Smarter Products

The Building Blocks for a Smarter Planet

by Scott Hebner
Vice President, Marketing and Strategy, IBM Rational Software

Innovation for a smarter planet.

Contents

Executive Overview

As a way to differentiate their offerings and optimize business returns, manufacturers across all industries are delivering a new generation of "smarter products." They are unleashing the creativity and productivity of the individual like never before -- whether that's an individual business or an individual person. These smarter products can better adapt to the unique needs, preferences, and characteristics of consumers to get things done. They are helping people tackle many of their biggest challenges, and they better exploit scarce resources such as time, money, skills and energy. As a result, they are sparking innovation for a smarter planet and transforming our world as we know it. We are entering a new era of flexible, real-time customization where the products we rely on are consumed seamlessly within integrated experiences or processes.

How is this all happening? What is new? Product companies are tapping into accelerating innovation using **embedded software control** – the new "brains" that make products smarter. When software is effectively fused with micro-electronic, actuator, sensor, and mechanical technologies, products can become increasingly **intelligent**, **instrumented,** and **interconnected.** That is, they can respond to changes quickly and accurately and produce better results by anticipating and optimizing for future events. They can measure and sense the relevant condition and are able to interact with other products, people, and IT systems in entirely new ways. This is what makes them "smart" – their ability to adapt to the unique needs of individual businesses and people.

As software becomes a critical ingredient in product innovation, traditional manufacturers are essentially becoming software companies. The success of traditional manufacturing companies across multiple industries is increasingly tied to how well they harness software to deliver a competitive advantage.

While this transformation is sparking unprecedented leaps in product value, it also introduces new challenges and implications. Today, 66% of products rely on software as a key differentiator.[1] And it's only going to continue to expand. The automotive industry, for example, is expected to experience a 165% growth in embedded software through 2015.[2] Even a key purchasing consideration for treadmills has become related to software innovation, not only for their mechanical capabilities.

For the world's manufacturers, software is playing an increasingly significant role in key business success factors such as customer satisfaction, safety ratings, product reliability, profitable cost and risk models, and their overall image as an innovator. For example, over 30% of car warranty costs are now related to electronics and their embedded software.[3]

The successful businesses of the future will be those that build a strong competency in software, which is where IBM can help. IBM has extensive expertise, technologies, tools, and methodologies to help the world's manufacturers and their consumers reap the value of smarter products as we all work toward building a smarter planet.

---

[1] Aberdeen Group, Embedded Systems Development report, March, 2009
[2] IDATE, "Software intensive systems in the future", September 2005
[3] IBM Institute for Business Value, "Shifting car makeup shakes up OEM status quo: Software strength is critical" whitepaper, 2002

A seismic shift is underway in how we interact with everyday products

There is something profound going on in how we humans run our daily lives. There are nearly 7 billion people on the planet – individuals with unique needs, desires, and approaches to getting things done and enjoying life. There are over 100 million businesses, worldwide, all facing a wide variety of challenges based on their unique characteristics and conditions. Yet for so long, the products they rely on have been largely "one-size-fits-all." They were not created for unique needs of individuals, but rather produced for the masses with limited options for personalization.

Thus the era of "one-size-fits all" products is rapidly coming to an end, shifting to a focus on integrated experiences designed to help businesses, institutions, and consumers get things done that are uniquely important to them. Manufacturers and consumers are realizing quickly that "individuality" – the desired experience – is what can differentiate their offerings in a competitive marketplace. As a result, mass production no longer dictates how people use specific products. Instead, businesses and consumers are craving personalization and integration of the products they rely on every day. This demand for "smarter products" is driving manufacturers and service providers to look for new and innovative ways to differentiate their products and enable them to be easily configurable to highly individualized experiences. In turn, this is driving consumer-focused businesses and individuals to invent new ways to solve big and small challenges – such as "Smarter Cities" that educate the young, keep citizens safe, attract and facilitate commerce, and enable the smooth flow of planes, trains, cars and pedestrians; or "Smarter Healthcare" that includes personalized work-out programs and monitors your status to improve your health. Smarter products are enabling innovation, and we are only at the beginning of this worldwide revolution in product design.

Demand is driving a need for unprecedented personalization and innovation in every industry

With the era of the "one-size-fits all" products drawing to a close, the result is a departure from the mass produced, "cold" commodities that once limited productivity in terms of energy, time, application of skills, and money. Consumers desire products that are better able to work together and help create experiences that are completely unique; molding to the specific preferences of an individual's objectives and personal characteristics. Businesses and consumers everywhere are looking to unleash the human experience and capability to succeed like never before and this is best accomplished with smart products that can adapt to the task at hand. Consider that in 2006 there were nearly 203 million licensed drivers the United States[4], yet clearly there are not 203 million uniquely manufactured automobiles tailored to the desired experience and unique needs of every driver. Well, not yet.

To be sure, there are many aspects of automobile design regarding safety that absolutely require the standardization that highway and auto regulations have evolved over the decades. Yet imagine this scenario, which could definitely give those 203 million drivers a different perspective on their daily commute:

As you exit your driveway, your car automatically senses you are leaving the residence and activates the home alarm system, thus ensuring the appropriate lighting is set. Your cell phone capabilities are automatically consumed into the car's dashboard without lifting a finger and enabled to the car's voice command system. Your iPod has already downloaded the podcasts for your daily business briefings that you to listen to right from your radio. Your car has been using your new GPS to analyze driving patterns and has recommended a new route to lower your fuel costs and help you avoid heavy traffic. Finally, the car informs you that your anti-lock brakes need servicing and has checked with the dealer and your Blackberry calendar to present options for Saturday morning appointments, which it knows you prefer from previous appointment patterns and your availability. An email is waiting for you to accept the appropriate time. Overall, you are comforted by knowing that you are in a safe vehicle. It understands its passenger load, assists in lane changes, and can detect and respond to potential threats. In the event of an accident it would balloon the airbag to the appropriate level based on your weight provided by the car seat sensor and would use the GPS and cell

---

[4] U.S. Dept of Transportation, Federal Highways Administration, Office of Highway Policy Information, Highway Statistics.

phone to call emergency services. You are encouraged knowing that nearly 2,800 lives have already been saved by such capabilities, according to the NHTSA.

This example of a "smart" automotive experience is just the tip of the iceberg. Businesses and consumers around the world are looking to revolutionize all types of industries and daily activities, from the treadmill that helps track weight loss, to the medical devices that can save lives, to the airplanes which bring passengers safely to their destination and to improving traffic flow in congested cities.

Yet the question remains, how can these demands and desires be met?   How are products becoming smarter?

Smarter products are increasingly complex, creating the need for a new paradigm in how they are designed, created and evolved.

First, they are becoming more **interconnected** so that people, systems, back-end applications and objects can communicate and interact with each other in entirely new ways. Mass production no longer dictates how people use specific products. For example, as quickly as a consumer activates their smartphone, they begin to forge a personal relationship with the phone, the applications and other systems with which it interconnects. When a collection of these smarter products are interconnected into an ecosystem to work together, it creates experiences that are completely unique and can mold to the specific preferences of an individual's daily work and personal life.

Second, they are becoming more **"intelligent"** and thus able to respond to changes quickly and accurately, and get better results by anticipating and optimizing for future events. This allows the array of products that a person, or business, is using to deliver an experience, or tackle a task, to better understand you or the problem. The technologies that allow manufacturers to build these increasingly intelligent products are completely transparent to the consumer, yet allow them to bring differentiated value to an increasingly commoditized market.

Lastly, they are becoming better **instrumented**. The potential of products is exploding with the incorporation of sensors, actuators, cameras, GPS positioning, etc., all of which provide individualized context and deliver ground-breaking functionality that enables measuring and sensing the exact condition of the device environment. By interconnecting to weather systems, "smart home" controls can have sprinklers turn on only when it's not raining. Instrumentation makes way for many smarter applications, such as the wall/ceiling heater in your bathroom turning on automatically on chilly mornings 5 minutes before your alarm clock goes off, so that it is warm when you enter. This helps fine tune your energy usage to your exact needs

How is all this getting enabled? Manufacturers are tapping into accelerating innovation in embedded software control – the new "brains" that make products smarter. When software is effectively fused with micro-electronic, actuator, sensor, and mechanical technologies, it accelerates the innovation so key to delivering smarter products. As software becomes the key ingredient in product innovation, traditional manufacturers are essentially becoming software companies! That's right, the success of automotive companies, cell phone providers, medical device companies and kitchen application companies to name a few, are increasingly tied to how well they are able to harness software to deliver competitive advantage.

While this transformation is sparking unprecedented leaps in product value, it also introduces new challenges and implications. The drive to infuse these "smarter" capabilities is resulting in an exponential leap in complexity. Just consider the challenge inherent in designing, building, and managing smarter cars:

- 90% of innovation in today's cars are based on electronics & embedded software. 35% increased value of in-vehicle electronics & software by 2010 [5]

---

[5] Venture Development Corporation report, 2006

- Frost and Sullivan estimated that cars will require between 200 and 300 million lines of software code in the near future. [6]

- For today's cars, the cost of software and electronics can reach 40% of the cost of a car. The software alone represents about a billion dollars' worth of investment. [7]

We've only seen the tip of the iceberg of what is possible. For example, a leading automaker is already proto-typing new automotive capabilities which can sense and respond to human thoughts. This would require a significant degree of software control and management to make successful.

Managing the growing complexity of smarter products infused with software is becoming a critical business success factor.

While most of us take these technologies for granted, the design, development and management of the embedded technology (software, sensors, semiconductors, mechanical systems, etc.) that makes our cars more innovative also adds a layer of complexity, cost and risk to the products we use each day. Embedded systems, sensors, and software which differentiate the manufactured products of the world, and the applications that interconnect them to back-end IT systems, must be created to perform specific functions and tasks. Likewise, products themselves must be designed to do what their 'brains' tells them to do -- for example, automatically deploying an air bag when the driver slams on the brakes and then dialing emergency services to send help on the way while leveraging a GPS device to identify your location.

As the complexity of the product creation and lifecycle management multiplies due to the increasingly sophisticated degree of **interconnectivity, instrumentation and intelligence**, it's becoming an outright business success factor for manufacturers to better **manage the risk and cost** associated with these smarter products.

---

[6] IEEE Spectrum, "This car runs on code", 2007, http://www.spectrum.ieee.org/print/7649
[7] IEEE Spectrum, "This car runs on code", 2007, http://www.spectrum.ieee.org/print/7649

This jump in complexity, if not well managed, can negatively affect the bottom line of many companies. For the world's automotive manufacturers, software is playing an increasingly significant role in key business success factors such as customer satisfaction, safety ratings, product reliability, profitable cost and risk models and their overall image as an innovator. Again, just consider a few examples:

- An automaker stops sales of their hot selling truck due to an engine control software flaw that failed to recognize improper levels of heat in the exhaust system. [8]

- Another automaker recalls 24.461 automobiles due to power train control modules which were programmed with software that may allow the engine to stall under certain conditions. [9]

- Yet another automaker recalls 16,000 of their SUVs to fix a software program that may cause passenger air bags to fail. [10]

- 50% of car warranty costs are related to embedded electronics and software, costing automakers in the United States around $350 and European automakers €250 per car. [11]

Yet this is only the start of the challenge of managing the complexity of a world composed of smarter products. Once the smarter capabilities are created, they become "living things" -- evolving, morphing, and growing in subsequent releases. Expectations grow, as does the need to be compatible with previous releases of products that make up the ecosystem in a person or business' workflow or life experience. Products progressively become more instrumented, more interconnected and more intelligent. In turn, they drive greater degrees of the vision for a smarter planet over time by further unleashing the creativity, and thus expectations, of businesses and people everywhere. Managing their evolution in an increasing interconnected, real-time and fast-paced world is resulting in

[8] Consumer Affairs.com, March 2007
[9] Consumer Affairs. com, May 2008
[10] Consumer Affairs.com, April 2008

unprecedented complexity which can threaten a business' long term viability if not well managed.

Furthermore, as these smarter products become the foundations which run the businesses, institutions and personal properties of the world, they will help transform our world at a speed that perhaps we have not yet experienced.

The successful businesses and institutions of the future will be those that can best apply software to competitive advantage.

The successful businesses and institutions of the future must start today to build the competency to design, build, deliver and manage a new generation of smarter products. The reality is that product manufacturers are now also becoming software companies, infusing the technological capabilities of electrical, mechanical and software components into a new generation of innovation. Further, the businesses and institutions which use these smarter products will be compelled to do the same, as they integrate value around these smarter products, building layers of customized interconnectivity, instrumentation and intelligence.

---

[11] IBM Institute for Business Value, "Shifting car makeup shakes up OEM status quo: Software strength is critical" whitepaper, 2002

Challenges of the existing approach

Software is the "invisible thread" that differentiates so many products that we use today and makes them seem so smart. While you often can't see software is intangible, like most forms of intellectual property, it is increasingly the driving force behind the functionality of a device, what animates it and gives the device its purpose. Yet it is precisely the intangible nature of software -- especially the development and management of software assets -- that presents the challenge that most organizations struggle with every day. For example:

- Only 34% of software products are deemed successful, costing the industry nearly $300B annually. [12]

- Only 37% of organizations are satisfied with the current speed of software development, even with current levels of complexity. [13]

Product manufacturers must become more adept at software delivery and software-led conceptualization, design and systems integration. Most products are still being developed with ad-hoc techniques for software delivery, which are not adapted to the modern challenge. Many of these companies do not have the skill sets, resources or development platforms necessary to build and maintain the software that is needed. In fact, they often have such limited experience in software development that their business model needs to be completely rewritten. One such organization, developing baggage handling systems, had to go from a purely mechanical belt with human interaction to a completely automated, smart system based on software, in order to win the new airport and delivery contracts it needed to stay in business. As a result of the speed of software-led innovation, traditional "hardware" systems design and delivery processes also need to evolve to keep up. Organizations will need to rethink the way they have

---

[12] The Standish Group, "CHAOS Summary 2009", April 2009
[13] The Standish Group, "CHAOS Summary 2009", April 2009

traditionally developed electrical, mechanical and embedded software to ensure they don't become a bottleneck to innovation.

Since smarter products need to be **instrumented**, they must connect to the hardware components. The challenges here are also increasing as the amount of integration with sensors and actuators grows; needing flawless quality and high responsiveness in what is becoming an increasingly complex system. Historically, software and hardware development teams have been relatively disconnected, with the mechanical and electrical components evolving much slower than the newcomers on the software side. As new instrumentation functions appear, these two disciplines need to evolve together to provide a high quality working component and a lifecycle process that manages newly instrumented products as they evolve over the years. This is easier said than done, as requirements need to be decomposed, assigned and tracked across multiple disciplines. Heterogeneous systems must be simulated up front to validate designs. Changes may impact components across multiple teams leading to complex project management, testing and change control. One organization designing a smart entertainment system recently discovered just before delivery that change requests that had been implemented in the software hadn't been included in the hardware… leading to two months of delay.

Finally, what helps to create a unique experience is how these components come together and **connect** to the Internet and to back-end IT systems. Organizations must learn how to develop products that can talk together within their intended ecosystems. Standardized communication protocols are needed so that all these products can interconnect seamlessly. Wireless interaction and radio waves must comply with new heath standards and organizations must be able demonstrate that compliance. This means going beyond traditional silos between software and hardware development, between IT and systems, between competing companies, between vendors and governments.

Enterprises and their suppliers, customer and partner communities will also need new ways of working together**.** They will require capabilities such as consulting, training and collaboration services to help tackle this transformation successfully. They will need to implement best practices and thereby create value quickly, learning from the lessons of others. Not only is this necessary in order to manage cost and improve time to market, these organizations need to do all of these things while still maintaining the level of quality their customers expect in this smaller, flatter planet - any failure can have cascading effects and be publicized globally in minutes.

Implications of an inefficient approach

Failure to adapt to the new challenges for building and delivering smarter products can significantly impact a company's bottom line and brand image. If organizations cannot create the products required to build a smarter planet, they risk being left on the sidelines as this infrastructure is deployed within vertical industries. Industries cannot deliver on the promise of a smarter planet without smarter products that are customizable, individualized, and efficient. Whether the target industry is energy, automotive, healthcare or transportation, their very participation in the creation of a smarter planet is at stake. Increased cost, risk, low customer satisfaction and delayed market entry will threaten businesses, industries and institutions as complexity takes over.

Even today, 49% of software-related projects suffer budget overruns and 50% of outsourced projects are expected to under perform.[14] With the levels of integration and interconnection planned between products, systems, companies and countries, the potential cost will increase dramatically... unless the right processes, products and people are put in place.

Examples abound. For instance, poor quality management can be extremely expensive in the automotive industry. Consider a situation where a leading automotive manufacturer had to recall vehicles with improperly working Rain Sensing Wipers, costing them millions of dollars. The development of Rain Sensing Wipers contains mechanical, electronics and software components that are procured by tier-one suppliers. They need to be integrated, instrumented and interconnected to the dealership applications for maintenance.

---

[14] Dynamic Markets Limited study, August 2007

The speed of innovation across a smarter planet means that organizations must evolve now in order to remain competitive tomorrow. The risks of inaction are significant:

1. **Loss of market leadership or relevance:** Organizations can quickly lose their current foothold in their market, yielding share to more nimble organizations that have made the transition to building smarter products. This is especially obvious in the consumer electronics and telecommunications domain where consumers are particularly fickle, but equally relevant in other industries such as Aerospace and Defense or Automotive.

2. **Unnecessary risk and profit-hits:** The competitive pressures to develop complex, innovative products in shorter cycles are compounded by the challenge of maintaining quality standards and therefore brand equity. More and more products are becoming "user critical" – beyond mission critical. A software flaw in an airplane's control system, or in a medical device, or in a fire alarm needs to be prevented before a tragedy occurs. It can also mean dramatic increases in warranty and maintenance costs and total cost over the lifecycle of the product.

3. **Increased cost of development and customer service:** As the company works on new projects using new technologies, the cost of development needs to be managed. Without being able to leverage best-practice product development processes, companies have to re-invent the wheel and have no predictability into budgets and deadlines. Nor does the company have the assurances that these products meet the requirements of the end-user – until they are in the marketplace. Having to prove compliance and pass audits to evolving standards and regulations can be very expensive.

What IBM is doing today to help our clients make smarter products?

IBM helps its clients deliver products that are increasingly *intelligent* and real-time *instrumented*, enabled through components (software, chips, embedded systems, technology) and capabilities (tools, best practices and deep industry know-how). We enable our clients to create and deliver products which are *interconnected* to the Internet and backend IT systems to radically infuse functionality and value. Our clients can deliver value through innovation at lower cost and risk through software, embedded systems, best practice product development and product lifecycle management capabilities.

IBM has the unique blend of experts, knowledge and solutions that is necessary to help bring the promise of accessible, wide-spread, high quality smarter products to the planet:

Solutions design, development and evolution of products
IBM Rational provides a platform for delivering the software that powers smarter products, helping organizations develop increasingly complex, groundbreaking functionality that can be the intelligence behind innovation and manages the communication between the interconnected devices.

Rational also provides critical System Engineering solutions such as Requirements Engineering, Integrated Change Management, Model-Driven Systems Development, and Product Portfolio Management which help ensure manufacturers bring the RIGHT products to market at the RIGHT time.

Product Lifecycle Management Solutions
IBM is leading in PLM to help clients improve time-to-market and reduce costs through improved design, delivery and lifecycle management of manufactured products, while bridging the schism between hardware and software, to help our clients ensure that

their instrumented products are high quality, efficient and deliver on expectations

Smarter Products development and delivery best practices
IBM Global Business Services provides best practices that organizations need to address the challenges of building the Smarter Products that enable our Smarter Planet. This can help them transform their businesses to be more competitive at lower risk.

Providing the building blocks of Smarter Products
IBM STG delivers microchips that are a key enabler of a Smarter Planet, providing the billions of transistors embedded in devices big and small that make the world more digitally aware and interconnected. IBM also provides the sensors and actuators that are critical to instrumented products.

For instance, IBM is teaming with Ramtron for the production of ferroelectric random access memory (F-RAM) chips, used in applications ranging from automobiles to medical devices to electrical metering systems. Ramtron provides chips for advanced metering devices that enable two-way communications via phone, radio frequency or satellite, allowing customers to see and control their energy use in real time. Ramtron also provides chips that enable "intelligent" automobile airbags, which use sensors to control the force of how the airbag deploys based on the severity of the accident, the weight of the driver, and other factors.

Industry leading community of subject matter experts (SME's)
IBM's Systems Engineering Community of Practice unites thousands of experts who exchange their experience in building Smarter Products and in helping organizations succeed in this area. We are an innovation leader in business process, product, and technology. IBM has been the US patent leader for 14 consecutive years

Service management

IBM Service Management (Tivoli) offerings deliver the visibility, control and automation needed to deliver quality service, manage risk and compliance, maximize return on investments, and accelerate business growth. This allows organizations to deliver new personalized services around smarter products more rapidly, at a lower cost of operation.

Application integration

IBM can help organizations bring together, in a collaborative, consistent environment, the disparate development tools that teams use to produce smarter products, by providing the IBM Product Development Integration Framework (PDIF), consisting of industry extensions built on service-oriented architecture (SOA).

Building a solid business partner network

IBM coordinates a network of tens of thousands of business partners, which provide industry vertical expertise and local know-how to help the world build and manage customer-tailored smarter products.

Summary

It's all about the increasingly complex web of individual relationships with products and technology --- an ever-growing concentric circle.   People, and the businesses they connect to, are driving the need for smarter products. The potential of the "individual," whether an individual business, an individual institution or individual person, to now create custom, personalized experiences that are efficient, productive and transparent is vast. Therefore, many products that are commoditized are increasingly becoming obsolete. But products designed to make the most of time, resources, skills and energy, and above all, fit the individuals' specific needs, are the way of the future.

The challenge is clear: Smarter products must be increasingly **intelligent**, real-time **instrumented** and **interconnected** to the ecosystem of users, customers, IT environments, the Web…in short, the world. Nothing less than this is necessary to achieve the magnitude of pervasive design, production, and usage that smarter products can unleash. Smarter products are **"intelligent"** and able to respond to changes quickly and accurately, as well as gauge performance and adjust to optimize moving forward. Smarter products are **instrumented** for measurement and feedback on data, preferences, and interactions. And the larger payoff of smarter products is that they bring **interconnectivity** to people, systems, other products, back-end applications. Businesses can now respond more effectively to the personal needs and desired behaviors of the user in unprecedented ways.

Software is the invisible thread.

As software becomes the most active ingredient in product innovation, traditional manufacturers are essentially becoming software companies!   While this transformation is sparking unprecedented leaps in product value, it also introduces new challenges and implications.

For the world's manufacturers, software is playing an increasingly significant role in key business success factors such as customer

satisfaction, safety ratings, product reliability, profitable cost and risk models and their overall image as an innovator.

As software becomes the invisible thread linking this system of smarter products and the key enabler for differentiation, the world's manufacturers will use it to influence everything from customer experience to reliability to brand image and beyond. Smarter products will be the building blocks for new solutions across every industry, and will collectively help us build a smarter planet. IBM will be there to help make this all happen.

Let's build a smarter planet. Join the conversation at:
ibm.com/think

Customer Examples

- Video: [Eaton Corporation is using our platform to help UPS slash fuel consumption.](#)
- Analyst report: [EADS, Cardinal Health, and Chrysler are using Rational to manage product requirements.](#)
- Case Study: [Delphi is collaborating across 35 countries to deliver innovative auto components.](#)
- Webcast: [Daimler FleetBoard, Merge Healthcare, and Rocket Gang are all using the Rational platform.](#)

Acknowledgments