To Policy Makers and Industry Leaders:

Ten years from now, the global manufacturing sector will look nothing like it does today. Advanced manufacturing technology is rapidly transforming the global competitive landscape. The companies — and nations — that act now to seize its promise will thrive in the 21st century. Those who are devoted to incremental change and fail to engage in smart manufacturing will rapidly fall behind.

Along with 40 other leading companies and universities, Rockwell Automation and UCLA are part of a National Science Foundation initiative to define a roadmap for the implementation of advanced manufacturing technology — or smart manufacturing — in the United States.

Smart manufacturing marries information, technology and human ingenuity to bring about a rapid revolution in the development and application of manufacturing intelligence to every aspect of business. It will fundamentally change how products are invented, manufactured, shipped and sold. It will improve worker safety and protect the environment by making zero-emissions, zero-incident manufacturing possible. It will help keep jobs in this country by keeping manufacturers competitive in the global marketplace despite the substantially higher cost of doing business in the United States.

In the 1980s and ‘90s, manufacturers took steps to address those higher costs by reducing waste and improving their operations through “lean manufacturing” practices. Those efforts, while ongoing, are producing diminishing incremental returns. And businesses cannot cut their way to prosperity — innovation is the path to growth. It is time for a new, bold strategy for U.S. competitiveness that will capitalize on smart manufacturing as a strategic asset for growth.

Investments in a smart manufacturing infrastructure are essential to securing America’s industrial future, and the future economic well-being of our citizens. Smart manufacturing will increase the flexibility of our plants, lower the cost of products and improve environmental sustainability. It will enable us to development of innovative new products using next-generation materials.

We must act together to make that future a reality. Here are three crucial first steps:

• Invest in public-private partnerships to establish smart manufacturing innovation centers with “test beds” to catalyze and drive breakthroughs.

• Rebalance federal investments in research and development to restore equal funding for applied research at the same level as basic science.

• Prepare the country for the market-altering leaps in manufacturing productivity and efficiency that smart manufacturing will bring about.

We urge you to seize this opportunity for competitive leadership that smart manufacturing can deliver for American industry and workers and for the global marketplace, and to take action to make that opportunity a reality.

Sincerely,

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Profound transformations are coming within this decade in the way goods are manufactured — changes that will fundamentally alter the worldwide competitive marketplace.

Smart manufacturing technologies will drive these transformations in three rapid progressive phases:

**Phase 1**
- The integration of all manufacturing data throughout individual plants and across enterprises will facilitate significant, immediate improvements in costs, safety and environmental impacts.

**Phase 2**
- This data, paired with advanced computer simulation and modeling, will create robust “manufacturing intelligence” that will enable variable-speed, flexible manufacturing, optimal production rates, and faster product customization.

**Phase 3**
- As that manufacturing intelligence grows, it will inspire innovations in processes and products that comprise smart manufacturing’s promise — a major market disruption such as a $3,000 automobile or a $300 personal computer.

The countries and companies that strategically start this journey toward smart manufacturing and are first to achieve “manufacturing knowledge” will earn long-term competitive advantages well into the coming decades.

1. **Plant-and Enterprise-wide Integration**

   In its first phase, smart manufacturing will interconnect and better harmonize individual stages of manufacturing production to advance plant-wide efficiency.

   A typical manufacturing plant uses information technology, sensors, intelligent motors, computerized controls, production management software and the like to manage each specific stage or operation of a manufacturing process. However, each is an island of efficiency.

   Smart manufacturing will integrate these islands, enabling data sharing throughout the plant. The convergence between machine-gathered data and human intelligence will advance plant-wide optimization and enterprise-wide management objectives, including substantial increases in economic performance, worker safety and environmental sustainability. The emergence of this “manufacturing intelligence” will usher in the second phase of smart manufacturing.

2. **From Plant-wide Optimization to Manufacturing Intelligence**

   Connecting in-plant modeling and data technologies with high performance computing platforms (cloud computing) will make it possible to build significantly higher levels of manufacturing intelligence and connect it throughout the factory. Complete production lines and entire plants will run at variable speeds with real-time flexibility — which is not feasible now — in order to conserve energy and optimize outputs.

   Businesses will be able to develop advanced models and simulations of manufacturing processes to improve current and future operations. For instance, manufacturers will be able to develop models for the mass-manufacture of products and devices that use nanotechnology. Nanotechnology, as the name implies, involves the development of ultraminiaturized, highly complex devices, systems and materials. It is widely expected to revolutionize technology and industry with smaller, stronger, lighter weight materials and powerful precision devices for nearly every industry.
Monitors as small as the head of a pin may be implanted in a patient’s arterial stent to gather real-time data on blood flow. Lighter weight vehicles, made from nanotechnology-enabled materials, will be more fuel-efficient and safer. Nanotech-enabled sensors, tailored to detect specific toxins and biohazards, will help protect our armed forces, police and the public. It appears that nanotechnology will have even more profound effects on every aspect of our lives than did the invention of microchips and microprocessors. Its implementation will require the precision modeling and manufacturing that smart technology will enable.

The second phase of smart manufacturing also will connect factory-specific information to data throughout the supply chain — from raw material availability and customer demand through the delivery of finished goods. It will facilitate the use of smart grids to schedule energy-intensive activities during low-demand periods and slow production during peak energy demands. It will enable greater product customization, new product simulations and new, more efficient processes. It will support the production of safer products and precisely defined, faster product tracking.

3. Manufacturing Knowledge Will Inevitably Disrupt Markets

Smart manufacturing’s third phase will transform industry in a similar way to how the strategic use of information technology transformed the business model — and consumer shopping behavior — at Amazon.com. Amazon began 15 years ago as an online bookseller. By capturing extensive data about consumers’ book-buying habits, Amazon developed extensive knowledge about its customers’ lifestyles that enabled a “disruptive” shift in its business model. Within a decade, Amazon expanded its product offerings to span many new categories. It is now the largest U.S.-based online retailer. Books and other media represent only 52 percent of its $24 billion dollar net sales. As anyone who has ordered from Amazon knows, its Web site will suggest products you might like and tell you what other consumers bought when they considered a product you are viewing. In short, Amazon makes smart use of its industry knowledge to bolster its competitive advantage.

Smart manufacturing will deliver a similar, extraordinary shift in the competitive landscape of American industry. It will reverse the flow of the 100-year-old industrial supply chains that forced consumers to accept whatever was mass produced. Flexible factories and IT-optimized supply chains will change manufacturing processes to allow manufacturers to customize products to individual needs, such as medications with specific dosages and formulations. Customers will “tell” a factory what car to manufacture, what features to build into a personal computer or how to tailor a pair of jeans for a perfect fit.

This most dramatic — and competitively vital — third phase of implementing smart manufacturing will come from innovation spurred by this growing body of manufacturing knowledge. These will not be incremental or gradual changes — they will be game-changing, market-disruptive innovations in products and processes.

Changes at this phase will push down prices, open new markets and offer a broader array of choices to a wider range of people — such as $300 personal computers, or the $3,000 car produced in the smart-designed Tata Motors factory in India.

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Product innovations will arise from the creative use of smart manufacturing intelligence gathered from every point of the supply chain, from consumer preferences through production and delivery mechanisms.

The knowledge businesses gain through process innovations will transfer far beyond the doors of manufacturing into the services sector at every level, delivering better pricing through improved process efficiency and economies of scale. That knowledge transfer will, in turn, yield broader use of smart manufacturing technology — the application of new technology and new information to disparate fields.

Just as space exploration drove the innovations that led to everything from pacemaker technology to cell phones, and a vast array of other now-common household items — so too, the change in thinking and working that smart manufacturing will enable has the power to deliver disruptive innovations in every sector of society. It is time for the public and private sectors to make that leap possible.

**Smart Manufacturing Essential to U.S. Industrial Strategies**

The United States must engage an effective industrial strategy for smart manufacturing through public-private partnerships, in order to retain our global economic competitiveness. Acting now will deliver near-term and long-term economic gains for America’s industries and consumers. Delaying will hand those successes to the economies of other nations.

Already, innovative companies in some of the world’s emerging economies are building “smart” factories: those designed deliver quality products at significantly reduced costs through innovation and production processes radically different from those in place in most industries today. These are not cheap labor-cheap parts solutions; they are entirely new ways of operating industrial plants through the intersection of human innovation and integrated technology.

American manufacturers must have the support of the public sector to catalyze breakthroughs with these smart technologies in rapidly successive phases. Public-private partnerships will advance applied research, mitigate risk in the initial phases of this change, and spread the benefits rapidly throughout the nation’s businesses.

**Federal applied research funding — a gap of more than $10 billion.**

To retain our global competitive leadership, America must re-invest in applied research and in innovation centers for smart manufacturing, and prepare ourselves to win in the profoundly changed market realities this decade will bring.
Invest in smart manufacturing to spur innovation and keep America competitive

America must invest in applied research funding to enable smart manufacturing to take root in our industries, spur additional process and product innovations, and keep American industry competitive.

An August 2009 article in the Harvard Business Review, discussing strategies to restore U.S. industrial competitiveness, emphasized the impact of a shift in federal funding away from applied research — the research that is essential to manufacturing innovation. Applied research funding dropped more than 40 percent from 1990 to 1998. Prior to 1990, funding for applied research and basic science research had been equal. Current federal funding for applied research is 30 percent lower than funding for basic science — a gap of more than $10 billion which continues to grow larger.

To retain our global competitive leadership, America must re-invest in applied research and in demonstration sites for smart manufacturing, and prepare ourselves to win in the profoundly changed market realities this decade will bring.

Your call to action:

• **Invest in public-private partnerships to establish smart manufacturing innovation centers with “test beds” to catalyze and drive breakthroughs.**

  “Test beds” will mitigate the risk that individual companies would face in researching and implementing smart manufacturing on their own. Test beds bring together government, manufacturing and university resources to accelerate the development of broadly applicable approaches and technologies. The European Union has already committed €1.2 billion to a smart-manufacturing applied research program through such public-private partnerships.

• **Rebalance federal investments in research and development to restore equal funding for applied research at the same level as basic science.**

  To transform American manufacturing and make it competitive for the 21st century, Congress and the Administration need to close the major funding gap between applied research and basic science. Funding must return to the pre-1990 levels. It is no coincidence that when basic and applied research funding were equal, the manufacturing sector was stronger and more competitive.

• **Prepare the country for the market-altering leaps in manufacturing productivity and efficiency that smart manufacturing will bring about.**

  Learn about smart manufacturing and its benefits for consumers and workers. Support programs to promote more efficient energy use and improve the environment using Smart, Safe and Sustainable Manufacturing.

For more information, contact Bruce Quinn, Vice President for Government Affairs for rockwell Automation at 202-215-9782, or visit the National Science Foundation Smart Manufacturing Initiative website at http://oit.ucla.edu/smart_process_manufacturing/