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Manufacturing's Role in Creating a Smarter Planet

The Internet of Things was born in manufacturing. Now manufacturers need to catch up.

The concept of the Internet of Things is much talked about as a certainty in our future. The premise is simple: that everything will be connected via the Internet, and the world will be a smarter planet because of it.

Figure 1. A depiction of the Internet of Things. (Source: Program for the China International Internet of Things Conference, 2010).

At the China International Internet of Things Conference in Shanghai in 2010, experts predicted that the emerging industry of global information communication will become a trillion dollar industry, with 50 billion end-points connected to the Internet of Things by 2020[1]. That pales in comparison to IBM's estimate that there are already a trillion networked things in the world[2]. Regardless of which definition of thing you choose to count, and which estimate of the number of things you believe, there's no doubt that there will be a growing number of interconnected devices, products, resources, infrastructure, animals and humans. In China alone, compounded annual growth rate for the Internet of Things is expected to be 30% during the next 5 years[3].

IBM and a host of other technology companies are hanging their corporate strategy hats on the Internet of Things concept. IBM's Smarter Planet initiative espouses the company's goal to provide the technology that will connect devices around the world to make the planet smarter: with less traffic, healthier food, cleaner water, and safer cities.

IBM's mantra:

> **1. Instrument the world.**
> **2. Interconnect them.**
> **3. Make them intelligent.**

Hey, wait a minute. Instrumentation? Network connectivity? Intelligence? That sounds like what we've been doing in Industrial Automation for decades. In our factories and assembly lines, plants and mills, substations and pipelines—industrial automation engineers and operations personnel have relied on sensors and instrumentation to monitor the states and conditions of their operation. Industrial networks connect the sensors and instruments, distributing the data to the control & automation applications. It's sometimes referred to as Machine-to-Machine (M2M) communication within closed loop control systems or machinery automation systems.

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1. Program for the China International Internet of Things Conference, Shanghai, 2010.
2. Taft, Darryl K., eWeek, "IT & Network Infrastructure: 25 Things You Might Not Know About IBM's Smarter Planet Strategy", October 19, 2009.
3. Program for the China International Internet of Things Conference, Shanghai, 2010.

Indeed, the factory floor, process plants and utilities have been the proving ground for many of the technologies that are catapulting us in this revolution dubbed the Internet of Things. But as wireless, mobile, nano and computing technologies have advanced in strides in recent years—infiltrating our everyday lives as connected consumers and entertainment and social media junkies'—manufacturers have been cautious to adopt them.

There are myriad issues to resolve when considering connecting our systems and mining the data located within. While some issues are technical, those are the issues that will be most easily solved through innovation and competent system integration. The biggest challenges will be in guarding against misuse of the information, and will require systemic, regulatory responses supported by intra-industry and inter-company collaboration. Security of corporate information and critical infrastructure. Privacy and legitimacy of data usage. Personal and public safety. Environmental responsibility and stewardship. These are the real obstacles to—and opportunities for—a ubiquitous Internet of Things.

IBM's President & CEO, Samuel J. Palmisano, says he's asked questions all the time about how to implement smarter systems in corporations and public infrastructure. However, the questions are about how to garner support and agree on a direction. "They are not questions about technology. They are questions about leadership,"[4] Palmisano says.

"Just as the systems of a smarter planet are inherently multi-stakeholder, so the issues they raise inherently span all sectors of society," Palmisano says. "The key is collaboration."

He calls on us all to learn from the progressive leaders who are showing the way. They are CIOs and IT managers with visions of interconnected operations, and CTOs and engineers with technology and tools at their disposal. They are academics working on the new frontiers. They are government officials, regulators and trade organizations working towards higher safety and compatibility standards. They are consumer marketing strategists starting to place production decisions in the hands of customers. They are working not only for corporate strategic advantage, but for sustainability and greater public good. That is … a smarter planet.

The smarter planet is an inter-connected world, where time and distance collapse, where consumer behavior instantaneously triggers corporate responses, where product responsibility exists from cradle-to-grave. The world is becoming a closed loop system … and fortunately, that's a model with which manufacturers are familiar!

In this new connected era, manufacturing operations cannot be separated from the bigger social picture. Manufacturing is the forum in which corporate response will take place, and where traceability is initiated. Manufacturing is a vital piece of the closed-loop social system of the future.

While many of the techniques and technologies of closed-loop systems are familiar to manufacturers, the seven trends discussed in this white paper are new. While some trends affect the Factory and some affect the Product, they all have long-reaching impact for a manufacturer's competitiveness and profitability. The IT, design & development, process engineers, operations, and strategic managers who run manufacturing companies should start to prepare for them, put in place strategies, and begin adopting them in order to stay competitive.

1. Instrument everything and everyone

The sensors and switches found in instrumentation devices are getting smaller, with lower power requirements. In the mid-90s, MEMS (Micro-Electro-Mechanical Systems) started appearing in commercial products, as the tiny pressure, temperature, chemical and vibration sensors, accelerometers and switches used to monitor and control our devices.

MOEMS added optical components to our sensors and switches. These same solid-state techniques are being used to create nano-electro-mechanical systems (NEMS) allowing fabrication of yet smaller microprocessors.

Nanotechnology also holds promise for atomic- or molecular-sized electronic circuits, nano-robotics and the fabrication of biomaterials. As the science and its applications advance, it is conceivable that nanotechnology's progeny will follow Moore's Law (that the number of transistors on a chip doubles every 18 months), becoming smaller and more capable at lower cost.

In parallel, wireless technologies are advancing and becoming more common place, more reliable and more capable. The significance for manufacturing is that the traditional model of data collection from static end-points connected on a wired sensor network, fieldbus or computing network may soon be a mere fraction of all the data collected. Wireless technology is creating a burgeoning business in tiny wireless sensors and actuators, supported by the wireless networks that connect them.

A broad spectrum of radio-frequency technologies is available for various applications. Wireless networks based on the IEEE 802.15.4 standard for low cost, low data rate personal area networks (wirelessHART, MiFi, ZigBee, ISA100) have been used extensively in sensor networks. Now, used in conjunction with 6LoWPAN, an acronym for IPv6 Low Power Wireless Personal Area Networks, basically any device on the network using standard internet protocol effectively has embedded wireless internet. This opens up a litany of possibilities for smart wireless sensor networks, and is the basis for many utility Smart Grid models, environmental monitoring and energy conservation programs.

Figure 2. Passive RFID adoption.
(Source: ASI Research)

RFID is another type of monitoring and data collection network to have benfited from advances in wireless technologies. Short- to mid-range wireless technologies have proven themselves in the factory and warehouse RFID applications for localized scanning of RFID-tagged items in inventory and supply chain management, as seen in Figure 2. Now, a revolution is taking place in RFID, according to Dr. Peter Harrop, Chairman of IDTechEx[5]. First there was a passive RFID tag, an application which ASI Research's graph in Figure xx shows has grown exponentially in recent years.

Then came conventional active RFID, which used a battery in the tag to initiate a signal – as in the remote car door keyfob which alone have generated about$2 billion in sales. Second generation active RFID is the Real Time Locating System (RTLS), where people or things are located almost continuously from 30-300 meters away, usually by using many emitters. In the third generation
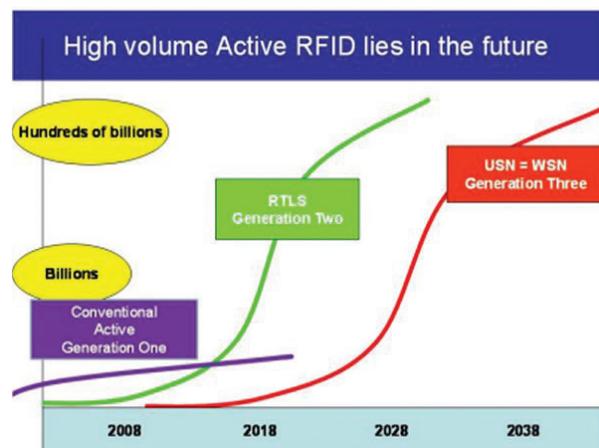
4. Palmisano, Samuel J. IBM Chairman of the Board, President and CEO, addressing business and civic leaders at Chatham House, London, January 12, 2010.

5. Harrop, Dr. Peter, Chairman of IDTechEx, "Third generation active RFID bursts onto the scene."

Ubiquitous Sensor Network (USN), the RFID tag doubles as a reader and mesh network with a choice of sensors on each tag, making it scalable, self-healing, affordable and extraordinarily capable. Figure 3 shows IDTechEx's forecasted adoption rates that go along with its prediction of a multi-billion dollar market.

These more capable RFID tags will make it possible to identify and track just about anything throughout its lifecycle at reasonable cost.

Further, ongoing standardization of communications protocols make it possible to collect data from sensors almost anywhere at any time. The consortium EPCglobal is an example of collaboration for standardization. The main focus of the group currently is to create both a worldwide standard for RFID and the use of the Internet to share data. EPCglobal's board of governors includes representatives from Auto-ID Labs, Cisco Systems, DHL/Exel Supply Chain, Haier Group, Johnson & Johnson, Kimberly-Clark, LG Electronics, Lockheed Martin, METRO, Novartis Pharma, Office of the Secretary of Defense, Procter & Gamble, Sony, Dow Chemical and Wal-Mart—a wide cross section of manufacturers, distribution and technology companies combined with industry and governmental bodies.

Amongst its specifications, the EPCglobal RFID standards doesn't require embedded information. Rather, it specifies an identifier to point to a digital location where everything related to that ID is stored. Because, in the future, data about individual items will abound, and storage and retrieval of that data will be critical to a company's information systems. I will discuss this further in the third Trend: Ubiquitous Data and Big Data Management—the New IT Frontier.

So RFID used in all manner of product will make possible the smart consumer systems we've heard about when people talk about the Internet of Things: smart appliances, easy shopping and returns, and personalized experiences.

For manufacturers, RFID will continue to be used in supply chain management, except that it will feedforward information automatically, and carry far more information about the product. RFID makes possible the cradle-to-grave traceability demanded for security, safety monitoring and waste management.

In the future factory, sensors and instrumentation will no longer be used just for controlling production machinery. Data collection will no longer take place only as a stationary application. Sensors and tags will also become integral to our raw materials, tools and processes, manufactured products, tracing documentation and laborers. They will monitor for hazards and worker safety. They will monitor and control energy consumption and efficiency. They'll ensure adherence to process standards, and will trace parts and products throughout their lifecycle—from production to disposal. Sensors and tags, in particular ubiquitous wireless ones embedded in our production tools and in the products of its output, will form the foundation of the information systems we use to record our business activity and consumer behavior, and make our strategic decisions.

Then consider smart phones, which are increasingly used to read and write data. They can be used as both a reader (e.g. barcodes reader) and writer (e.g. smart wallet swiped over RFID reader). Further, with their embedded proximity sensors, GPSs, accelerometers and other sensors, the smart phone is rapidly becoming a valuable source of data, as well as a means of distributing data.

2. Interconnect for a Culture of Immediacy, Adaptability and Predictive Planning

Needless to say, all these embedded wireless devices will be connected to some form of network. In the traditional factory floor application, devices will still be connected to a sensor network or fieldbus mentioned above, or directly to a control network or computing network.

But the opportunities for connectivity don't stop there. Long-range technologies (cellular, microwave), whose infrastructure costs are significant, have been the domain of the telecommunications and utility companies. These long-range technologies have been used for decades for remote telemetry and data communications. With mid-range wireless high data-rate technologies (WiFi, Bluetooth) pervading consumer entertainment and communications devices, granting access to the internet from just about anywhere, the connectivity expectation is set. It's not a far stretch to imagine that any device, sensor, or RFID tag that communicates using internet protocol can and eventually will be connected to the internet from anywhere.

What happens when a manufacturer's world is interconnected? When the status of production in your supply chain is visible to you? When one facility sees the results of a process improvement trial at the same time it is performed on the other side of the globe? When reports of product failures are reported directly to you in real-time? When customer usage information feeds into your design and production planning offices?

Distances are effectively shortened, and collaboration is easier. Historical information and analysis gives way to real-time analysis of data. Real-time analysis and trending produces better predictive models.

Real-time feedback shortens cycle times all along a product's lifecycle. As a manufacturer, it's understood that shorter production cycle times typically mean lower inventory costs and better asset utilization, as productivity is higher and inventory turns over faster. It's also understood that real-time feed forward from the supply chain helps to synchronize production to supply for better JIT inventory control with minimal idle inventory. Likewise, feedback from the distribution chain and consumer base about consumer preferences or quality issues helps synchronize production to demand to minimize over-production of unwanted product, stop defective products from leaving the factory and reduce lead-times for products in high demand.

Interconnection takes much of the guess work out of production planning, and fosters a more adaptable, predictive style of production planning.

3. Ubiquitous Data Collection and Big Data Management —The New IT Frontiers

As ubiquitous sensors, RFID tags and other information-sensing mobile devices collecting data continually starts to become the norm, we face another computing challenge unparalleled in computing history. The amounts of data collected and stored will be enormous. In fact, experts recognize that the storage and retrieval methods used to organize and sift through all the accumulated data will overwhelm traditional data management systems.

The information technology (IT) world is on the verge of its own transitional breakthroughs as academics, standards organizations, technology companies and corporate CIOs collaborate to re-invent the systems that manage so-called 'Big Data'.

What's needed for Big Data management are massively parallel processing (MPP) databases—distributed databases running on tens, hundreds or even thousands of servers. Advanced datamining grids and analytic tools are needed to help with visualization and interpretation of these very large datasets. Cloud-based computing platforms may provide scalable data storage and other vitualization solutions, and help to distribute and share the results of data analysis.

The fields of genomics, astronomy and atmospheric sciences have advanced recently in part due to vastly superior computational processing abilities. Photographic and video archiving, military surveillance, call detail recording, and web-based document provisioning have all tested and expanded the capabilities of storage, indexing and retrieval techniques. Social networking has added its own technological dimension with networks required to manage structured and unstructured data, synchronous and asynchronous communication.

As manufacturers begin to collect more data, they will also need to consider how they will store, retrieve, distribute and analyze that data within reasonable elapsed times. Corporate CIOs and IT managers will need to collaborate with manufacturing operations and the supply chain, marketing and distribution, service and maintenance departments, regulators and industry organizations—all the touch-points of the manufacturer's product during its lifecycle—to manage and effectively make use of the data.

This is the new frontier of Information Technology. While some may worry that cloud-computing and hosted systems negate the need for IT personnel in manufacturing operations, others embrace the new frontiers as opportunities for IT to again become a competitive advantage. Leadership and technical savvy in IT is required to develop a vision of how an interconnected world will benefit the corporation.

4. Using Intelligence as Competitive Advantage

Collecting the data is a critical first step. But so much data can be overwhelming. Knowing how to use it is what will give a company its strategic insights—market intelligence, innovation, and efficiencies to drive higher quality and higher productivity.

Myriad companies sell analytic tools, and computation power is abundant and relatively inexpensive these days making data crunching and analysis feasible. Where you once infered, now you know. Where you once interpolated and extrapolated, now you can determine.

The analytic tools help recognize trends, patterns, correlations in data collected. Manufacturers are familiar with these analytic tools being used in Statistical Process Control (SPC), where trending away from a target will trigger a corrective control action. Similarly, a trend or correlation in sales or usage data might trigger adjustments in production plans, target markets, or distribution techniques. Further, analysis of historical data in relation to predictions from past occurrences will help refine models to predict future outcomes in a new era of predictive analysis.

Data analysis can also highlight outliers that might represent opportunities for new markets or product innovation. The key is in knowing what information you need, how to get it economically, and how to distribute it to the people who need it in order to manage for efficiency and productivity, and seize new opportunities.

It will also be critical to output the results of analysis clearly through displays of dashboards, graphical depictions, imaging techniques, and auditory outputs that alert operators and managers to key performance indicators (KPIs), events and alarm conditions. Like an air traffic control tower, the production control room displays and controls will need to provide an birds-eye view of a manufacturers global factory operations and critical supply chain interfaces.

5. Software is a Critical Part of any Manufacturing Operation

In addition to IT staff, manufacturers in this brave new world are likely to see an influx of another kind of technology expert: the software and systems integration professional.

Software is now an integral part of almost all production equipment and manufactured product. Software is the thread in the fabric of microelectronics, sensors and mechanical technologies that makes them instrumented, intelligent and interconnected. As more parts and components embed software, and interconnection at multiple layers and stages of production are needed, systems engineering and integration will be critical.

If it hasn't happened yet, it will soon. Manufacturers of even 'low-tech' products are hiring or sub-contracting embedded software and systems integration teams in their product development groups. Development and operations management are facing a new set of challenges: issues like software version control and documentation, platform and software migration paths, compatibility and connectivity.

Further, process engineering teams are being augmented with software and systems expertise to optimize and support production. However, it may not be quality or throughput they are trying to control better. The control loops of the future include profitability, sustainability and energy conservation. Control and process engineers should be challenged to incorporate broader corporate and societal goals in their process optimization.

It will take leadership and collaboration to welcome this new breed of professionals and the challenges and opportunities they bring with them.

6. The Digital Factory

Customers' perpetual demand for the latest-and-greatest, now in a customizable format, is putting pressure on manufacturer's to be more flexible and adaptable, and produce smaller batch sizes even as small as one. It's too expensive to rebuild automated factories and processes for every modification and design change. So some manufacturers are responding with build-to-order capabilities, where intelligent robots and advanced machines fabricating customized products on demand. New advancements in manufacturing technology are facilitating the

process: 3D printing and direct digital manufacturing are allowing manufacturers to go directly from an electronic virtualization of a part to the final product, bypassing tooling to save time and capital resources.

However, the onus to respond to customer demand does not rest solely with the manufacturing group. The product's design needs to incorporate options that can be selected on-demand, or deduced from online customer buying patterns or usage preferences. Real-time, dynamic pricing models may be called for. And manufacturers will need to document and attribute each unique product design, assembled genealogy, quality statistics to the individual product itself for cradle-to-grave traceability and support.

Further, traditional distribution systems may need to be reconsidered, as smaller lot sizes and distributed manufacturing alter the sources of efficiencies and economies of scale. Distributed local manufacturing may make sense in order to customize and deliver products in lot sizes as small as one for local markets.

Here again, distributed sources and consumption of information—to and from customers, marketing, design teams, supply chains and distribution, regulatory bodies, and manufacturing facilities around the world—are facilitated by ubiquitous data collection, interconnection and intelligence at all stages of the product's lifecycle.

7. Data Association for Dynamic, Responsive and Adaptable Value Chains

Figure 4. All corporate functions interact with the Digital Factory with data association from feedforward, feedback and collaboration.

Corporate management will face profound changes in other areas of the business, and manufacturing management in the Digital Factory will be an integral part of the solution. As traditional business models based largely on static information give way to responsive, predictive and adaptable models, and as new technologies are tapped in search of new ways to create value, there will be game-changing opportunities for companies to differentiate and seize competitive advantage, as well as to put in place sustainable and profitable strategies and business models.

Every touch-point along a product's value chain will be a source of information required either for regulatory purposes, consumer purchasing decisions, or corporate intelligence. From designer to sub-contractor to manufacturer to distribution to customer to service centers to disposal/recycling centers, CIOs and other IT and technology experts will need to figure out how best to collect, manage, retrieve, analyze and distribute information to those who require it, in secure and cost-effective systems.

A key challenge will be data association—whereby data from one system is related to a disparate system. It's a challenge that will need collaboration from multiple disciplines in a company, software and systems vendors, standards and trade organization in order to solve the complexities of data association.

Some examples of how data association will help make our systems smarter are cited below:

- **Smart parts and materials for better traceability and compliance**. Embedding parts and materials with unique identifiers will start the information trail for traceability from cradle to grave. The ID tags can identify a part's material, test and quality results, and expiry, retirement, replacement and recycling plan. Further, it simplifies documentation and reporting required for DoD UID registry and the new European waste, packaging and hazardous materials laws (WEEE and ROHS), opening new market opportunities for compliant products.

  Manufacturing software suppliers are enabling Product Lifecycle Management (PLM) data association between CAD software and factory floor machines, control architectures and MES systems so that design and process changes and product configuration information can be captured as part of a product's genealogy.

  Manufacturers of food and beverage and other perishables, and the consumer- and industrial-scale appliances that house them, are improving the ways they monitor the environment in which their products are stored and transported, and investigating ways to automate a product's removal from consumer distribution if it has been improperly handled or has reached expiration.

- **Smart devices for better design, service and end-of-life feedback.** Smart devices and social networks can report back on their own operating status, wear and tear, re-tries, calibration, and failures. This feedback can lead to new product designs and innovation, and better quality products. It will provide better warranty and service forecasting, as a manufacturer will know the number of remaining units and their service trends. Products can proactively be scheduled for routine maintenance based on usage data, to reduce unplanned downtime and catastrophic failures. In the event of product failure, recall information will be faster and more comprehensive, while production planning can be based on the rate of reported failures.

- **Smart, connected workers capture and deliver "knowledge".** Workers enabled with information about quality, schedules, and consumer preferences will be able to make better decisions. Laborers whose movements are captured and correlated with productivity rates will help determine and replicate best practices. Sales and distribution channels using marketing automation tools will have the opportunity to make every customer interaction one that builds loyalty and ongoing business. Employees throughout the organization will be able to contribute to green and sustainable initiatives. Opportunities abound to empower workers to make decisions that improve productivity and responsiveness, and to reverse the loss of knowledge due to aging workforce.

Interconnection, flexibility and customizability will need to be built into the production process, the product, and the product's life cycle management. It will be the job of brand managers, business analysts and CTOs to figure out corporate product and customer communications vision and strategies. The task of making the vision actually work will fall to the CIOs to provide the leadership, and IT managers, system engineers and technology experts to roll out the solution.

Overcoming challenges and barriers

There are many issues to overcome when data is at stake. Technology issues are the least of our worries: compatibility, data integrity, data rates and technology costs will sort themselves out as technological advancements continue at their dizzying pace.

The more sticky concerns are about 'surveillance society' and loss of personal privacy. There is always the question of who owns the data, and while it is still generally under control of the enterprise to determine what will be made public or shared through access rights, regulators and the public are hankering to be involved in those decisions.

Manufacturers, utilities, infrastructure providers and government bodies worry about cybersecurity and question whether our infrastructure will be no more secure than a laptop.

Further, some question how to make a system smart when nobody owns it? As the social networks, mobile information-sensing devices, open platforms, cloud computing and a plethora of technology and service providers become part of our systems, who takes ownership of them? Again, collaboration amongst corporations, government regulators and industry groups are the key to resolving these issues.

As IBM's Palmisano puts it: "Technology may be ready, but your culture may not be." He continues: "We need to build more than systems. We must build constituency. The key is collaboration." He urges corporate leaders to involve key players in the value chain—research partners, academia, infrastructure providers and government.

Lower barriers to adoption will prove out technology and techniques

Manufacturers are in the perfect position to be early adopters of the "Internet of Things" concept. As long-time users of sensor-driven manufacturing control systems, it is a reasonable extension to employ similar technology models used in control systems to drive other areas of the business.

In his article "The Future of Industrial Automation" in Automation.com, Jim Pinto writes that for automation companies: "Innovation comes from targeted application, rather than any hot, new technology. [They are] innovative extensions of technology developed for other mass markets, modified and adapted for industrial automation requirements."[6]

Undoubtedly, the cost of wireless sensors and actuators will continue to fall to enable widespread adoption. Network technologies and their standards will continue to evolve and prove themselves secure and reliable.

Companies can take steps now to begin exploring the new technologies, to understand their limitations and possibilities, and to open their doors to what the future may bring.

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6. Pinto, Jim. "The Future of Automation," Automation.com.

Table 1 lists some of the sensor-driven interconnected systems discussed in this paper, along with a brief summary of the benefits and current barriers to implementing the solution. It behooves a manufacturer to begin taking steps in the areas with lower barriers and risk, yet significant benefits.

Table 1. Examples of sensor-driven interconnected systems, their benefits and barriers for adoption.

Application	Benefits	Barrier
FACTORY		
Energy management	Cost savings. Lower emissions.	Few.
Environmental stewardship: hazardous material tracking, carbon counting and emissions tracking.	Better tracking of measured resources and outputs.	Few.
Quality and process improvements.	Higher quality. Higher productivity.	Few.
Parts tracking	Higher productivity.	Few.
Asset tracking	Better asset utilization. Lower capital cost.	Few.
Laborer skills and movement tracking	Higher productivity. Best practices replication.	Privacy issues.
Supply chain collaboration	Better throughput, less waste.	Few. Some data association expertise needed.
Design collaboration	Better product design, quality and innovation.	Few. Some data association expertise needed.
Build-to-order	Better customer responsiveness. Less over-production and inventory cost.	Capital costs of 3D and digital manufacturing equipment, new distribution methods.
Distributed manufacturing	Closer to markets and/or supplies. Faster time-to-market and time-to-value.	May be capital intensive. May require control over distribution chain.
PRODUCT		
Unique parts identification	Cradle-to-grave information. Better compliance reporting.	Few in manufacturing. Distribution and consumer info management needed.
Perishable products ID/tracking	Better consumer safety. Better information for recalls.	Few in manufacturing. Collaboration in distribution chain needed.
Smart appliances	Convenience, better service.	Widespread adoption and collaboration required.
Product Lifecycle Management. Automated service tracking.	Better compliance reporting. Better service information and quality.	May be some data association challenges. Requires control over distribution, service and maintenance facilities.
Customer-sensing configuration	Products & services better suited to customer preferences.	Privacy issues.
Consumer usage stats	Feedback for design, innovation.	Privacy issues.
End-of-Life planning: disposal, recycling.	Better environmental stewardship.	Requires consumer cooperation. May require control over distribution, service and maintenance facilities.

When the options above are ranked according to potential benefit to the corporation compared to the risks and challenges associated with them, the prime targets for a corporation's steps towards a Smarter Planet are likely found in the list below:

- **Energy efficiency monitoring and control.** Consumption monitoring, with time-of-day control and peak-demand shedding. Power factor monitoring and phase shifting. Increased energy efficiency of 15%-25%.

- **Process optimization through SPC.** Automated quality monitoring, where statistical trends in data trigger corrective action.

- **Time & Labor Tracking.** Working with laborers to develop the most automated comprehensive system tolerated within the limits of local privacy customs.

- **Asset tracking.** Beyond labeling a tool or die. Also tagging it with its production limits and acceptable uses, i.e. the part ID numbers it produces, processes or work cells where it is used, and laborers permitted to use it.

- **Parts tracking, including the unique (UID) model used in the Aerospace & Defense industry.** Tracking parts in the supply chain, and movement through production stages. Synchronizing JIT deliveries and point-of-consumption with demand pull inventory systems.

- **Material content tracking.** Documentation of material content, especially hazardous materials, from raw material supply throughout the supply chain and processing to comply with European waste and hazardous material disposal laws.

- **Carbon counting.** Emissions monitoring to track and demonstrate reductions in emissions, calculate carbon credits.

- **Centralized production control.** Central displays of key operations and performance indicators from multiple global facilities. Central control and command. Centralized planning and analysis for optimal asset utilization and replication of best practices.

These applications can all be done with proven sensor and network technology, existing computing methods and processors, and relatively established industry standards so that risk and uncertainty is minimized. Capital outlay is also relatively predicatable, and the benefits are documented from other early adoption so Return on Investment calculations are feasible.

Each can be extended from localized manufacturing trials, to broader multi-facility implementations reaching into supply and distribution chains for even greater benefit.

IBM's Palmisano concludes: The time to act is now! "Applying smarter technologies to drive cost out of our legacy systems and institutions—doing more with less will be critical to our near-term and long-term economic prospects. We will need to extend our infrastructure's useful lifetime, and we will need to ensure that next-generation systems

are inherently more efficient, flexible and resilient. The good news is, it's happening. Forward-thinking leaders are learning how to make their parts of our planet smarter."

As executives and managers of manufacturing companies, we need to embrace new technologies and network paradigms within the strategies we put in place for product life cycle management and global facilities optimization. The Internet of Things is not that different from our familiar models of industrial automation and closed loop control. Manufacturers can immediately take progressive steps towards energy conservation, parts and materials traceability, and resources stewardship to do our part in making a smarter planet.

About Serenic Software

Serenic Software develops and delivers mission-critical ERP software solutions for public service organizations including: K-12 school districts/boards, public sector, nonprofits (NPOs), and international non-governmental organizations (NGOs). Serenic is a Gold ERP and ISV vendor and a development partner for Microsoft. Serenic public service solutions are trusted by over 1,000 organizations around the globe. You can learn more about Serenic Software at www.serenic.com.

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