Smart Systems, Asset Management, and Strategic Services Innovation

Machine builders and equipment manufacturers need to address the true potential of connectivity and information-driven service innovation. By integrating service and support automation directly into the fabric of machine solutions, new asset management platform technologies can help OEM's leverage the continuously evolving relationship between connected machines, smart services and customer value creation. This paper and supporting research highlights the productivity impacts and customer responsiveness gains new asset management solution platforms inform.

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Virtually all equipment and machines now contain a wealth of information about their status, usage, and performance. Until recently, this information has gone largely un-harvested and un-leveraged, even though it can offer extraordinary business advantage to the companies that manufacture and service those machines, especially in terms of customer relationships. The new world driven by networked services is one in which every connected machine turns manufacturers, and in many cases others along the value chain, into a new kind of "smart service" business. It bends the traditional linear value chain into a "feedback loop" through which data rich heartbeats and insights will continually flow back through the complex business alliances that create, distribute, and service those systems. Unfortunately, while most "product-centric" businesses are now embracing the concept of growth-creating services, many are not developing new business models and not investing in new digital systems to realize the true strategic potential and value. These businesses are thinking services, but they're not thinking "smart services." Leaders are creating unprecedented performance and unique barriers to competition by combining a fundamental understanding of the role of after market support and its inherently unique business and operating requirements with an acute understanding of the strategic impact of intelligent machines, data management and analytics.

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THE AGE OF SMART SYSTEMS, ASSETS and SERVICES

Today, it's conventional wisdom to say that machine builders and equipment OEM's should embrace services as a means to generate growth and sustain value. The logic has been examined many times: services typically involve a recurring revenue stream, less fixed capital, and potentially much higher margins than those of a strictly product-centric business. Designed and executed properly, after sales services and support can prevent the downward spiral of commoditization, and create a nearly unbreakable bond with the customer.

However, as the intelligence and computing capabilities embedded into machines rises and the capabilities to network the machine become pervasive, an OEM's new services must be wholly different than the service offerings of the past, and the customer must perceive these as having entirely new value. They must be "smart services" that are enabled by "smart [embedded] systems" and are fundamentally preemptive rather than reactive. Preemptive means actions based upon hard field intelligence. Smart services would thus be based upon actual evidence that a machine is about to fail, or that a customer's supply of consumables is about to be depleted, or that a shipment of materials has been delayed, and so on.

Such "connected" services create new value by removing unpleasant surprises from the customer's life—by preventing the customer from being blindsided by happenstance or outdated methodologies, such as time based maintenance. Further, the field intelligence makes product performance and customer behavior visible as never before, giving the manufacturer unprecedented R&D feedback and insight into the customer's needs, and thus the ability to provide ever greater ongoing value. Gathering and analyzing the necessary field intelligence is not a role for human beings because of their natural predisposition to error. The only way to achieve it is to have the machine's "intelligence" continually delivered back to its creator.

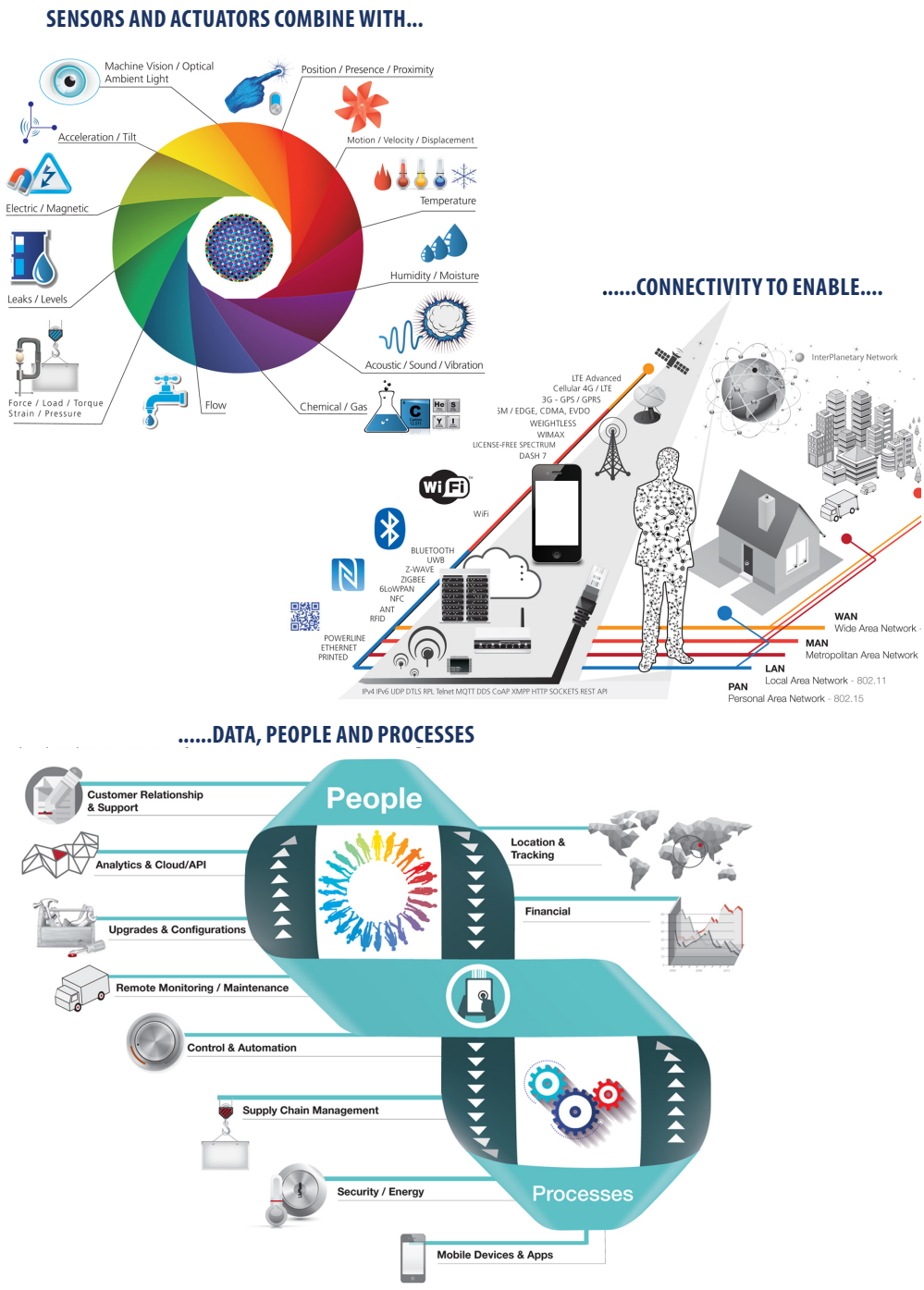
THE STRATEGIC ROLE OF SERVICES - CREATIVE CONTENTION

Products and services, while complementary, have historically had opposite strategic goals and divergent operational models. As a result, each business type has had to seek out its own distinct strategies. The traditional machine builder and equipment manufacturing business typically defined services and after sale support as subservient to the product, as no more than a "bootstrap" business with little upfront investment. This model is rapidly disappearing. The ability to closely couple machines and equipment and a wide variety of new support services has emerged as a requirement to stay ahead.

The two thrusts need to be mutually supportive without inhibiting one or the other. However, trying to coordinate and leverage the respective roles of products versus services often creates contention. Many leading manufacturing

organizations have come to understand that each have distinctive strategies, operating modes and organizational requirements, and most importantly, that services cannot rely on products to be its "role model."

Exhibit 1: Smart Systems and the IIoT Are Enabled By Sensors, Connectivity and Data

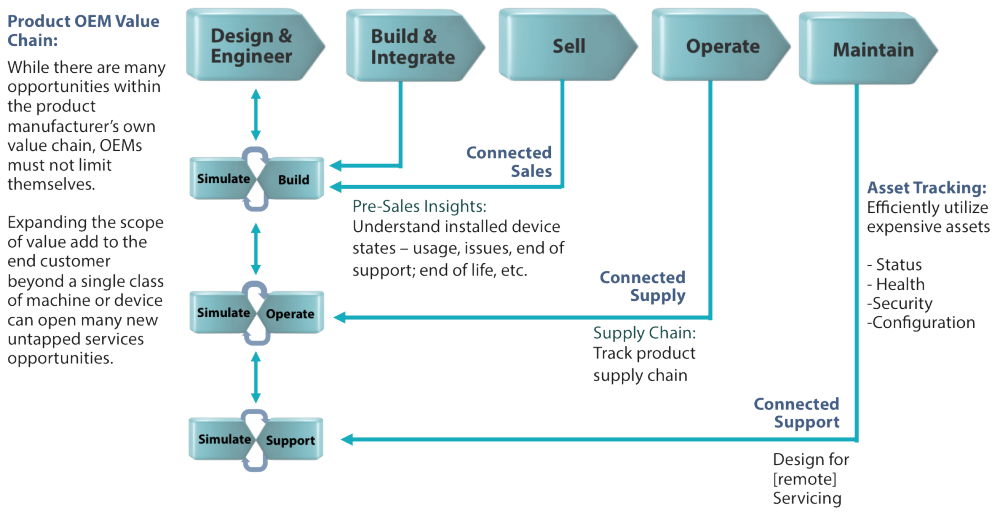


The best companies have come to see the continuously evolving relationship between products and services as a fertile ground for innovation. The two need to be interwoven and mutually supportive, and increasingly, success in either goes to the company that effectively utilizes the combined potential of both, but only when services has been designed for its own unique destiny.

As products evolve, so do the attributes of the services required to support the product. Each impacts the other in an ever changing set of relationships. The salient characteristics of each model are often very fluid in nature. Understanding this critical evolving relationship is the key to effective and profitable service delivery. Service business design requires organizations to address several critical aspects of their business, including:

- The overall strategic role of services;
- The uniqueness of the business model and the delivery schema; and,
- The required organization structure and skills requirements.

Exhibit 2: Connectivity Produces Data Value Across a Machine Builders Entire Value Chain



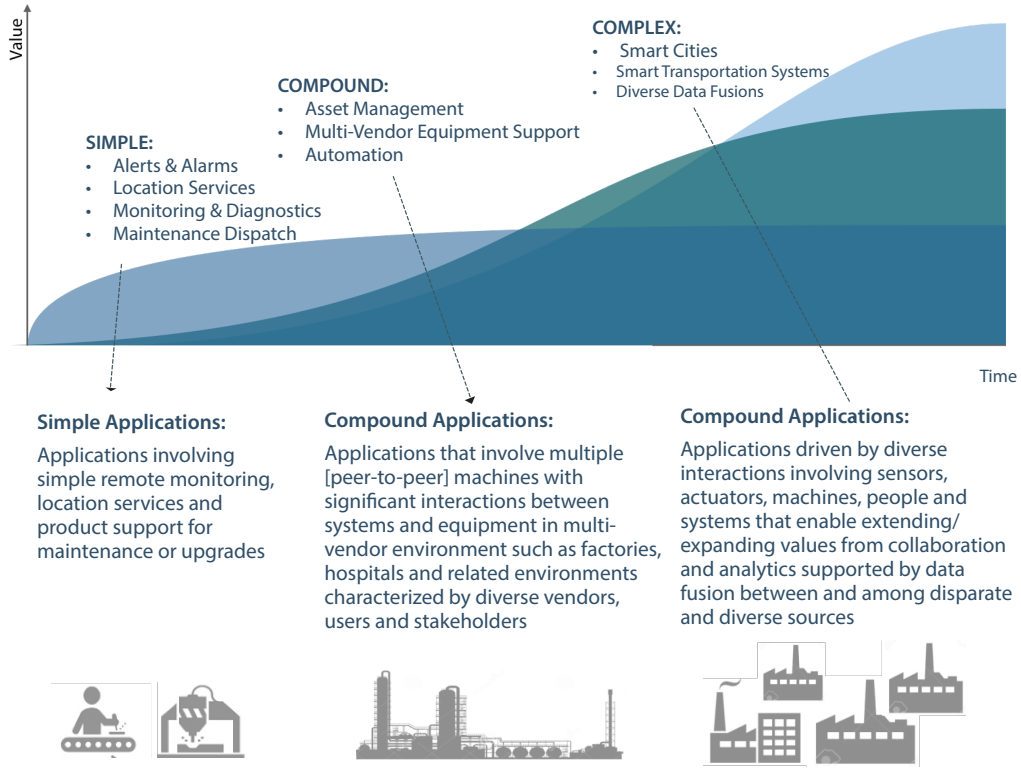
The electronic linking of machines, users, channels and support specialists, will continue its inevitable march forward, but the value of networking machines and equipment and, in turn, automating and orchestrating support functions will become ever more tightly coupled. This linkage must become more cooperative and interrelate in a mutually advantaged way; "creative" contention, not negative contention.

SMART SERVICES JOURNEY; MOVING BEYOND SIMPLE AFTER MARKET SERVICES

A networked machine generates information value over its entire lifespan. Machine builders and equipment manufacturers can know where the device is located, when it was installed, critical specifications, diagnostics, availability of spare parts, usage patterns, support status and so on.

Traditional customer relationship and equipment support programs yield only intermittent, uneven and incomplete windows into how customers interact with a machine. Once a machine is shipped to a customer, the manufacturer loses sight of who buys it, how it is configured, what its use is and what the customer experiences with it. When machines become networked and support is automated, the environment in which they are utilized becomes more "aware" and responsive. Eventually, this environment helps customers optimize their processes, save money, and become significantly more efficient.

Exhibit 3: The Journey From Simple To Compound To Complex Applications



Up till now, most of the discussions concerning machine and asset data, analytics and customer support automation focus almost exclusively on "simple" monitored values such as alarms and alerts. Return from simple applications,

while extremely valuable, is limited to the manufacturer's service delivery efficiency. Contrary to what current market offerings depict, however, the value of connectivity does not have to end with just simple applications focused on a single class of device or machine.

As technologies mature and open standards become the norm, applications based on deeper, peer-to-peer interactions between devices, machines, systems and people will drive more "compound" and dynamic value streams. This opens up new collaborative business model opportunities that have the potential to drive much greater value for the customer.

Moving from "Simple" to "Compound" applications involves multiple collaborating systems with significant interactions between and among devices, systems and people. No longer is the focus solely on the product supplier's ability to deliver support for their product efficiently. Rather, value is brought to the customer through business process automation and optimization.

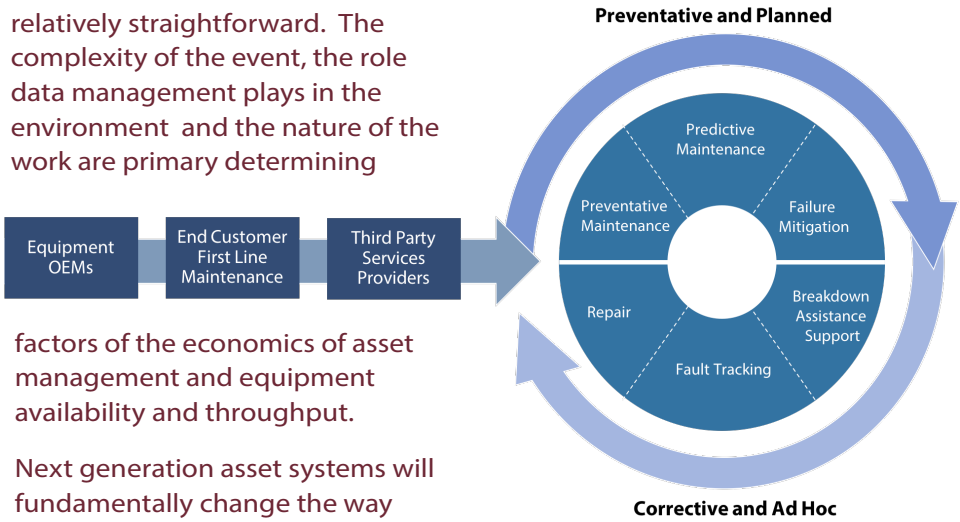
Consider any of the larger diversified industrial players that sell complex machines like turbines, compressors, and the like. In the power turbine business, for instance, major electric utility customers have good reason to loathe equipment failures. At the least, any downtime creates huge opportunity costs for these customers; often it means they have to pay hefty regulatory compliance fines.

To reduce that risk, players like GE have invested heavily in monitoring and diagnostics so they can deploy a technician or engineer ahead of a failure (preemptively) as opposed to doing so according to a schedule based upon prescriptions (pro-actively) or, even worse, after the power has gone off (reactively). For one thing, this has a dramatic effect on the profitability of these players maintenance services. Most manufacturers cannot charge more than $100 to $130 per hour for their technical support because of price and benefit pressures

THE ECONOMICS OF MODERN ASSET MANAGEMENT

By it's nature, maintenance is an ad-hoc event. It's reliant on triggering events that by themselves are relatively straightforward. The complexity of the event, the role data management plays in the environment and the nature of the work are primary determining factors of the economics of asset management and equipment availability and throughput.

Next generation asset systems will fundamentally change the way maintenance is conducted and, more importantly, the economics and costs.



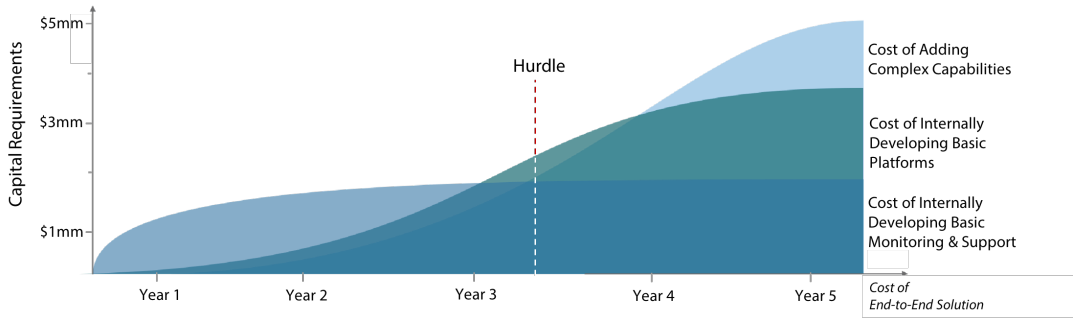
from local competitors. But because of efficient network-enabled services, leading players can charge $500 to $600 per hour for the same technician who has become a subject matter expert.

But, in the end, these are still examples of simple applications largely focused on a machine builders or equipment manufacturer's own value chain. They are simple "hub and spoke" remote support. While there is value in these models, there are significant untapped opportunities for providing new compound value for the users and customers.

LEGACY and HOME GROWN ASSET MANAGEMENT IS NOT DATA MANAGEMENT

Most machine builders and equipment manufacturers, even those companies that have built remote services offerings, have tended to only focus on their device, their machine and their value chain – missing the opportunity to more openly collaborate with partners and customers and provide integration for a much broader scope of systems within the customer's operations.

Exhibit 4: The Cost of Internal Solutions are Fully Realized at "The Hurdle"



As a result, their use of asset management systems has largely been limited to supporting their services delivery. Many machine builders have, in the past, resorted to developing their own monitoring, asset management and services delivery systems. To say the least, these systems, for the most part, are also really just "simple" applications and cannot be leveraged to utilize the data they collect to do more than know how many spare parts are available or when the next scheduled maintenance is required on a given machine or system.

A new Smart Systems, Assets and Services vision will re-think the whole relationship of devices, machines and people to business systems and processes. It must be built upon true, across-the-board digital automation, accomplished

by enabling everyday electronic devices to communicate with and control each other, supplemented by whole new generation of information tools for managing rich, vast streams of meaningful data. The goal is to fully integrate people and assets into smart systems and assets that are self-sensing, self-controlling, and self-optimizing—automatically. Unfortunately, not enough manufacturers are thinking about it this way.

BUILDING COMPOUND VALUE FOR USERS and CUSTOMERS

Smart Systems, Assets and Service's true potential lies in the integration of diverse machines, information systems and people—its ability to connect billions upon billions of smart sensors, devices, and ordinary products into a "digital nervous system" that will smoothly interact with individuals and the physical world. The nature of compound and complex smart system applications is just beginning to be understood where the information value generated by these capabilities positions players to take on significant additional tasks for the customer, such as:

large scale data integration, management and analytics will drive unique values from smart systems and assets

» Managing and automating a customer's spare parts inventory and service delivery chain for maintenance processes providing vastly improved levels of service and responsiveness;

» Providing the customer's first line support staff, the machine builders' service technicians and other third party support personnel with complete access to a unified machine maintenance record that captures all of the machine's performance data, history and knowledge about the status of the equipment enabling faster and more effective maintenance processes;

» Analyzing the history of the equipment in use against diverse data sources such as weather patterns and peak usage requirements to optimize its performance; and,

» Providing entirely new services to the customer such as "security as a service" where security and privacy for all devices, machines, networks and data is provided as a managed service.

Customers are looking to equipment manufacturers not just for high-quality equipment, but also for help in optimizing their ability to supply consistent and high-quality products and services to their customers. This evolution will allow machine builders and equipment manufacturers to tie their revenue and pricing models directly to the value and related benefits they provide.

Taken one step further, applications that drive interactions between and among devices, sub-systems, machines and people across operational and enterprise systems will potentially allow extending and expanding values from third party

collaboration and large scale data integration and analytics that, while complex, will drive the highest possible value from smart systems and assets.

If you place this evolution into a much larger context – say how the Internet of Things will impact our planet's resources – the potential impacts become even more profound. Even with the productivity improvements we see today, modern electricity and power delivery systems are still extremely inefficient. Over 20% of electricity generated each year is never consumed from the grid. This represents more than enough energy to power an entire region like the United States or Europe for an entire year. Utilizing network and data management technologies to make the grid more efficient would allow us to retire well over 1000 coal-fired power plants. Combining sophisticated sensors, real-time connectivity, and massive computing power to leverage the data from these operational systems, can equip businesses for the next level of optimization across virtually all sectors of the economy.

OT Meets IT

Consider the role of a plant manager at an oil refinery. In these harsh and demanding environments, downtime can cost hundreds of thousands of dollars an hour, which makes effective equipment operation & maintenance a mission critical function. Add to this the fact that a single large refinery complex produces more data in a day than the New York Stock Exchange and AMEX combined, and it quickly becomes apparent just how complex these functions can become.

Leaders in the oil and gas industry are aggressively moving to integrate IT with operations technology (OT) to drive a single service management capability to span end-to-end ownership of service delivery, performance, and SLA's for all of their IT equipment, network technology as well as automation and control systems. They want a unified, secure end-to-end process to manage their systems.

Players like Chevron and ExxonMobil are organizing IT and network systems to tightly integrate highly complex mission critical process control systems with traditional IT assets in one secure environment. They believe this will allow maintenance to really benefit from big data impact — leveraging maintenance "informatics" into an orchestrated service delivery model for all services, all providers, not just one supplier's services.

WHAT ARE THE NEW STRATEGIC SERVICES OPPORTUNITIES?

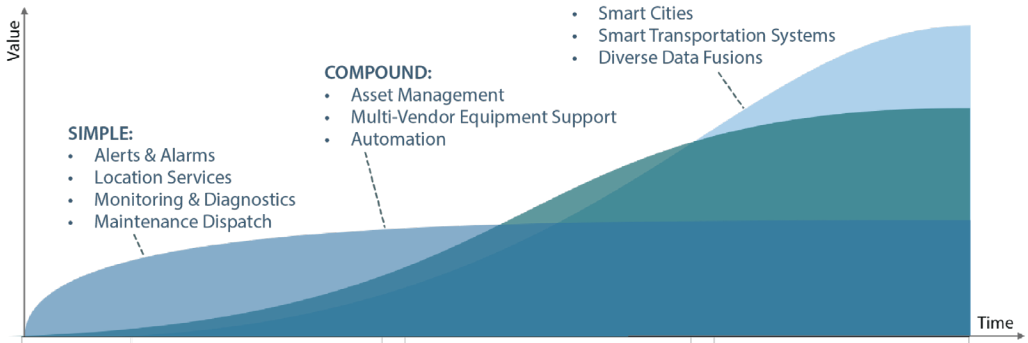
When machines and equipment become networked, the environment in which they are utilized shifts to a much more "aware," and responsive support environment. Eventually, this environment helps customers optimize their processes, save money, and become significantly more efficient.

Leadership in many of these complex machine builders and equipment OEM's are really only just beginning to understand the opportunities driven by the complicity between service business design, networked systems and embedded machine intelligence. It is this set of relationships, not the technology alone, that will benefit but also challenge many machine builders and equipment manufacturers.

In a unified network environment, information becomes currency, and can be shared and utilized collaboratively. For many machine builders and equipment

OEM's, what might have started a handful of years ago as a traditional "after-market" services view of the opportunity has quickly evolved to a broader understanding of the impact of digital technologies, the challenging transformation they inform and the related benefits, including:

Exhibit 5: Simple, Compound and Complex Application Values Driven From Data



End Customer Evolution	• Simple asset monitoring to increase uptime and OEE • Increased plant floor visibility • Basic preventative maintenance offerings	• Predictive maintenance leveraging advanced data management and machine learning technologies • Visibility across full ecosystem, and integration of plant floor data into multiple operations and enterprise systems	• New levels of ecosystem collaboration through integration of data from operations with multiple partners, including OEMs, suppliers and value added services providers
OEM Evolution	• Provide classic "remote service and aftermarket support" offerings, only focusing on the OEM's own assets/systems and service delivery	• Increasing service scope and value is provided to the customer through: system enhancement and optimization, installed base data management, predictive analytics	• Offering entirely new services that create value through collaboration between/amongst parties across a complex, multi-brand, multi-business system

Cost and Service Lead Time Reductions: Machine OEM's that have implemented equipment monitoring and health solutions have been able to remotely connect to their networks, including after-hours when customers have no staff on-site, and remotely diagnose and schedule downtime required for the fix, therefore potentially saving the customers hundreds of thousand of dollars. Service centers can be automatically linked to interrogate the machine to find out what happened and ensure that technicians and operators are equipped with the correct diagnosis, spare parts and support plan before initiation of any on-site activities, thereby reducing the technician time while also improving the overall

uptime for the customer. These actions obviate the need for manual support and "truck rolls" while ensuring maximum availability.

» **Agility and Flexibility:** An "aware" networked machine strategy introduces the capability to apply changes almost instantly to many responding partners and customers. With less need for direct human interactions, updates are now sent automatically and support changes to intelligent products are deployed much more efficiently.

» **Improved System Support Knowledge:** Implementation of new digital operations and asset system technologies allows for improved services on several fronts. Customers, who are accustomed to being "blind" to the state of their machines have gained visibility. With performance data available at any time for service providers and customers alike, partners have been able to signal and flag potential problems, and also are now in a better position to predict possible future failures or to advise on a course of action to save cost or improve availability or throughput.

» **Better Leverage of Machine Builder's and Customer Support Ecosystem Capabilities:** Deploying asset management platforms in combination with data management and analytics can help customers orchestrate the many differing services and support "persona's" throughout their operations - first-line maintenance, OEM service technicians as well as third party supplemental services providers. New tools provide customers with compelling options for equipment, systems and staff optimization opening the door to new collaborative relationship opportunities between machine OEM's peer equipment providers and users.

» **"Stickier" Customer Relations:** Due to the visibility provided by new asset management platforms, there is much more visibility of an OEM's installed base of machines and their respective configurations and effectiveness of support. This has, in turn, improved relations as customers and their OEM

Healthcare Stops Hemorrhaging

If ever a sector of the economy needed system-level intelligence, optimization, collaboration and automated asset management, it's healthcare. This beleaguered market space offers untold opportunities to apply Smart Systems technologies to collect, process, and transform healthcare data into information and action.

Adoption of smart systems solutions in the healthcare arena has largely been the focus of equipment OEM's and "specialist" value-added services players. We believe the market has entered a phase where planning, specification, justification and deployment of systems will shift to end customers who are seeing a wider array of applications and business benefits than any single product OEM recognizes.

Several of the largest healthcare delivery organizations have discovered many more opportunities to use networks, sensors and data technologies for new business innovation.

This is leading to re-design and automation of a wide range of business processes for greater efficiency, safety or validated compliance.

partners become much more responsive and ultimately more proactive. This is largely driven by the data stream captured from the customers' equipment and is increasing the chances of supporting a customer need before they even know of its existence.

» **Collecting Valuable Information Drives Multiple "Compound" Values:** Asset management systems are collecting information from machines and equipment that has considerable leverage with users, customers, and OEM's. When the OEM and end user can access to data and information about the complete history of the machine - its usage, performance, and beyond - this data can inform improved machine and system designs and reveal where features and functions can be added or improved in the machine design. Product developers and R&D organizations will gain immediate feedback on how a particular product is used, which features are most popular and what problems typically arise.

Cyber-physical systems will produce data at a scale few can barely imagine as the Internet is integrated into plants, machines and workers

For machine builders and OEM's, new network integration, data management and analytics for machines open many new services and value adding opportunities to capitalize on.

EVOLVING MACHINE BUILDER and OEM BUSINESS MODELS

We have observed many new and creative value added services and business model innovation opportunities which, for the most part, often appear too "aggressive" or "risky" for the typical industrial B2B players. Machine builders and OEM's often miss new opportunities because traditional machine and product-focused company cultures have all too often defined services as subservient to the product, as no more than a "bootstrap" business with little up-front investment or innovation.

Fundamental changes to business models will accompany every organization's decision to utilize and act on the data flowing from its connected machines and equipment.

While looking for and identifying the tools available to product-centric businesses shifting to services, it is vitally important that businesses consider whether or not the opportunity is one that can be seized alone or in conjunction with another or even with many others.

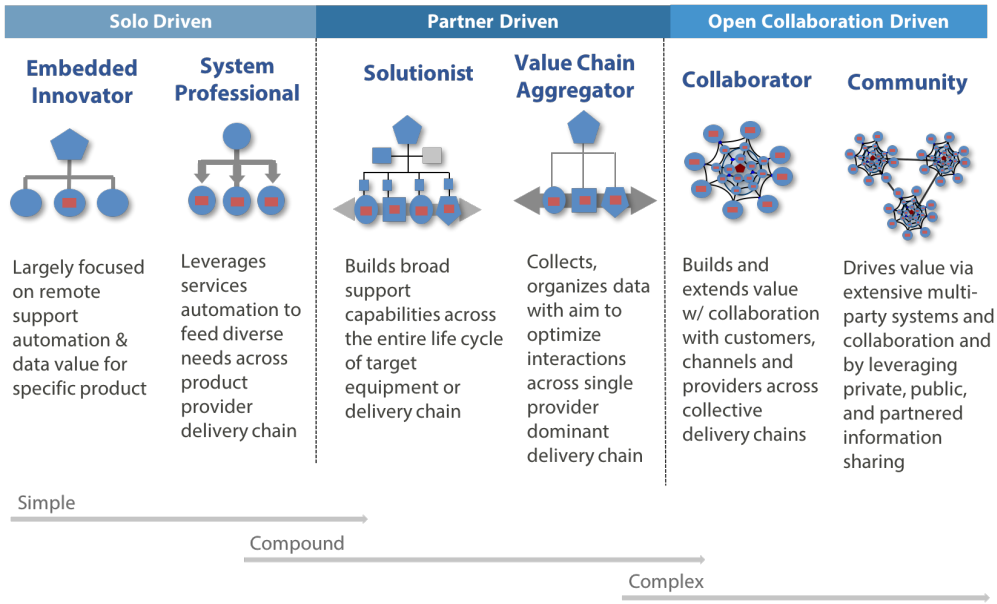
Simply put, the overall smart systems, assets and services opportunity is one a company can seize alone, a partner-driven opportunity, which will in one way or another be an opportunity that is shared with others, or an open collaborative opportunity.

» **Solo:** Where most of the elements of the opportunity are attached directly to a product's life cycle such that they are designed to be deployed by the product player alone;

» **Partner-Driven:** Where the opportunities require multiple value adding partners working in a closely coupled fashion and are designed with partnerships in mind; and,

» **Open Collaboration:** Where the opportunity is forged around a platform model that provides for and enables extensive third party collaboration and contributions and clearly addresses a broader scope of the customer's operations systems than any single equipment manufacturer would address alone.

Exhibit 6: Smart Systems and Services Business Models



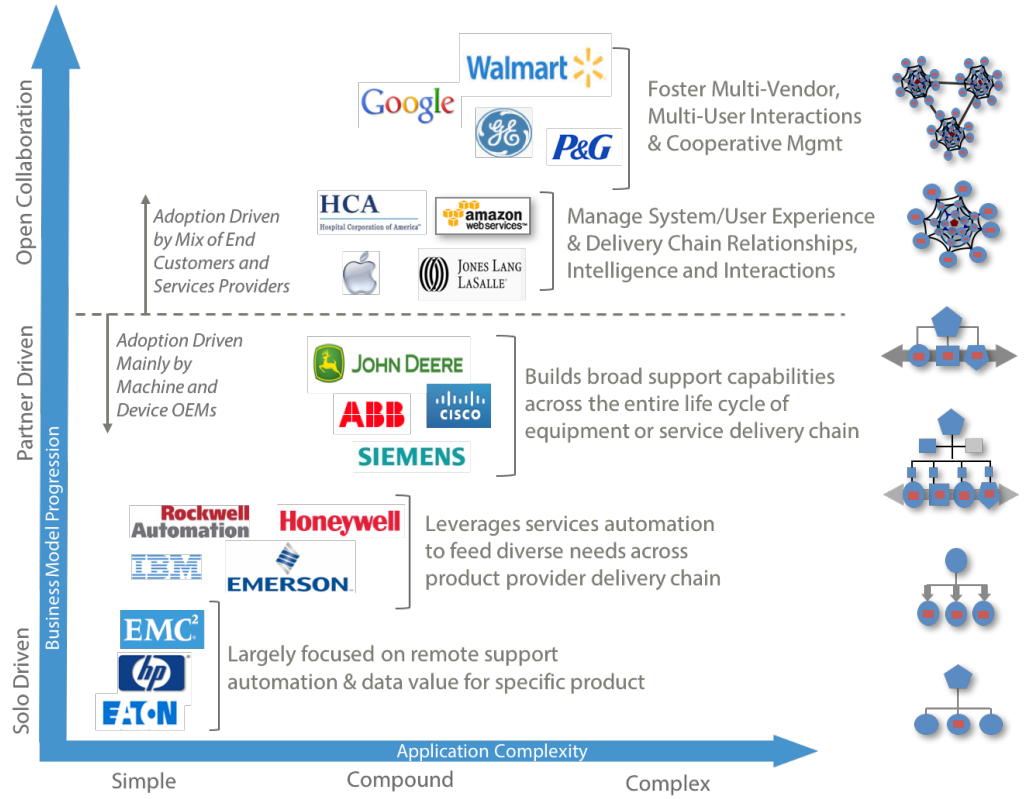
The direction a company takes will help determine the kind of business model it should adopt. For players that go at it alone, it may be what we call an "embedded innovator" or "system professional." Examples of solo models include remote services for office equipment or other types of machines.

If you partner with others, it may be as a "solutionist" or "value chain aggregator." Examples of these models include construction and agricultural equipment from players like Deere and Caterpillar where the value chain is integrated with equipment dealers and other adjacent value added services suppliers. But if your

goal is to leverage a more open participative model, it is what we would call a "collaborator" or a "community builder."

Moving beyond simple applications for connected products requires broader collaboration across multi-party ecosystems that drive numerous interactions between and among people, systems and devices.

Exhibit 7: Smart Systems Business Models Are Progressive



These models are progressive where the value increases with the integration of each additional player's equipment and systems and the increased resulting interactions. These "complex" applications and the significant increase in interaction value they inform, inevitably require open information flows and shared data across the ecosystem and participants.

ASSET SYSTEMS REQUIRE NEW DATA and PLATFORM INNOVATIONS

When it comes to preparing for the digital global information economy of the 21st century, most people assume that the "technologists" or the "IT department" are

taking care of it. They take it on faith that the best possible designs for the future of connected assets, people, systems and information will emerge from traditional functions. But those are big, unfounded assumptions. In fact, most of today's machine builders and OEM's have shown little appetite for radical departures from current practice. Yet current practice and current asset management systems will not serve the needs of a genuinely connected world. What are the major obstacles that need to be overcome?

» **Optimizing All Assets - Tangible And Intangible:** New software technologies and applications need to help organizations address the key challenge of optimizing the value of their balance sheets, allowing them to move beyond just financial assets and liabilities to their physical assets and liabilities (like factories, electric grids or hospitals) and then to their intangible assets and liabilities (like a skilled workforce). The task of optimizing the value of financial assets, physical assets and people assets requires new technologies that will integrate diverse asset information in unprecedented ways to solve more complex business problems.

Moving beyond simple applications for connected products requires broader collaboration among stakeholders and across services delivery ecosystems

» **Flexible, Scalable Systems:** IT professionals rarely talk these days about the need for ever-evolving information services that can be made available anywhere, anytime, for any kind of information. Instead, they talk about web services, enterprise applications and now cloud computing. The Web stores information in one of two basic ways: utterly unstructured, or far too rigidly structured. The unstructured way gives us typical static Web pages, blog postings, etc., in which the basic unit of information is large, free-form, and lacking any fundamental identity. The overly structured way involves the use of relational database tables that impose rigid, preordained schema's on stored information. These schema's, designed by database administrators in advance, are not at all agile or easily extensible. Making even trivial changes to these schema's is a cumbersome, expensive process that affects all the data inside them. Just as importantly, they make deep, inflexible assumptions about the meaning and context of the data they store. Both of these approaches to data-structure enforce severe limitations on the functions you want most in industrial pervasive-era information system: scalability, interoperability and seamless integration of real-time or event-driven data. The client-server model underlying today's systems greatly compounds the problem.

» **Automated Development:** When telephones first came into existence, all calls were routed through switchboards and had to be connected by a live operator. It was long ago forecast that if telephone traffic continued to grow in this way, soon everybody in the world would have to be a switchboard operator. Of course that has not happened, because automation was built into the systems

to handle common tasks like connecting calls. We are quickly approaching analogous circumstances with the proliferation of smart connected devices. Each new device requires too much customization and maintenance just to perform the same basic tasks. We must develop software and methods to automate development and facilitate re-use, or risk constraining the growth of this market.

» **Leveraging Collective Intelligence:** For all its sophistication, many of today's so-called asset management systems and platforms are a direct descendant of very traditional computerized maintenance management systems where each machine on a network acts in a "hub and spoke" mode. The inability of today's popular asset management systems to inter-operate and perform well with distributed heterogeneous machine and equipment environments is a significant obstacle. The many "nodes" of a network may not be very "smart" in themselves, but if they are networked in a way that allows them to connect effortlessly and inter-operate seamlessly, they begin to give rise to complex, system-wide behavior. This allows an entirely new order of intelligence to emerge from the system as a whole—an intelligence that could not have been predicted by looking at any of the nodes individually. What's required is to shift the focus from simple device monitoring to a model where device data is aggregated into new applications to achieve true systems intelligence.

Creating an unbroken circle of data and information value based on the integration of people, processes, and relationships across the complex ecosystem partners is the "holy grail" of smart systems and assets

Because it is impractical to deploy human beings to gather and analyze the real-time field intelligence required, connected services depend on "machine intelligence" and device data as a fundamental building block.

THE COMMON CURRENCIES OF ASSET SYSTEMS and THE IIoT

Financial economies that lack an abstracted, liquid currency are barter systems. You can accomplish rudimentary trade in such a system, but not sophisticated, ever-evolving exchange that transcends the inherent meaning of traded objects such as silk or grain or livestock. The idea of a liquid currency was a paradigm-shifting innovation in running an economic system.

The common "currencies" of the bit, the byte, and the packet made massive and rapid evolution possible in computing and networking. What is the common currency of the Web world? Is it HTML? XML? The Web "page"? The relational database table? The hard truth is that the Web has no common currency for information or information objects and devices. As a platform for the world's information, be it information from traditional IT systems or from OT systems,

the Web and legacy asset management solutions resemble a comparatively primitive barter system of "apples and oranges," not a sophisticated economy.

Smart Systems, Assets, Pervasive Computing and the Industrial Internet of Things implies a true global information economy where we understand that and data access, usage and interoperability are essential requirements—remarkably simple foundations for intense complexity that remains comprehensible and useful at any scale. The key point is that making very few assumptions about the data and about the devices connecting to the network to send and receive data. It is this extensible, technology-neutral information architecture that will allow new applications and services to scale dramatically (and gracefully), with minimal central administration.

Demand for interoperability is growing, and as designers of information systems to manage OT systems and assets work to provide it, they will be laying the foundation for an information system far vaster than the existing World Wide Web.

This is the fundamental reason that new asset management and OT systems will require new data and information architectures to enable the integration of senors, actuators, machines, equipment, systems and people. The next generation of asset management systems and technologies are opening a whole new realm of business process innovation, including:

» **Multi-Vendor Service Provisioning and Handling:** Monitoring and managing machines in the field as well as keeping track of service resolution routines and alternatives relative to machines and equipment systems from multiple vendors is a significant feature. This allows a value based approach based on factors such as the timing, the nature of and the technical personnel involvement for a given service activity provided, but orchestrated across the reality of these systems configured and installed; well beyond a single equipment vendors scope of coverage.

SMART AG DRIVES COMPOUND VALUE

According to the United Nations, food production will need to increase by 6000% to feed the expected 9 billion people on this planet by 2050.

Players like Deere, a global leader in agricultural equipment, is connecting its equipment with farmers, operators, dealers and agricultural consultants. This interconnectivity helps farmers enhance crop yield and productivity. They are collecting and processing massive amounts of data to truly revolutionize farming.

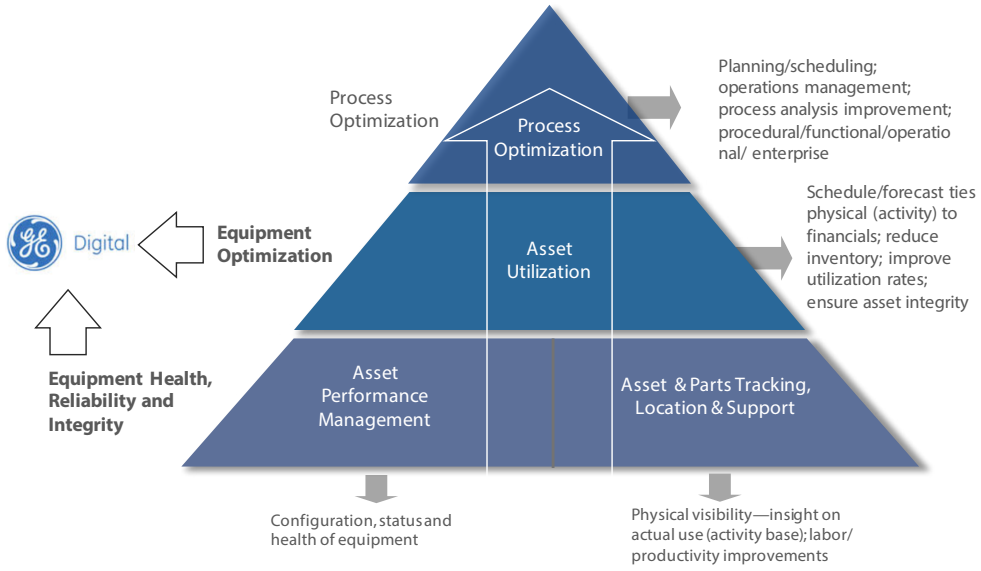
Deere leverages their "Smart Systems" and data values to benefit all their business relationships, not just their relationships with customers. Companies like Deere do not cut partners out of the services data value loop because their possession of equipment-generated data puts them in the position of being able to offer services more intelligently. Deere has created multiple portals where users [and others] can manager their fleet, see weather forecasts, access any application (including third party applications for other machines) and view financial information related to their farming. Additionally, users have remote access to consultants able to see what is going on from a distance. Deere is leveraging open smart systems to allow multi-party collaboration.

» **Systems & Software Management:** Software based services have the potential for constant improvement once incorporated into an asset management program. In order to deliver this value, machines in the field must be able to be updated remotely. This set of capabilities can deliver and track such updates, and also maintain records for compliance or billing purposes.

» **Usage & Performance:** Usage monitoring and performance tracking are required functions for this type of value delivery. Partners can step up to higher levels of impact on the customer.

» **Decision Support Extends Customer Relationship:** Providing users and customers with valuable information that helps them run their own businesses more efficiently will extend the relationship between the machine builder and end customer well beyond the initial product sale, helping to build a "mutual, shared understanding of customer systems allows knowledge gained on either side to be continuously leveraged."

Exhibit 8: GE's Value Proposition Lies in its Platform Modularity and Ease-of-Use



Beyond the immediate benefits that are visible to equipment OEM's today, networked machines will become portals into other network resources in which users will gain utility not only from the machines themselves, but from a variety of adjacent value added processes and services. This new knowledge becomes extremely valuable when combined with other information, allowing the creation of new service value.

The next great step in IT and OT development—completely fluid information and fully inter-operating devices, people and systems—requires a new generation of data and application integration platform technology that will make information itself truly portable in both physical and information space, and among any conceivable smart information devices and machines.

Technology advancements need to engender new system elements and new services. Correctly balanced, technology and new service delivery modes can help customers reach their goals of increased operating efficiency, reduced costs, automated system upgrades, and more efficient operations. Achieving this critical balance is the challenge that GE Digitals delivery platform is aimed squarely at solving.

The role of digital information and asset management platform technology in business has evolved from being first a luxury, then a mainstay, and finally what it is today—nothing less than the core value of the business itself.... data generated by connected machines will soon become the very air that business breathes

GE's platform is intended to reduce a significant percentage of the complexities of application development, systems management and application delivery. The challenges of networking smart devices, developing connected product applications, integrating complex IT systems and unifying services delivery in a coherent and cost-effective manner have been big hurdles to adoption that new platform technologies are finally addressing.

PARTNERSHIPS and ECOSYSTEMS

To achieve real compound value in smart systems and asset applications, equipment players and value adders will need to think and act differently. A renewed focus on developing ecosystems and the critical relationships that will drive value are key to success.

Smart services applications are highly specialized. Embedding connectivity into the next generation of devices, ensuring they are deployed profitably and that new cloud and services delivery capabilities can scale across multiple countries, are challenging tasks.

Integrating physical and virtual systems will require expert application knowledge as well as a deep understanding how these systems will work. Choosing the right partner, one that fully understands the different elements involved and has industry domain and equipment knowledge, and correctly aligned with delivery infrastructure partners will be critical to successful deployments. Working with a technology and solution provider that has a deep rooted understanding of the complexities of large global deployments will ensure that the solution is successfully delivered. A new chapter in the story of smart systems and assets, OT, IT and Telco partnerships has begun that will inform new value in the converged Internet of Things and People.

Radical new thinking about connected product technology must begin at the most basic levels, future proofing their innovations by making the fewest possible assumptions about the nature of networked objects and the data they produce, carry or process - the company takes a much broader, all-encompassing view of information. Ultimately, this type of platform solution will alter traditional business models and how new applications are realized.

MINDSET & PROCESS FOR SERVICES STRATEGY and DEFINING NEW MODELS

Thinking about the business opportunity associated with a connected product is a highly creative process. Often there are no cut-and-dried markets to identify and size. Rather, there are whole new markets that might develop as networked products and systems are brought to market.

Today, with the emergence of connected products and information-based services, even more complexity has arisen in the design of the systems and the services as well as in the core of the products and elements within the core system. Additionally, from our viewpoint, because networks add yet more complexity to the process and because just about everything will get connected, we strongly believe business developers need to address multiple interrelated dimensions in order to fully address the nature and scope of the resulting business opportunities.

To move from thinking to research to real-world solutions, you will go through a process of synthesis and interpretation that needs to begin with a discovery phase that can help organizations connect better with the customers they serve. Done properly, discovery sets the stage to drive new concepts and innovation potential and help organizations to see tangible new opportunities. The elements that need to be addressed in the discovery phase follow here:

» **Experience:** Developing solutions based on user-centered experience for users, customers and partners;

» **Behaviors:** Understanding the many and diverse buying and usage behaviors and modes of collaboration across ecosystems and markets;

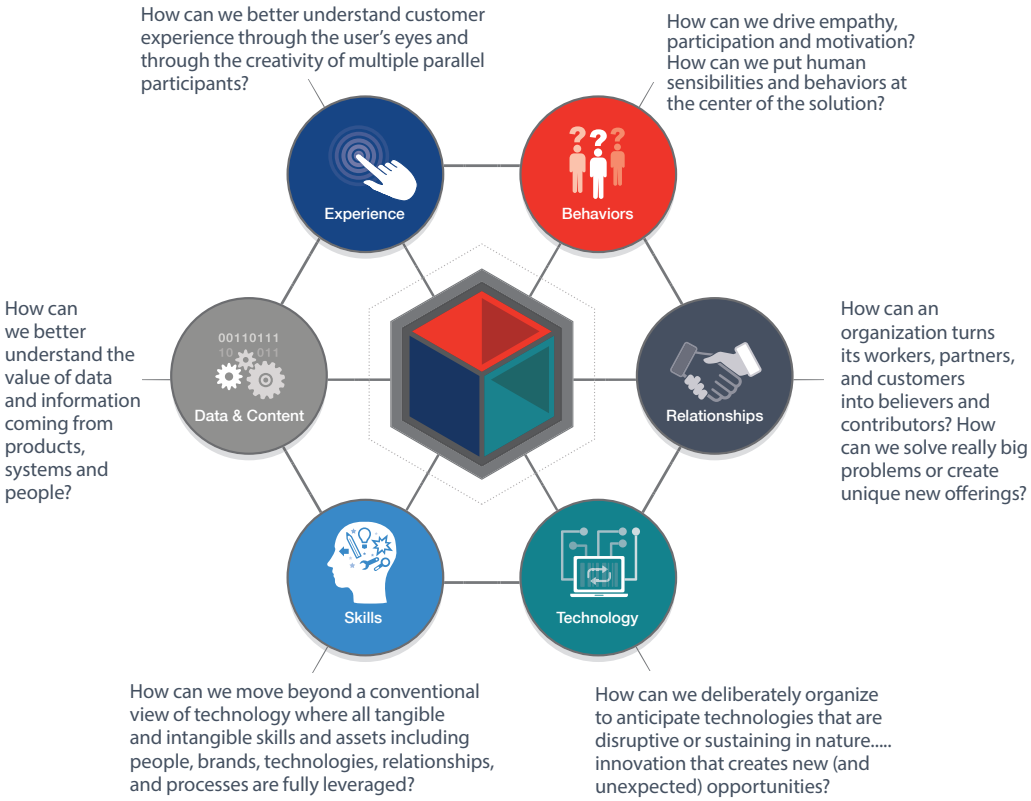
» **Relationships:** Potential to engage and leverage extended communities of users, companies, OEM's and suppliers with real-time interactions and information value;

» **Technology:** Emerging technologies, if properly nurtured and applied, can foster many opportunities to disrupt current competitive structures;

» **Skills:** Leveraging human capital and skills in this connected world to re-design and automate business processes will create entirely new solution values; and,

» **Data and Content:** Organizing the rapidly growing amounts of data from open systems for wider use, awareness, collaboration and collective intelligence.

Exhibit 9: Business Design and Model Development Process



The intersection of the five dimensions above is where discovery of business models begins. This discovery phase is where organizations can identify a "business model design challenge." The foundation of smart systems and asset business model development is identifying a concise design challenge. This challenge will guide the queries and questions you will ask customers during field research and the opportunities and solutions you will develop later in the process.

But the whole process begins by discovering and identifying challenges customers are facing or leveraging opportunities your organization has identified and is interested in exploring. The goal is to narrow feedback and inputs from the discovery process down to one specific business system and model design challenge.

Once addressed, the diverse perspectives developed during discovery can help feed a more structured process that addresses the tasks that need to be undertaken to define and develop new smart systems and assets businesses.

Inevitably, companies will fail to understand the disruptive threat inherent in the Internet of Things and connected products, and a merely defensive justification to network a product or machine may not succeed in creating sustained competitive differentiation.

Fortunately, a simple process and methodology, which we present at the end of this document, will allow most companies to think through the advantages of pushing towards new models and allow many to find the required motivation.

Still, many companies will be hampered in their thinking by a tendency to assume that the company after networking assets and smart systems will be the same company and in the same business as before networking. This is a safe assumption in almost no case.

Business model design needs to transcend discrete product or service innovation; business developers need to creatively imagine fully developed systems and whole marketplaces

The first fact about a networked product, which is so obvious that no one needs to be told, is that it will capture and convey valuable data. The second fact, not quite so obvious, is that these new data become a core asset. The third fact, not an obvious leap for many managers, is that information as an asset makes for fundamental changes in a company's business. The fourth fact, which makes things simple but by no means easy, is that most changes brought about when information becomes central have the effect of moving a company toward an entirely new service business model.

We say this is simple but not easy, because while the fact that service moves to the fore is not hard to grasp, in practice service is a paradigm so foreign to manufacturers that they cannot understand, let alone implement, the changes necessary to make the shift successfully.

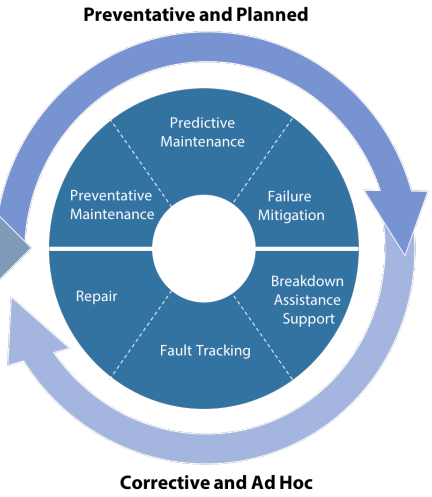
This is the reason that machine builders and OEM's will need to develop forward-looking strategies that fully leverage embedded intelligence and computing capabilities integrated into their assets. As obvious as this path may seem, many are overlooking the most important aspects of innovative services models. Those players that are the first to embrace the strategic value of information-driven services will create "moats' wide enough to set competitors back years. This process ultimately requires leaders who are wiling to embrace a new vision of after market services where the intersection of data value, services innovation and ecosystems defines a completely new breed of players.

ADDENDUM:

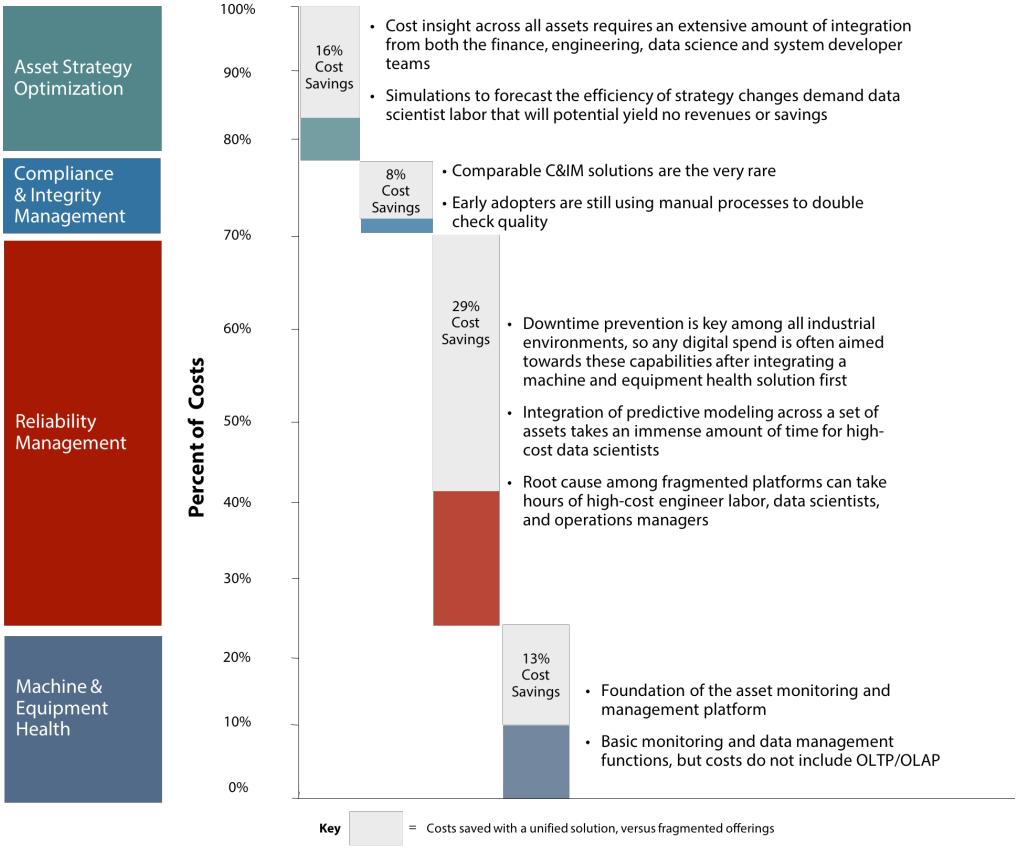
THE ECONOMICS OF MODERN ASSET MANAGEMENT

By it's nature, maintenance is an ad-hoc event. It's reliant on triggering events that by themselves are relatively straightforward. The complexity of the event, the role data management plays in the environment and the nature of the work are primary determining factors of the economics of asset management. Next generation

asset systems will fundamentally change the way maintenance is conducted and, more importantly, the economics and costs.



COST BREAKDOWN OF ASSET MANAGEMENT SOLUTIONS

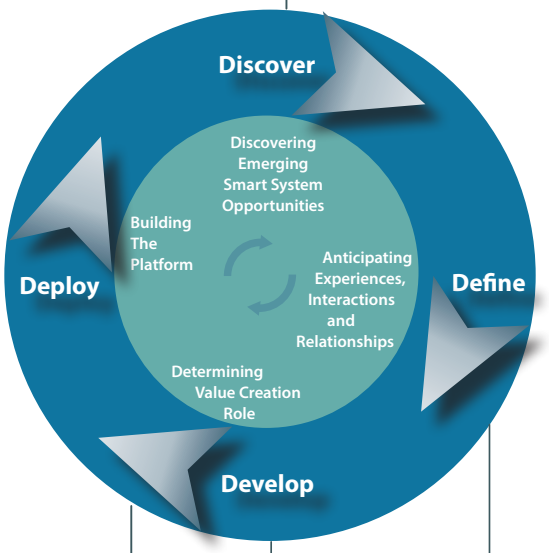


ABOUT HARBOR RESEARCH

Founded in 1984, Harbor Research Inc. has more than twenty five years of experience in providing strategic consulting and research services that enable our clients to understand and capitalize on emergent and disruptive opportunities driven by information and communications technology. The firm has established a unique competence in developing business models and strategy for the convergence of pervasive computing, global networking and smart systems.

ADDENDUM:

Smart Systems Design is a new discipline.....



Discovering Emerging Smart Systems Opportunities

Explore

Who are our customers? What are their experiences?

What personas, applications, devices & systems does our product or service touch? What is the nature of the interactions?

How can we best use technological and market uncertainty to our advantage?

Experience

What primary customer activities can we observe; be involved with?

Which activities represent opportunities for us? Do these activities benefit from smart devices and/or services?

What adjacent activities can we observe; be involved with? Will these activities benefit from smart devices and/or services?

Map

What elements will combine to create value for the customer? What benefits can be added over time & what advantages will they bring?

Are there special challenges in making the value salient to the customer?

Do these elements extend existing product or service offerings or are they completely new?

Based on desired peer interaction & technology maturity, is the timing right?

Defining Interactions, Collaboration & System Values

Developing Value Creation Model & Role

Deploying the Smart System

driven by a core set of critical questions....

Conceive
Who will be the users and customers potentially participating in our solution?

What needs, concepts and solutions will serve our users, customers and partners?

Who are our natural allies (players; devices; peers); what companies will play or contribute to the new system; who is best poised to help develop our opportunity?

What formal and informal relationships might exist in the future?

Participate
Is there an explicit (or implicit) community of participants? If so, which participants interact with which value elements?

What manner of interactions can we use to drive empathy? involvement? innovation?

Who can we invite to collaborate? Which potential participants can help us best understand the user/ system experience?

How can we best present, iterate and test our system concepts; hypothesis?

Prototype
How should we prototype the customer and partner experiences?

What are the critical information interfaces? Interactions? How will information flow between and among constituents?

What are the key system elements & design factors?

How can we quickly iterate our assumptions to learn more?

Model
What characteristics should we use to segment our users, customers, markets and articulate the benefits of our proposed offering?

Which actual or anticipated segments are most attractive?

What role/s can we/they play in the proposed system?

What ecosystem configuration best supports our strategy; open; closed; hierarchical; select members?

Which value elements should we own; which should we obtain by partnering?

What are the business model alternatives; which is best aligned with the offering?

Innovate
What technology innovation is available to enhance or extend our system's value?

What is the architectural "blueprint" behind the customer experience?

What technology alllies will be required for system/service realization?

Validate
How can we best test our business design? What is the best means to prove our system's value in the field?

How attractive are the economics of the business case; what will it cost to bring the system to market? Will it result in cost savings; new values; new experience?

Architect
What are the key systems and ecosystem design factors? How will our role or the role of others evolve?

What is the business system that will best enable the customer experience

How should the new system be positioned in the marketplace?

Invest
How can we align investments and resources with our chosen strategy?

How should we approach critical make, buy, partner decisions?

Build
What is our system development and launch plan?

What technology allies will be required for product / service / system realization?

What organization levers will best drive this business? What leadership priorities will drive the most effective market role?

What are the critical path elements that need to addressed: activities; timing; responsibilities; costs; uncertainties?

What key on-going support elements need to be in place to continue to enhance our objectives?

What will be the mode of iteration for improving and expanding the business?