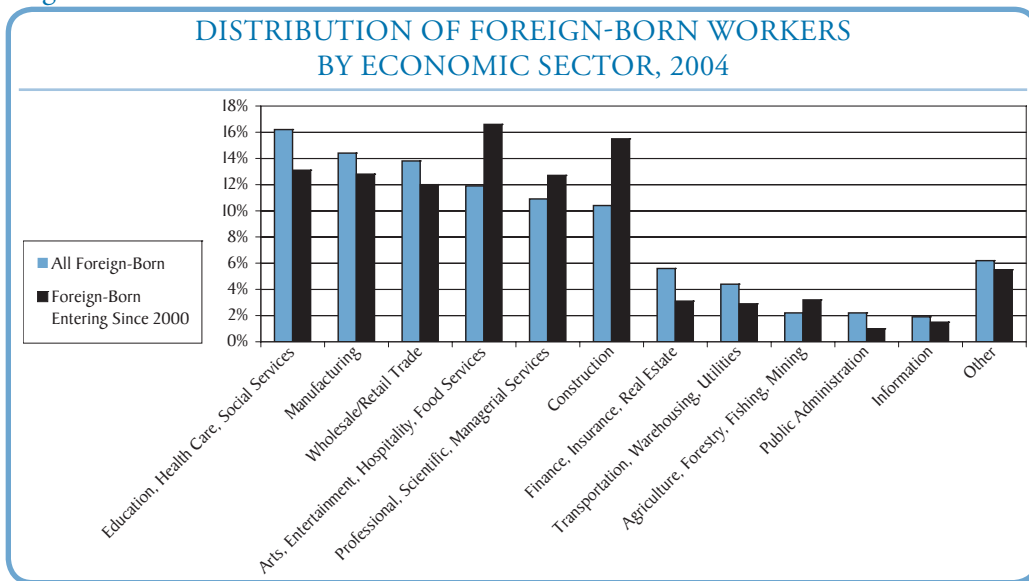
<sup>13</sup> *ibid.*

Figure 1:



Source: U.S. Census Bureau, 2004 American Community Survey, Subject Table S0602: Selected Characteristics of the Native and Foreign-Born Populations.

Figure 2:



Source: U.S. Census Bureau, 2004 American Community Survey, Subject Table S0602: Selected Characteristics of the Native and Foreign-Born Populations.

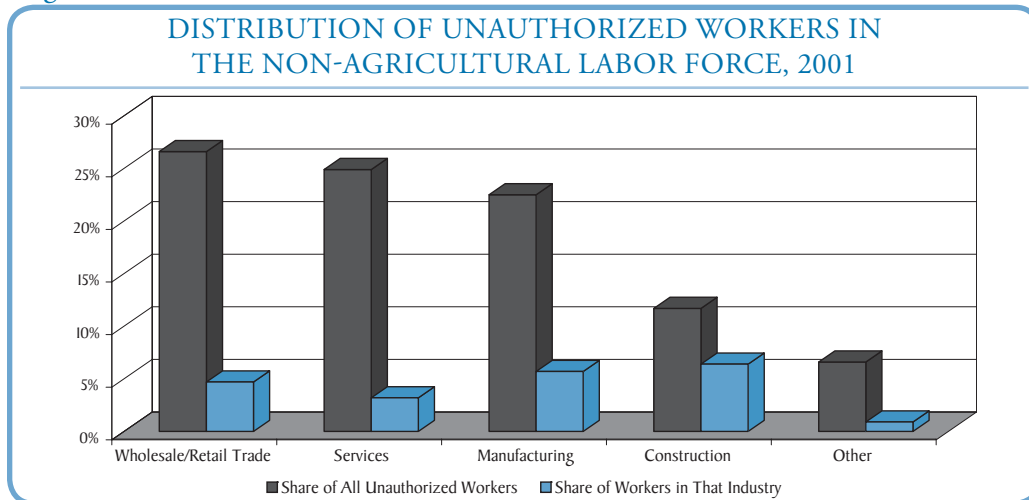
the fact that the timeframe covered in the new arrival data (2000-2004) overlaps the 2000-02 recession, during which the manufacturing sector incurred nearly 3 million job losses nation-wide. Furthermore, manufacturing employment barely increased during the “jobless recovery” of 2003-04.

### UNDOCUMENTED WORKERS IN THE U.S. LABOR FORCE

Much of the public debate over U.S. immigration policy has focused on undocumented workers. However, the role of unauthorized workers in U.S. manufacturing is con-

siderably smaller than often is presumed. The Pew Hispanic Center estimates that undocumented workers accounted for 3.7 percent of the non-agricultural U.S. labor force in 2001, or 5.3 million workers. Undocumented immigrants accounted for just 5.7 percent of manufacturing workers, compared to 23.8 percent of private household service providers (primarily in-home babysitting), 16.6 percent of business service providers (chiefly building maintenance and office cleaning), and 9.1 percent of restaurant workers. Among all undocumented workers employed outside of agriculture, the largest share (26.6 percent) worked in wholesale and retail trade, followed by services at 24.9 percent. Undocumented

Figure 3:



Source: B. Lindsay Lowell & Robert Suro, *How Many Undocumented: The Numbers Behind the U.S.-Mexico Migration Talks*. Washington, DC: Pew Hispanic Center, March 21, 2002, p. 7.

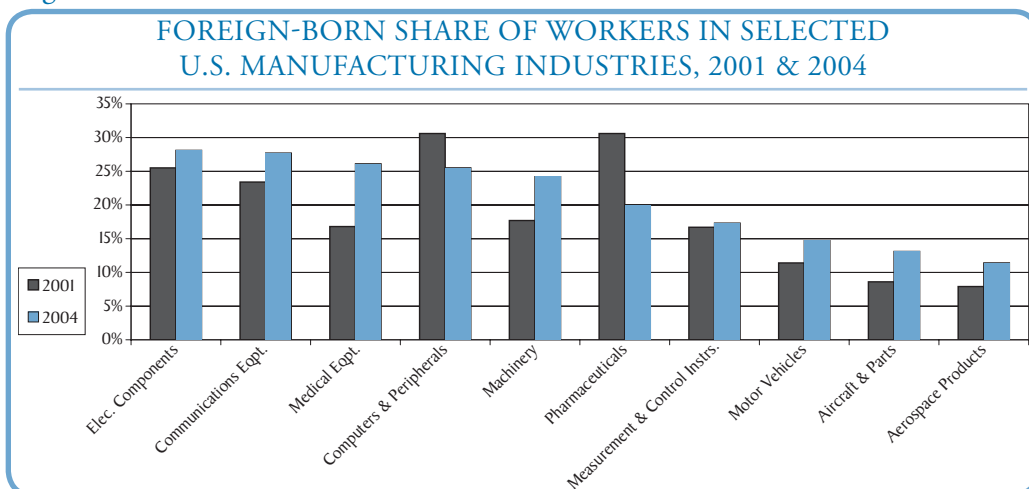
manufacturing workers represented 22.5 percent of all unauthorized workers, or 1.2 million individuals {Figure 3}.<sup>14</sup>

The relatively low share of unauthorized workers in the manufacturing labor force reflects (1) the more exacting legal and regulatory standards for manufacturers than other non-agricultural sectors (e.g., domestic child care), which favor the hiring of authorized workers; and (2) the preponderance of less-skilled employees within the unauthorized population. In short, undocumented immigration—which is the focal point of current debates over U.S. immigration policy—has relatively little effect on American manufacturers encountering labor shortages.

## FOREIGN-BORN MANUFACTURING WORKERS

Foreign-born manufacturing workers are most prominent in technology-intensive industries {Figure 4}: electronic components (28.1 percent of employees in 2004), communications equipment (27.7 percent), medical instruments (26.1 percent), and computers/peripherals (25.5 percent). Machinery—an other industry with high demand for scientists, engineers, and skilled production workers—also was characterized by a significantly above-average share of foreign-born employees (24.2 percent). With the exception of computers/peripherals, the shares of foreign-born workers increased in these industries between 2001 and 2004. This trend is most pronounced in

Figure 4:



Source: U.S. Census Bureau, 2001 & 2004 American Community Survey, Public Use Microdata Sample (PUMS).

<sup>14</sup> B. Lindsay Lowell & Robert Suro, *How Many Undocumented: The Numbers Behind the U.S.-Mexico Migration Talks*. Washington, DC: Pew Hispanic Center, March 21, 2002, p. 7.

medical instruments, with the foreign-born share of workers increasing from 16.8 to 26.1 percent during the same period.<sup>15</sup>

The aerospace, aircraft/parts, and motor vehicles workforces had below-average shares of foreign-born employees in 2004, indicating both formal and informal barriers to entry in these highly unionized industries. But foreign-born worker shares increased in all three industries after 2001, reflecting the rising technical demands of aerospace/aircraft manufacturing and the growing prominence of foreign-born workers in the U.S. automotive industry. In contrast, the foreign-born share of workers in pharmaceuticals fell from 30.6 percent in 2001 (the highest foreign-born share in a manufacturing industry in that year) to 20 percent in 2004—an intriguing trend given the increasing shares of foreign-born employees in medical instruments and other life science industries with high technological content.<sup>16</sup>

### HIGHLY SKILLED FOREIGN-BORN MANUFACTURING WORKERS

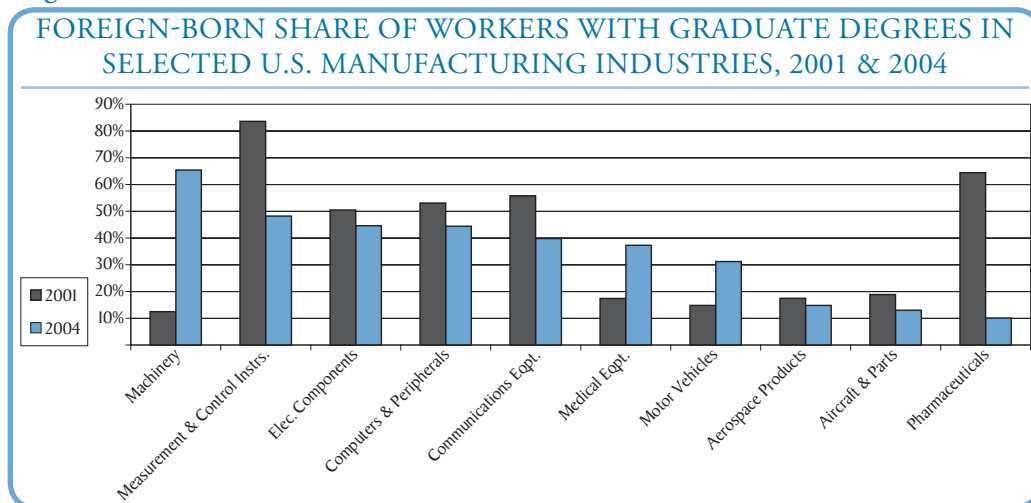
Foreign-born manufacturing workers are clustered in the upper educational stratum, with foreign-born holders of graduate and professional degrees playing a major role in many manufacturing industries. In 2004, 32.2 percent of U.S. manufacturing workers with post-baccalaureate degrees were foreign born. But immigrants represented even larger

shares of advanced-degree holders in technology-intensive manufacturing industries: 65.4 percent in machinery, 48.2 percent in measurement/control instruments, 44.6 percent in electronic components, 44.4 percent in computers/peripherals, 39.8 percent in communications equipment, and 37.3 percent in medical equipment {Figure 5}.<sup>17</sup>

Several industries experienced large swings in the foreign-born share of their highly educated workers between 2001 and 2004. For example, the share of foreign-born advanced-degree holders in the machinery industry grew from 12.5 to 65.4 percent during that period. This increase stemmed from growth in the number of foreign-born employees with graduate or professional degrees in an industry with relatively few advanced-degree holders. Similarly, both the absolute number and relative share of foreign-born workers grew in motor vehicles.<sup>18</sup> Conversely, the foreign-born share of workers in measurement/control instruments fell from 83.6 to 48.2 percent.

In four other industries (computers/peripherals, electronic components, aerospace, and aircraft), absolute numbers of foreign-born advanced-degree holders increased while their relative shares declined amid rapid growth in the total number of employees with advanced degrees. The opposite pattern is found in medical equipment, in which the number of foreign-born workers with advanced degrees fell amid an even steeper drop in the total number of advanced-degree holders.<sup>19</sup>

Figure 5:



Source: U.S. Census Bureau, 2001 & 2004 American Community Survey, Public Use Microdata Sample (PUMS).

<sup>15</sup> U.S. Census Bureau, 2001 & 2004 American Community Survey, Public Use Microdata Sample (PUMS).

<sup>16</sup> *ibid.*

<sup>17</sup> *ibid.*

<sup>18</sup> *ibid.*

<sup>19</sup> *ibid.*

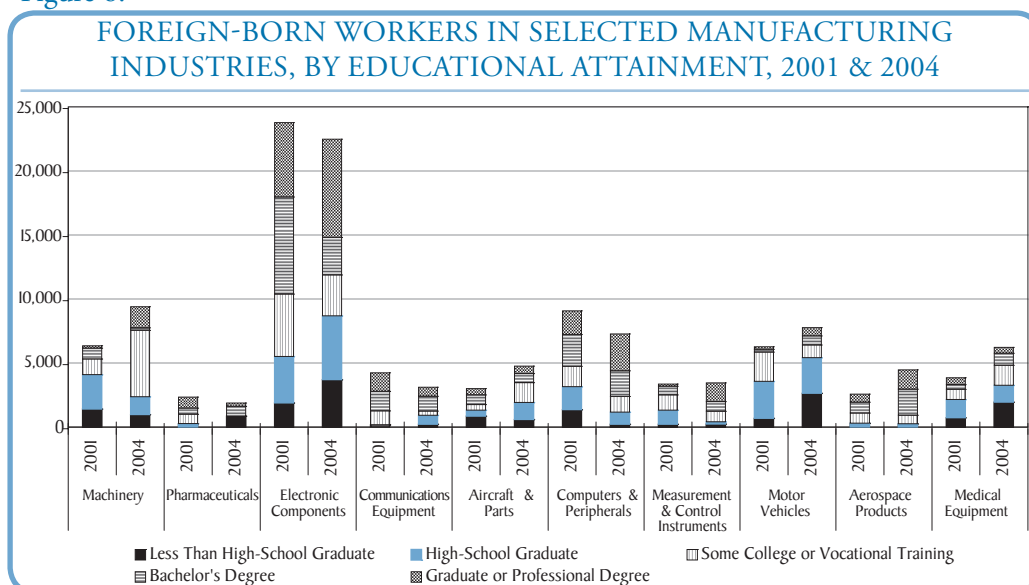
Only in pharmaceuticals did the number of foreign-born advanced-degree holders fall while the total number of workers with advanced degrees increased. Foreign-born workers accounted for just 10.1 percent of pharmaceutical workers with advanced degrees in 2004.<sup>20</sup> One potential explanation for this trend is increased offshoring of research and development (R & D) functions—particularly clinical trials—by U.S.-based pharmaceuticals tapping low-cost, high-quality talent pools in India, the Russian Federation, and other emerging economies.<sup>21</sup> The growth of R & D-related offshoring in the U.S. pharmaceuticals industry in turn expands professional opportunities for advanced-degree holders in other countries, weakening incentives for foreign-born workers with graduate/professional degrees to immigrate to the United States and inducing foreign-born advanced-degree holders already working in the United States to return home. The high shares of foreign-born advanced-degree holders in other manufacturing industries—machinery, electronic components, computers, measurement/control instruments, motor vehicles, medical equipment—suggest a lower propensity for outsourcing of technology-intensive functions than in pharmaceuticals and, hence, a greater domestic demand for foreign-born workers holding graduate/professional degrees.

Between 2001 and 2004, total employment of foreign-born workers with advanced degrees rose in seven industries

(machinery, electronic components, aircraft, computers/peripherals, measurement/control instruments, motor vehicles, and aerospace) and declined in three (pharmaceuticals, communication equipment, and medical equipment). Electronic components—which includes the semiconductor and disk-drive industries—is by far the biggest employer of foreign-born workers with advanced degrees in the American manufacturing sector (23,772 in 2004).<sup>22</sup>

At the opposite end of the educational spectrum, employment of foreign-born workers lacking a high-school diploma increased in three industries (electronic components, motor vehicles, medical instruments) and shrank in all of the others. Employment of foreign-born workers with only high-school diplomas rose in just three industries (machinery, aircraft, medical instruments) and declined or held steady in the others. Moving further along the educational spectrum, employment of foreign-born workers with only some college or vocational training increased substantially in machinery and modestly in aircraft and medical equipment, but held steady or declined in the other industries. Similarly, foreign-born workers holding only bachelor's degrees rose slightly in motor vehicles, aerospace, and medical equipment but declined elsewhere {Figure 6}.<sup>23</sup>

Figure 6:



Source: U.S. Census Bureau, 2001 & 2004 American Community Survey, Public Use Microdata Sample (PUMS).

<sup>20</sup> *ibid.*

<sup>21</sup> McKinsey Global Institute *The Emerging Global Labor Market*, June 2000, p. 219-250.

<sup>22</sup> U.S. Census Bureau, 2001 & 2004 American Community Survey, Public Use Microdata Sample (PUMS).

<sup>23</sup> *ibid.*

## THE GROWING IMPORTANCE OF SCIENTISTS & ENGINEERS IN U.S. MANUFACTURING

Growing numbers of university-trained scientists and engineers (both native and foreign-born) are choosing non-academic occupations, including manufacturing. Between 1980 and 2000, non-academic S&E jobs grew by an average annual rate of 4.9 percent versus 1.1 percent for the entire U.S. labor force. S&E-related employment is projected to grow three times more quickly than the rate of job creation for all occupations. Within the S&E category, computer software engineering, computer systems analysis, and environmental engineering are expected to post the largest job gains.<sup>24</sup>

The Bureau of Labor Statistics (BLS) forecasts 2 million new S&E jobs by 2012, including 1.3 million openings for computer and mathematical specialists.<sup>25</sup> However, the American educational system is failing to produce a sufficient number of scientists and engineers with university degrees to meet this growing demand for non-academic professionals. Although the growth rate in the number of S&E degrees earned by students in U.S. universities exceeds the growth rate of the civilian labor force in general, it lags behind the growth rate of S&E occupations. While the BLS projections do not specify the S&E industries in which shortfalls are likely to occur, the NAM survey makes clear that a significant portion of the S&E shortfall likely will occur in manufacturing.

## THE CRITICAL ROLE OF FOREIGN-BORN SCIENTISTS & ENGINEERS

The critical role of foreign-born scientists and engineers in filling these labor gaps is illustrated by the disproportionate share of S&E graduate degrees that are awarded to foreign students by U.S. universities. According to the National Science Foundation, foreign students received 13.2 percent of master's degrees conferred by U.S. universities in 2002. However, they accounted for a much larger share (27.8 percent) of master's degrees in S&E disciplines. Foreign-born students play an even greater role in American doctoral programs, representing 35.1 percent of total Ph.D.s granted

in 2003 and 41.5 percent of S&E-related doctorates. Foreign graduate students also display a markedly stronger preference for S&E than their American counterparts. Of total graduate degrees conferred upon foreign students in 2003, 49.9 percent were in S&E fields, compared to 19.7 percent for U.S. citizens. Foreign graduate students are especially prominent in engineering, comprising 60.3 percent of doctoral degrees conferred in the United States in 2003. By contrast, foreign students accounted for just 12.6 percent of engineering Ph.D.s earned in Germany and 13.4 percent in Japan.<sup>26</sup>

In addition, scientists and engineers predominate among the recipients of both employment-based legal permanent residence and H-1B visas for highly skilled professionals. In Fiscal Year (FY) 2004, 72.5 percent of employment-based legal permanent residents (LPRs or "green card" recipients) held managerial/professional positions, versus 5.9 percent of the LPR population working in service jobs and 1.6 percent in construction. Within the managerial/professional group, computer/math specialists represented the largest occupational share (17.1 percent), followed by engineers (15 percent) and executives (13.4 percent).<sup>27</sup>

Scientists and engineers also figure prominently in the H-1B visa program, which enables foreign-born professionals with university degrees to work in "specialty occupations" in the United States for up to six years. Half of H-1B visa recipients in FY 2003 possessed bachelor's degrees, 31 percent master's degrees, and 12 percent doctoral degrees.<sup>28</sup> Computer-related jobs represented by far the biggest occupational share of H-1Bs in FY 2003 with 38.5 percent of approved petitions, followed by architecture/engineering/surveying at 12.4 percent. Education accounted for 11.1 percent of approved H-1B petitions, significantly lower than the combined totals of industry-related occupations {Figure 7}.

## RESTRICTIONS ON HIGH-SKILLED IMMIGRATION

Taken together, the H-1B and employment-based LPR groups constitute a tiny share of the U.S. labor force and a small fraction of the number of workers needed to

<sup>24</sup> National Science Foundation, *Science & Engineering Indicators 2004*, p. 3-4 & 3-7.

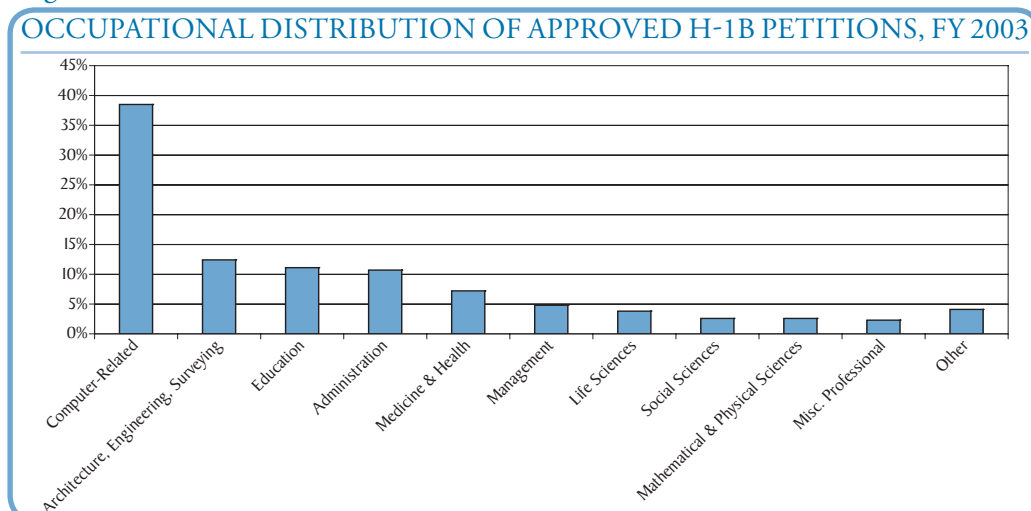
<sup>25</sup> National Science Foundation, *Science & Engineering Indicators 2006*, Appendix, Table 3-4.

<sup>26</sup> National Science Foundation, *Science & Engineering Indicators 2006*, Appendix, Tables 2-29, 2-31, 2-48.

<sup>27</sup> Kelly Jefferys, *Characteristics of Employment-Based Legal Permanent Residents: 2004*. Washington, DC: Office of Immigration Statistics, Department of Homeland Security, October 2005.

<sup>28</sup> Office of Immigration Statistics, Department of Homeland Security, *Characteristics of Specialty Occupation Workers (H-1B): Fiscal Year 2003*, November 2004, p. 10.

Figure 7:



Source: Office of Immigration Statistics, *Characteristics of Specialty Occupation Workers (H-1B): Fiscal Year 2003*, p. 13.

fill projected shortages of skilled employees. Furthermore, issuance of employment-based legal permanent residency requires certification by the sponsoring employer that hiring foreign workers will not adversely affect American workers. In FY 2003, U.S. Citizenship and Immigration Services approved 217,340 H-1B petitions, of which 105,314 went to foreign-born workers pursuing initial employment in the United States and the remainder (112,026) to those already in the country seeking extensions of their visas.<sup>29</sup> In FY 2004, 946,142 persons became LPRs, but only 72,550 of those were employment-based. The balance of LPRs (873,592) were (1) the dependents of employment-based petitioners, (2) family-sponsored applicants, (3) nationals of certain countries with low rates of immigration who are admitted under quotas set by the U.S. government, and (4) refugees and asylees.<sup>30</sup>

However, the high demand for foreign-born professionals did not prevent Congress from allowing the annual H-1B quota to fall from 195,000 to 65,000 in FY 2004 (an additional 20,000 H-1B visas are allocated to foreign-born holders of master's degrees and Ph.D.s conferred by U.S. universities). The FY 2006 H-1B quota was exhausted in August 2005, two months before the fiscal year even began. The move by Congress to restrict H-1B visas is unfortunate insofar as (1) demographic trends are clearly unfavorable with regard to the supply of skilled labor in the American economy, and (2) U.S. companies (particularly manufactur-

ers) have unambiguously signaled their need for greater access to talented foreign workers.

Furthermore, this action comes at a time when America's key economic rivals are liberalizing their foreign labor laws. Six members of the European Union (EU)—Finland, Ireland, Portugal, Spain, Sweden, and the United Kingdom—have revoked the EU's seven-year ban on the entry of guest workers from recently admitted East European states.<sup>31</sup> Even Japan, long noted for a highly insular national culture, has loosened its foreign labor laws to attract skilled workers from abroad. In 2003, 268,045 high-skilled foreign workers entered Japan, 93 percent more than in 1992 and surpassing inflows of foreign professionals to the United States.<sup>32</sup>

## REVERSE BRAIN DRAIN

In addition to the advanced industrialized countries, developing/emerging economies have become important rivals of the United States in the global war for talent. In FY 2003, India and China accounted for 45.7 percent of H-1B visas issued by the United States, well surpassing the shares of Canada (5.1 percent), the United Kingdom (3.5 percent), Japan (2.6 percent), Germany (1.6 percent), and France (1.5 percent).<sup>33</sup> These two emerging market giants also represented the dominant share (34.7 percent) of new employment-based LPRs in the United States in FY 2004 {Figure 8}.<sup>34</sup>

<sup>29</sup> Office of Immigration Statistics, *Characteristics of Specialty Occupation Workers (H-1B): Fiscal Year 2003*, p. 4.

<sup>30</sup> Kelly Jefferys, *Characteristics of Employment-Based Legal Permanent Residents: 2004*, p. 2.

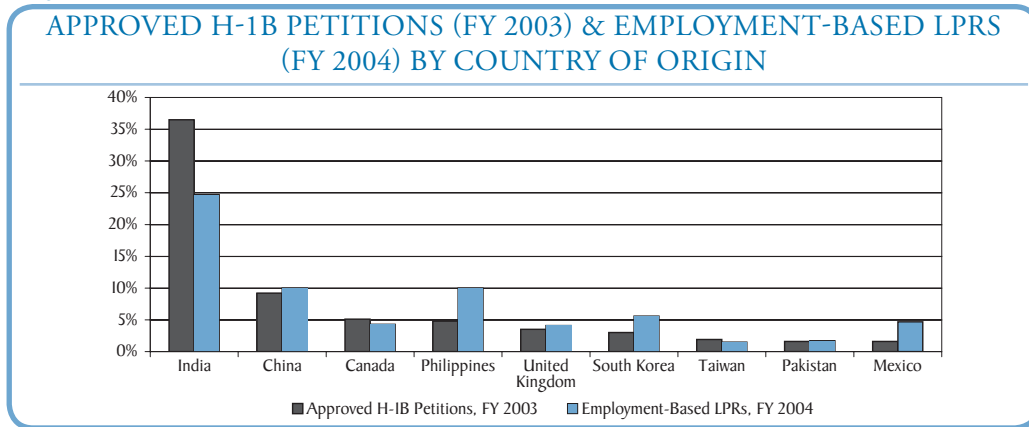
<sup>31</sup> Adam Cohen, "More EU Nations Lift Restrictions on Foreign Labor," *New York Times*, March 13, 2006, p. A8.

<sup>32</sup> National Science Foundation, *Science and Education Indicators 2006*, p. 34.

<sup>33</sup> Office of Immigration Statistics, *Characteristics of Specialty Occupation Workers (H-1B): Fiscal Year 2003*, p. 8.

<sup>34</sup> Kelly Jefferys, *Characteristics of Employment-Based Legal Permanent Residents: 2004*, p. 2.

Figure 8:



Source: Office of Immigration Statistics, *Characteristics of Specialty Occupation Workers (H-1B): Fiscal Year 2003*, p. 8; Kelly Jefferys, *Characteristics of Employment-Based Legal Permanent Residents: 2004*, p. 2.

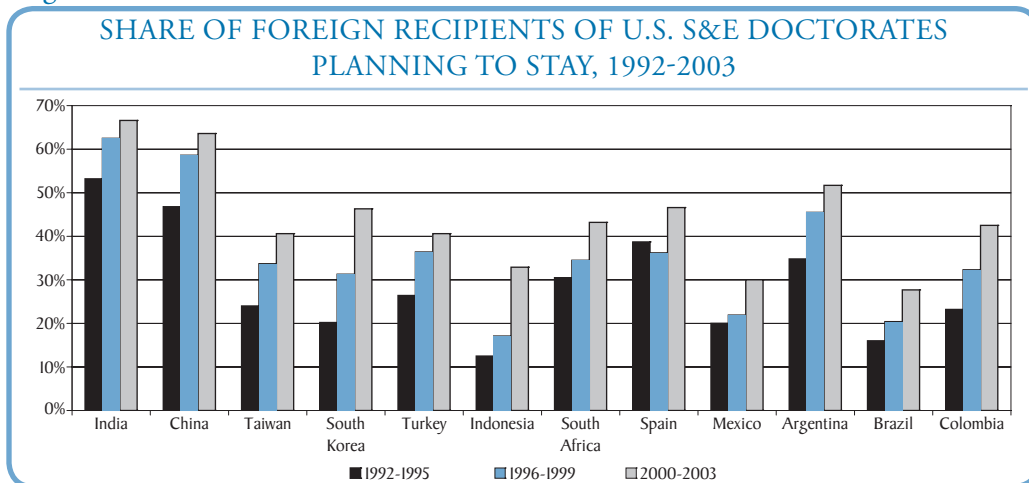
These figures testify to (1) India and China’s growing prominence as sources of scientists and engineers in the United States, and (2) the allure of the United States as a destination for talented professionals from those countries. Nevertheless, the danger facing the United States is “reverse brain drain,” whereby young people from India, China, and other emerging markets acquire cutting edge skills in American universities and corporations and then return home.

The available evidence does not provide any clear indication that this phenomenon is in fact occurring. Indeed, the “stay rates” of foreign recipients of American S&E doctorates—a reasonable proxy for the propensity of foreign-born professionals to remain in the United States—have risen in recent years {Figure 9}. Stay rates are influenced by economic conditions in both home and host countries. For example, the

1996-99 increase in stay rates of Ph.D. students from East Asia (Taiwan, South Korea, and especially Indonesia) partially reflected the impact of the Asian financial crisis that coincided with the American economic boom. The fact that a majority of foreign Ph.D. recipients (51.1 percent) voiced “definite plans” to stay in the United States in 2000-03 demonstrates the country’s attraction to foreign professionals despite the crash of the Information Technology (IT) sector, a manufacturing recession, and high-profile corporate scandals.<sup>35</sup>

However, the data on stay rates do not fully capture the repercussions of the September 11 terrorist attacks. F-1 student visa applications dropped from 380,385 in 2001 to 282,662 in 2004.<sup>36</sup> Moreover, anecdotal evidence suggests a general chilling of the foreign professional environment after September 11, as security concerns prompted the transfer of

Figure 9:



Source: National Science Foundation, *Science and Engineering Indicators 2006*, Appendix Table 2-33.

<sup>35</sup> National Science Foundation, *Science and Engineering Indicators 2006*, Appendix Table 2-33.

<sup>36</sup> National Science Foundation, *Science and Engineering Indicators 2006*, p. 3-37.

international scientific/technical conferences from the United States to other countries. The recent rebound of F-1 visa applications (333,161 in 2005) provides grounds for optimism that the September 11-related effects on the foreign professional community have begun to dissipate. Nevertheless, for talented young students and professionals from abroad who have multiple job opportunities, uncertainties over the course of U.S. immigration policy may heighten incentives to return home or seek positions in other countries.

## IMPLICATIONS FOR U.S. MANUFACTURERS

Any decrease in the supply of skilled foreign workers exacts a severe penalty on U.S. manufacturers who face growing competition from lower-cost manufacturers in Asia, Eastern Europe, and other emerging markets. Many of these same emerging market rivals of the United States are reaping the competitive advantages that come with the global diffusion of process technologies and operational best practices. Therefore, the prospect of reverse brain drain is particularly daunting for American manufacturers.

In addition, many U.S. manufacturers do not have the option of offshoring their operations. As a result of the IT revolution, which has permitted the rapid and secure trans-

mission of large information blocs across national borders, a growing share of back office business functions (finance, customer service, human resources) and professional services (legal, accounting, consulting, medical diagnostics) can be performed remotely.<sup>37</sup> Some large OEMs have outsourced wide swaths of their manufacturing operations to contract manufacturers (a phenomenon especially visible in consumer electronics), while others have become global supply chain integrators more than manufacturers (e.g., Dell). These economic and technological changes have lowered the threshold for global operations, enabling some small- and mid-sized U.S. manufacturers to undertake foreign activities previously reserved for multinational-sized companies. But for most small/medium U.S. manufacturers—which are major sources of job creation and which fill market niches that are too small to be interesting to global OEMs—manufacturing remains a local activity requiring a skilled local labor force.

Facing global rivals possessing unassailable cost advantages, U.S. manufacturers must attract employees with advanced training in science and engineering to meet the technical demands of modern manufacturing. Foreign-born professionals constitute a crucial part of the S&E workforce, underscoring the inextricable links between U.S. immigration policy and American manufacturing competitiveness.

<sup>37</sup> McKinsey Global Institute, *The Emerging Global Labor Market*, p. 38-39, 167.

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## BUILDING A COMPETITIVE WORKFORCE: Immigration & the U.S. Manufacturing Sector

by David L. Bartlett, Ph.D.

Shortages of skilled labor constitute the foremost challenge confronting U.S. manufacturers who face growing competition from manufacturers in Asia, Eastern Europe, and elsewhere. Demand for professionals with university degrees is rising as manufacturing becomes increasingly high tech. But the U.S. educational system is not producing enough highly educated native-born manufacturing workers to meet this growing demand. Moreover, the pending retirements of Baby Boom generation workers will further constrain the growth of the manufacturing labor force. Bridging this gap between the supply and demand for skilled workers requires new investments in the U.S. educational system and the formulation of immigration policies that respond to the labor needs of the U.S. economy. Yet current immigration policies, especially since 9/11, have made it more difficult for highly skilled professionals from abroad to enter the United States.



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