

## **The Renaissance of American Manufacturing**

**By Jim Ellison**

From its very beginnings, America has produced tinkerers like Jefferson, Franklin and Revere who built the things they envisioned. Men like this gave rise to the term “Yankee ingenuity”—that is, the notion that even upstart Americans could conceive, design and build useful products. In 1794, Eli Whitney invented the cotton gin, a machine that provided the means for cotton to become a major export product of agrarian America. Colt’s development of guns with interchangeable parts ultimately led to mass production of many different products. In the latter half of the 19<sup>th</sup> Century, the real momentum of American manufacturing began to emerge. Men like Thomas Edison, Henry Ford, the Dodge brothers, Charles Kettering, Cyrus McCormick, the Wright brothers and Henry Bessemer set the stage for 20<sup>th</sup>-century Americans to enjoy the first renaissance of manufacturing. The fortunes of that renaissance fueled the notion that manufacturing, not just agriculture, could contribute to economic growth.

Even before Model T Fords made all Americans mobile, U.S.-built threshing machines and steam-powered tractors had begun to automate farming. Steam locomotives built by Baldwin Lima Hamilton powered the movement of goods across the entire North American continent. Domestically produced steam-powered ships carried American agricultural and manufactured products to Europe and beyond. Americans innovated new mining machinery to extract coal and iron ore to satisfy global demand for American-made goods. And in 1859, Americans in Oil Creek, Pennsylvania first applied the oil drilling and refining equipment that would make gasoline available and affordable enough to fuel the internal combustion engines that would drive the auto and truck industries. By the mid-19<sup>th</sup> Century, even a global depression could not extinguish the American commitment to manufacturing as a core component of our economy and our culture.

History changed course during the dark days of World War II, which killed 70 million people and destroyed entire nations in Europe and the Pacific. The war also led to the second American renaissance. Reluctantly at first, but with increasing vigor after Pearl Harbor, Americans mobilized the nation to build the tools for war and for manufacturing post-war products while simultaneously committing their sons, daughters, husbands and wives to combat. The development of nuclear fission confirmed the country’s technological and productive capability. The ultimate Allied victory was equal parts courage in combat and production at home.

While the rest of the world rebuilt, America enjoyed a rich period of non-competitive growth. Pratt & Whitney made engines for commercial aircraft produced by Boeing, Douglas and Convair. GM, Ford and Chrysler built cars and trucks. AT&T (Bell Labs) developed communication products, and IBM made computers. All the while, American machine tool builders and steel companies fueled worldwide efforts to rebuild internal capacity.

A period of renaissance is often followed by a dark age, and so it was for some American industries. Business school libraries are filled with individual case histories that detail how entire industries fell from grace to oblivion. The machine tool industry in particular is identified as a group of historically successful companies that were not agile enough to recognize and adjust to changing realities of technology and global competitive forces. Too much success can breed indifference, and so it was with American machine tool companies. Rather than adopting U.S.-developed technologies for NC controls (later to become CNC) on a large scale, they preferred to rely on older technologies that had served them well for so long.

Grand and great companies that had so effectively served the production of the war and reconstruction now faced new competitive threats, largely from Japan. The Japanese offered basic, reliable products utilizing the latest technology at ownership costs well below those of the incumbent U.S. suppliers. These developments heralded the deaths of legacy companies like Warner & Swasey, Cincinnati Milling Machine, Kearney and Trecker, Bullard, American Tool, Monarch Machine, Burgmaster, Lamb, Cross, Norton, Pratt & Whitney, Gisholt, Jones & Lamson, Heald, Lucas, DeVlieg, Lodge and Shipley, Moog, and many more. The sector that had provided the basic tools to manufacture had essentially been hollowed out.

Interestingly, other industries experienced different outcomes. The steel industry closely followed the fate of the machine tool industry and fell from global significance. By contrast, the aerospace and defense industries relied on a common repository of developed technologies—NASA—to fuel competitiveness. They essentially banded together to maintain technical leadership. Aerospace thrived, and machine tools declined. Meanwhile, new technologies appeared, ranging from medical devices to computers, digital printing equipment, composite materials, and a new generation of farm, mining, logging and construction equipment. Leaders in these industries purchased machine tools from wherever they could to acquire the production capacity and productivity needed to sustain their competitive advantage. No tears were shed over lost American suppliers as they continued to turn to Asia and Europe for the required manufacturing technologies.

One interesting consequence of this shift to foreign supplied machines was the reliance of foreign builders on U.S. distributors to provide application engineering, training and service support. This elevated the distribution model to a clearly value-added portion of the delivery system for off-shore-manufactured machine tools. This shift does not presume a renaissance in manufacturing, but it does footnote the idea that American companies could rely on foreign-built machine tools, supported by domestic distributors, to continue meeting manufacturing goals during peacetime.

A parallel phenomenon in the business world contributed to the dark ages of manufacturing competency. In the years following World War II, the theory of consolidation as being more efficient and synergistic drove management to aggregate companies into conglomerates—Lytton Industries, Teledyne, United Technologies, Lockheed, Northrop, Boeing, Raytheon and General Electric, among others. Their approach to business was to eliminate costs and increase synergistic scale of efficiencies.

The idea of flatter, leaner organizations led to the inadvertent targeting of manufacturing engineering and tool designers as unnecessary costs that could be eliminated. Businesses favored outsourcing product. In contrast to vertically integrated manufacturing schemes, subcontractors could produce at lower cost and without the plant and overhead charges needed to turn out a finished product like an airplane, ship, automobile or truck. This created an enormous rise in private, often small enterprises that gladly took the responsibility to make quality parts at less cost for larger OEMs. Loss of knowledge and capabilities made U.S. manufacturers more dependent on outsourced services to develop new products and the means to produce them. Although this led to some increase in distribution-provided services, it ultimately contributed to financially-based decisions about the cost to build or buy. The increasingly global outreach of these conglomerates led them to reduce the capital deployed in U.S. manufacturing and to prefer off-shore sourcing as a way to increase return on investment and eliminate dependence on U.S. know-how. The promise of lower prices was irresistible, and America lost jobs and manufacturing control.

The 21<sup>st</sup> century ushered in new manufacturing realities. The first is that trade unions, politicians and economists have recognized that off-shore supply denies American jobs and control over core competencies while leaving us dependent on uncertain trade partners. Both labor and politicians now encourage re-shoring of U.S. manufacturing. This phenomenon is still playing out, but it appears to leave off-shoring as the preferred method of producing parts that are not impacted by automation, environmental restrictions, or higher costs for transportation or materials. Rising labor rates in Asia, India and Eastern Europe also contribute to new thoughts about sourcing.

The general rhetoric—perhaps even the common belief—is that American manufacturing is in decline. Jobs have been lost, and China and Germany are viewed as the new sources of manufacturing power. While it is true that both German and Chinese manufacturing is growing, America produces and exports more than both of those countries combined. Manufacturing is still a significant portion of the United States' \$15 trillion GDP. Although China could one day overtake the United States (the two countries are growing at 7.5 percent and 2 percent, respectively), its GDP is currently only about half that amount.

Of greater concern is the declining percentage of Americans deployed in manufacturing. At first blush, it may appear that this is further evidence of decline, but the greater story is one of productivity. That is, each labor hour generates more products of higher quality. Skilled machinists—or, more accurately, manufacturing technologists—from the baby boom era are retiring in alarming numbers. Meanwhile, the American educational system is failing to provide the basic math and science skills necessary for young high school graduates to qualify for even entry-level training positions. Despite high unemployment, there is a shortage of candidates who are qualified to enter the manufacturing sector.

Times have changed, and manufacturers no longer require a skilled machinist to run a single machine. They need technologists who understand cutting tools, machine

programming and editing, statistical process control, machine diagnostics, metrology, and the computer skills needed to communicate with ERP systems or enterprise-wide systems that oversee multiple machines. Supply and demand are favorable for these kinds of technologists, who have plenty of opportunities for a premium wage and significant benefits. A machine operator/machinist is no longer the critical labor component, and their wages reflect their declining value. A class “A” machinist earns about \$20 per hour, an amount that no longer facilitates paying a reasonable mortgage or sending children to college. That machinist earns less than a prison guard or carpenter. America desperately needs a vocational training system with a curriculum that matches the changing needs of industry and attracts qualified young people to begin careers as manufacturing technologists.

Despite diminished manufacturing jobs and a critical shortage of skilled labor, America appears to be experiencing a new manufacturing renaissance that is quite different from previous periods. It relies on three unrelated drivers: growth in subcontractors in virtually every industry group, new frontiers in computerized devices, and the elaborate financial models that underlie every decision to make or buy. Apple is a key example of the second and third of these drivers. The company’s cap value is greater than that of Boeing, yet it manufactures almost nothing at home and relies primarily on Asian subcontractors. The financial model that drives Apple and other technology companies preserves a high return on engineering and product development without the need to manufacture.

Yet, these companies are regarded as new renaissance manufacturers based on their design and assembly roles. Foxcon makes sufficient profits from manufacturing Apple parts to invest in rapidly expanding plant capacity while still providing profits to shareholders—Apple makes more. Even Samsung, its closest rival, relies on product engineering and systems development from a large research facility located only blocks from Apple in Silicon Valley. Nano technology, genetic engineering, 3-D printing, and satellite and space research are all following a similar model. The subcontracting growth began with business-school-spawned ideas about achieving high returns on invested capital by effectively penalizing vertically integrated companies and favoring subcontracting. In sectors ranging from aerospace, defense to automotive, medical, and energy, companies rely on subcontractors to build higher-quality parts delivered just in time. This new arm of American manufacturing accounted for more investment in new machine technologies and automation than OEM companies. Some have become large enough to rival the size and worth of their antecedent customers.

What comes next? Globalization has changed the world of manufacturing for good. We are not going to revert back to isolationism, and emerging markets in Africa, South America, India, Russia and China will not tolerate market exploitation without getting a piece of the action. They want profits, jobs and technology transfer—and they will get it. As byproduct of the potential competition, the advanced countries of the world must constantly find ways to become more productive, more innovative and willing to adopt new technologies to compete. Hourly labor costs will become less important as wages seek equilibrium. What will be more important is the training and education that nations provide to accommodate advanced manufacturing.

The American industrial renaissance is not unique to America. Other developed nations are following a similar path. The borders in the Americas will continue to blur as new plants are built in South America and Mexico to support global manufacturing strategies. The U.S. will continue to proudly be a manufacturing nation.