Thinking Connectedness Across Product Ecosystems
Thinking Connectedness

Are we witnessing the birth of Generation C? Or is it already too late to ask the question?
The Connected Generation is firmly in place. Blurring the boundaries between work and play, Generation C is busy exchanging presentations, pictures, opinions, meeting notes, personal notes, workplace gossip, and news, blitzing the world with their Tweets and FB updates. They are busy, talking to each other, in an endless stream of images, video, voice, and text.

Markets, industries, customers, employees, departments, devices, and business systems are following in their footsteps, trying to keep pace with events and opinions in real time. Seamless connectivity along with a multi-screen reality is transforming everyone’s lives. We have moved from discreet online sessions to deeply integrated online lives. This pervasive connectedness is giving birth to unprecedented intelligence and insights, and throwing up HUGE opportunities to mine unstructured data for insights.

The impact is dramatic. The network of products and technologies such as sensors, cameras, GPS systems, RFID, Bluetooth and mobile devices, continue to evolve. They are driving digitization, automation, and collaboration. In turn, these developments are placing tremendous pressure on businesses, forcing them to absorb and deploy new real-time technologies. Entire enterprise systems are being reconfigured and reshaped by the underlying demands of Generation C much faster than ever before in the history of technology.

How is all this changing our experience of the world? What are the new horizons to which connected products, systems and people can push organizational strategies? We asked ourselves these questions and the result has been captured in this issue of Winsights.

Our sharpest thinkers, experienced technologists, veteran consultants, and knowledge partners like McKinsey and Knowledge@Wharton take a deep dive into the future while trying to answer these questions. How do connected 3D printers challenge manufacturing in the future? How do digital oilfields that connect remote rigs to knowledge experts thousands of miles away in real time recast the Oil & Gas business? What is the magic retail businesses can conjure when their in-store digital systems begin to exchange rich data on customers? How does motor insurance undergo a revolution when underwriters are directly connected to vehicle performance?

I am sure you will find the viewpoints given by our experts useful and help you lead the coming change, driven by connectedness, in your business.

I wish you a Happy and ‘Connected’ 2014.

Puneet Chandra
Chief Marketing Officer, Wipro Ltd.
Global Connected Devices

$1.2 TRILLION REVENUE

Global connected device revenue is $200 billion now and could grow to $1.2 trillion in 2020.

Source: UBM plc Company
Navigating the White-Water World of New Product Development
This Knowledge@Wharton article talks of how shorter product cycles, unforeseen competition, mass standardization, and narrowly focused competition is affecting businesses.
G K Prasanna, Senior Vice President & Global Head, Product Engineering Services & Global Infrastructure Services, Wipro Limited

Connecting the Dots: How to Make Years of Investment in Retail Technology Pay Off
This article outlines how retailers today should bring together years of investment in technology for real-time customer engagement.
Raghavendra K.M., General Manager, Retail, Banking & Peripherals, Product Engineering Services, Wipro Limited

A Healthy Future With Wearable Semiconductors
How can real time diagnosis through small, portable monitoring devices, reduce healthcare costs and save lives.
Satish P., General Manager, Semiconductors & Systems, Product Engineering Services, Wipro Limited

Design to Value in Medical Devices
This McKinsey article outlines models for analysing true cost versus perceived value, to cut out the frills and make medical devices affordable.
McKinsey

Telematics: Driving an Accurate Insurance Model
This article describes breakthrough technology that will drive usage based motor insurance to benefit both the insured and the insurers.
Jonathan Roberts, Partner - Industry Advisory Group, UK & Europe, Financial Services Practice, Wipro Limited
V N Rajesh, Practice Manager – Insurance Analytics, Insurance, Wipro Limited
John Slosar, General Manager, Automotive, Product Engineering Services, Wipro Limited

3D Printing: Improving Accessibility and Protecting Intellectual Property
This article describes 3D printing - a whole new way of creating physical objects and also attempts to answer how manufacturers protect their investments in component design, ascertain only authorized number of designs are printed and what implications this model has on digital rights management.
Raghavendra K.M., General Manager, Retail, Banking & Peripherals, Product Engineering Services, Wipro Limited
Debjit Roy, Senior Consultant, Retail, Banking & Peripherals, Product Engineering Services, Wipro Limited

Data Convergence & Multi-Screen Display for Collaborative Work Environment
How is real time analytics and data convergence that distributes actionable insights to different screens, being used to predict, isolate and respond to calamities before they strike.
Dr. Arup Ratan Ray, General Manager, Industrial Automation, Product Engineering Services, Wipro Limited

Enabling Rational Decisions through Digital Oil Fields
How are digital oil fields leading to improved collaboration, streamlined workflows, right tools and better information management.
Hemant Kumar, Practice Head, Upstream Oil & Gas, ENU business Unit, Wipro Limited

Telematics: Driving an Accurate Insurance Model
This article describes breakthrough technology that will drive usage based motor insurance to benefit both the insured and the insurers.
Jonathan Roberts, Partner - Industry Advisory Group, UK & Europe, Financial Services Practice, Wipro Limited
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3D Virtualization for Plant Owners and Operators
Engineering, Procurement and Construction industries are using ‘3D virtualization’ techniques to create intelligent plant drawings that are becoming invaluable.
Arun K Talluri, General Manager, Energy & Utilities, Product Engineering Services, Wipro Limited
Kasturi Rangan, Head of Solution development, Energy & Utilities, Product Engineering Services, Wipro Limited
Developing new products today involves a chain of daunting new challenges. They include shorter product cycles, unforeseen competition, mass standardization and more narrowly focused customization. This is disrupting business models across industries, says G. K. Prasanna, a senior vice president at Wipro Ltd. To thrive in this new world, companies must build “innovation prowess,” says George Day, a Wharton marketing professor. The two suggest solutions to innovation challenges in this white paper, part of a Future of Industry series produced by Knowledge@Wharton and sponsored by Wipro.
New product development today thrusts companies into a “white-water” world of market turbulence wrought by shorter product cycles, competition from out of the blue, and the need for both narrowly focused customization and mass standardization, says G. K. Prasanna, a senior vice president at Wipro Ltd.

“When the number one camera company is a mobile phone company, what does it mean for the camera industry? Should carmakers like Ford and Toyota be worried more about competition among themselves or from Google’s driverless car project? And how might Calico, another Google project aimed at life extension, impact hospitals, insurers and others in the life sciences industry?”, asks Prasanna, who is also head of global infrastructure and product engineering services for the technology services provider based in Bangalore, India.

George Day, a marketing professor at Wharton and co-director of its Mack Institute for Innovation Management, believes companies that want to innovate successfully today must build “innovation prowess.” That means taking a disciplined “outside-in” approach to setting strategy, or looking at customer needs in the outside market first. Put another way, it means looking at the world through customers’ eyes rather than first looking within the company to decide which product – or product extension – should be built in order to best use existing resources. The latter approach – an “inside out” view – leaves companies flatfooted in responding to fast-changing market needs, according to Day.

A key part of understanding those customer needs is to develop the ability to spot early warning signals about new competition or technologies aimed at meeting those needs. Day’s advice for new product developers: “Be continuously on red alert. The problems arise when you are surprised.”

Spotting early warning signals

Companies need not grope in the dark about impending competition. “The reality is we always have early warning signals of changes in technology and emerging competitors the question is: Do we act on them?” asks Day. Often companies don’t, sometimes because the signals simply are “weak.” They tend to be “a little ambiguous and come with a lot of noise” or information clutter.

Day says companies must be “vigilant about the weak signals of new competitors, changes in technology and new markets opening up, and must share them widely through the company.” That last point is particularly important. Even when weak signals do end up getting picked up, too often the word does not get out. In research covering several companies, Day found that every time a company failed to see a competitor coming from an adjacent market or a new technology, many people within the company already knew about it as a threat. “But the senior officers, the decision makers, did not know about it and people down below didn’t know the senior people didn’t know about it.” He found that “there are a lot of organizational impediments to staying vigilant” and that companies with an ability to pick up the signals on time “have lots of degrees of freedom in dealing with them.”

Day offers the example of a prominent medical device maker. The company, is “very concerned” about the possibility of a drug that may replace its pacemaker (an electrical component that regulates heart beats) and is closely watching that space. Once that threat gets closer to reality, it could respond in several ways: Make investments in related areas, formulate competing products or simply monitor the situation.
Major product development trends
Prasanna sees five major trends defining new product development strategies today.

For companies to innovate effectively, Prasanna advocates “standardization at the core that is also modular to allow for variants to suit different markets.”

First, relatively inexpensive technology now allows powerful processing and ubiquitous computing.

Second, companies and investors with deep pockets are willing to finance big, long-term bets on new products. “Companies like Apple, Google or Samsung can take moon-shots. But smaller companies do not have that luxury and must find other ways to innovate.

Third, companies approach markets from both ends: a global market with standardized products and a market of even one individual with highly customized products. So, a new smartphone launch now is very different than in the recent past. It is now typically a global event versus the regional market-by-market release of recent years. In another example, “emission norms are different across countries. A car that works in China cannot be released in Europe, India or Japan.”

Fourth, companies often must design products with varying specifications that suit the needs of different markets. “The Indian customer doesn’t expect a trimmed down version or a less powerful version than the rest of the world, but twice the features at half the cost,” says Prasanna. One favorite example of a product designed for emerging markets is Procter & Gamble’s Gillette Guard brand of razors, launched in India in 2010. The Associated Press reported that Gillette found that many Indian men used low-tech, double-edged, T-shaped razors that caused many skin cuts. Indian men also had thicker hair with higher density than Americans. While American men wanted smoother shaves, Indian men were more concerned about avoiding cuts. Gillette’s Guard razor had one blade to emphasize safety over smoothness, compared with two to five blades found on many U.S. razors. It also designed the Guard for easy gripping, provided a hole at its base so that users could hang it, and a small comb by the blade to deal with thicker hair. It lowered manufacturing costs by reducing the number of parts from 25 in the Mach3 to just four in the Guard. The result: Gillette’s market share for razors and blades in India rose from 39.3% in 2007 to more than 49% in 2013, according to research firm Euromonitor.

Finally, companies today must rethink what is core to their organizations and outsource the rest. Shorter product life cycles and the need to ship products faster to the market means they have to do “product development which is rapid, iterative and close-to-consumer -- it is almost continuous R&D,” says Prasanna.

Strategies for the new environment
For companies to innovate effectively, Prasanna advocates “standardization at the core that is also modular to allow for variants to suit different markets.” Companies should consider an R&D model of rapid prototyping with on-going gradual changes to replace the traditional approach that took months to develop model blueprints. Earlier, a supplier’s engineers had to visit customer locations to modify equipment to suit specific requirements, but technology today allows incremental changes remotely, he adds.

Such customization on the fly now happens even with large industrial equipment like earthmovers. Until recently, getting different power capacities in earthmoving equipment required separate pieces of equipment, each with a single power capacity. But today’s earthmovers can be remotely reconfigured to provide more power for short bursts of time. “For example, I could send a code...
to give an earthmover three times the [existing] power for the next three days,” Prasanna says. “I can bill for it and collect the payment. Pay-per-use for earthmovers as a service is now possible it is not science fiction.”

He adds that “the only way to manage such fast-changing markets is through a systems integration approach rather than a develop-everything-from-scratch model.” Companies need to monitor customer equipment usage or regulatory requirements, for example, to be proactive. In the past, service was based on customer complaints or a customer “yelling for help”, Prasanna notes.

“Offerings that create superior customer value are often found at the intersection of technology advances and customer needs,” says Day. He cites an example from cardiac surgery, where there was “an enormous need” for an arterial stent that could open arteries and not cause problems years after insertion. In 2012 Abbott Laboratories launched a plastic stent that dissolves into the bloodstream within a couple of years after implantation. “This stent is a huge boon to customers and a source of organic growth for Abbott.”

Another recent example: Banks looking to penetrate rural India with automated teller machines (ATMs) face several obstacles, especially erratic or non-existent power supplies. A U.S. maker of ATMs has partnered with an Indian technology firm to build a rugged, energy efficient solar-powered ATM that works without air conditioning. “It was built at half the cost and twice the reliability parameters of existing machines,” says Prasanna.

Day further cites Cisco as a company that has
consciously embraced open innovation platforms. In his 2013 book Innovation Prowess he noted that Cisco has many engineers working on extending and improving its current products, or developing the next generation. They often work in open networks with external partners to access new technologies or market concepts. “It may otherwise take too long to build the internal capabilities,” he explains. For breakthrough or disruptive innovations that are beyond the company’s capabilities, Cisco has created an internal incubator that directly reports to the CEO. The group’s budget is “carefully protected in good times and bad.” On average, about four out of nine of Cisco’s internally incubated innovations succeed.

Costs of innovation
Prasanna notes that, contrary to what one might expect, the cost of innovation generally has not risen in today’s business environment. This is true despite the relentless demands for shorter product life cycles and like noted earlier, greater speed-to-market, extreme customization and rising standardization in basic modules. In fact, hardware and software are increasingly commoditized and thus cheaper. That can help support an incremental approach to innovation.

Prasanna’s ideas on “incremental R&D that is close to the customer” in some ways dovetail with Days’ view, which is to avoid going out on a limb with a large innovation without a full understanding of the market. It is cheaper overall to invest first in spotting and tracking “early warning signals” than it is to launch risky projects without adequate market intelligence. “Investing in the front end – sometimes called the fuzzy front end of the growth process – to seek out the best opportunities and developing them is still a lower cost option,” he says. “You lose a lot of money when you bring risky projects to market and they fail, because the cost of commercialization can be 20 times as much as the front-end investment in screening opportunities.

Innovators with a finger on the market pulse eventually bag satisfied customers and new markets. “Amazon Web Services, which offers customers access to its cloud network, came about because Amazon.com founder Jeff Bezos had a “working backward” mentality”, says Day. “Rather than ask what we are good at and what else we can do with that skill, you ask, who are our customers? What do they need? Growth comes from solutions based on an outside-in insight into how to solve a customer’s problems.”
Today’s stores are buzzing with technology. Scanners, digital signage, digital displays, kiosks, tablets, hand held devices, POS, RFID and inventory systems are working in silos. How does a retailer bring all these investments together, map it to customer needs, and ensure an ecosystem that drives real-time customer engagement?

CONNECTING THE DOTS: How to make years of investment in retail technology pay off?

Raghavendra K.M
General Manager, Retail, Banking & Peripherals, Product Engineering Services, Wipro Limited

Beam me an offer, Scotty: influencing customers

It may seem that most retail stores have been built the wrong way. It is only when a customer has finished shopping and is checking out, does the store know who the customer is. Using credit card and loyalty card details, the store finally figures the customer’s name, rudimentary purchase history and the actual ‘size of basket’. At this point, all the store can tempt the customer with is an additional pack of bubble gum or a magazine. It is too late to do anything else. By contrast, online customers tend to first log in and allow every action to be tracked. Now brick-and-mortar stores can also get to know customer details before the first purchase is made. This presents an exciting new opportunity, making it
irrelevant to depend on check outs for trivial increase in sales.

For several years now, retailers have built a formidable arsenal of in-store information display systems. These include digital signage, flat screen TVs, kiosks, interactive POS and store associates armed with tablets. For the last few years retailers have been busy investing in mobile applications that help connect with the customer. More recently they have placed their bets on increasing their social conversations. Now, it is time to make smartphones and other intelligent devices work for them, instead of moping that customers are ‘showrooming’ – the practice of purchasing items online from within a store using a smartphone after finding better prices online.

The reality is that as many as 80% of shoppers still visit stores. The question is, “Can these shoppers be influenced by connecting devices within the store?”

Using mobile technology to recognize the customer, retailers can ensure greater predictability in shopping outcomes. A large retail chain in the US found that a one point improvement for in-store close rates translated into US$200 million in incremental operating income. That kind of gain can be real for most retailers. What retailers need to put in place is a well-thought out connected device ecosystem. Such an ecosystem nudges customers towards buying more by beaming offers that are beneficial to customers.

Starting the connected device conversation: recognizing the customer

The crucial element in recognizing the customer and creating a personalized experience begins by ensuring the customer is persuaded to download a store app to their mobile device. This can be done by permitting the app download over the store Wi-Fi, over Bluetooth or NFC.

Several retailers have begun to target customers, making them offers as they pass by the vicinity of the store. Starbucks, for example, inserts a ‘passport’ into the customer’s smartphone. When the customer is driving...
Retailers are increasingly linking years of their investments in technology for better results. As a consequence, stores are getting smarter at recognizing, tracking and talking to customers. They are also getting intelligent thanks to the availability of data. The end result is better experience, service, loyalty and conversions.

past, the application recognizes the customer, maps the customer to data from internal and external sources to throw up offers that are immediately useful or those that fuel the customer’s curiosity. The practice is sometimes referred to as geo-fencing.

In-store sensors can use the same application to track customers as they walk through the store. But this is not necessarily the only way to track customers. Customers can be asked to tap their phones against sensors at the entrance, use facial recognition to be instantly identified or simply be persuaded to login through a kiosk at the store before shopping. Now the store knows the customer, the customer’s mobile number, unique loyalty ID, email ID, past shopping history, CRM interactions, social exchanges etc. Armed with this information, the store can begin to personalize the shopping experience.

Handy Helpers: providing what the customer needs
There is little point in carpet bombing customers with coupons, offers and promotions. Instead, using customer data, carefully personalized promotions, product information, reviews, product comparisons, pricing and Stock Keeping Units (SKUs) are pushed out to the customer over the mobile device.

The ecosystem built around the customer’s mobile device and in-store systems plays an important role is keeping the conversation alive. It is here that the store assistant’s mobile device (preferably a tablet) begins to play a pivotal role. The store assistant’s device must be equipped with data on the customer (wish list, likes/dislikes, etc.), their social conversations, general consumer trends, products in stock, in-store availability (inventory levels), real-time pricing, competitive pricing, on-going promotions, reward and loyalty program details. The data helps the store associate instantly personalize the experience, match prices, offer loyalty points and convert the conversation into a sale.

When a customer needs assistance or is unable to find a product, the store assistant should become the handy helper with immediate assistance. This requires:

- Customer location accessibility
- Real time price update on aisles with electronic shelf labels
- Pricing and product benefits pushed to the customer’s device
- Ability to point customer to the product using product location mapping
- If the product is not in the store, ability to locate it in the inventory on the store assistant’s device and make the product available
- If the product is not in the store inventory, ability to locate it in another store in close proximity on the store assistant’s device and get it delivered to the customer

The idea is to have an endless aisle by integrating infrastructure across stores. Regardless of the customer’s needs, there should be a way of fulfilling it. For this to happen, data maintained in silos needs to be brought out and into play; systems must be integrated to share information in real-time and analytics engines must deliver actionable insight to customers and store assistants anywhere within the store.
Going the extra mile: enhancing customer experience
The connected device ecosystem can be used to magnify the effect of the one-on-one engagement. Self-help kiosks, digital signage, digital displays, hand held devices with store associates and even the POS can be used to show promotions, real-life videos, interactive displays, real-time pricing, purchase patterns of other similar shoppers, social activity on products, etc. These have been known to improve sales several folds. One study on the use of digital signage across a hardware retail chain in North America showed sales of interior paint improve by 23% and air filters by a staggering 178%³.

Handy Helpers: providing what the customer needs
The ecosystem can be additionally deployed to enhance branding. Stores may have a variety of community service programs, customer-focused events, awards, recognition and industry leadership standards that may be explained to customers using the displays. These can be customized to ensure that only the relevant information is shown, based on customer profile and segmentation. (As an example, the value of showing a promotion for an event calling for children to participate may have limited value if the customer does not have children).

If the customer is showroooming, a store associate can help the customer find product matches. Studies show that at this point the product price can also be a little higher than what the customer finds online.

The customer will still buy. Price is not always the most important factor – elements such as convenience, incentives that combine promotions and loyalty rewards play a major role in the decision to buy at a marginally high price.

The final link in the chain: getting it right at check out

Does your customer abandon the cart because of long checkout lines? That’s simple enough to solve by dynamically opening POS counters or sending customers to self-check outs using video analytics of checkout lines. But we know that customers hate to wait. Modern queue busting technology takes care of this, improving store employee productivity along the way:

- **Hand held scanners**: Products in the cart can be scanned by store associates using a hand held device. Billing is complete before the customer reaches the POS. Payment is made at the POS in the traditional way.

- **In-aisle scanners**: Customers are handed wireless scanners when they step into the store. These are to scan the items being placed in the cart. Payment is made at the POS or at a self-checkout counter (tied to RFID technology).

- **Multi product scanners**: The entire basket can be scanned and billed in a single scan using RFID technology at the POS.

- **Hand held POS**: This device has complete POS functionality and can also accept payment, enabling billing within the store. The transaction can be closed at the hand held POS.

Many of these solutions have the additional benefit of reducing shrinkage, a major loss faced by retailers.

Today’s POS terminals can also be linked to inventory,
CRM systems and customer data. As store devices talk to each other, they can ensure that an increasing amount of customer data is captured and leveraged.

When the ecosystem is combined with newer payment methods such as contactless NFC payment or one click mobile wallet payment, cart abandonment can be significantly reduced.

**The future is here: and the consumer wants to shake hands with it**
Retailers are increasingly linking years of their investments in technology for better results. As a consequence, stores are getting smarter at recognizing, tracking and talking to customers. They are also getting intelligent thanks to the availability of data. The end result is better experience, service, loyalty and conversions.

The signs of this trend are around us. Several retailers have started following a self-regulatory code when tracking customers over their Wi-Fi networks. They are setting up signage within the store that makes customers aware they are being tracked. Stores know they must respect customer privacy at all cost. But they also understand that customers are willing to share personal information with those they trust in exchange for value. Retailers who bring this value through a connected device ecosystem will see customers returning to their doors.

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5. **Future of Privacy Forum**: http://www.futureofprivacy.org/issues/smart-stores/
Wearable Electronics Market

$8.3 BILLION IN REVENUE

Wearable electronics market was $2.7 billion in revenue in 2012 and is expected to reach $8.3 billion by 2018.

Source: PR Newswire
A HEALTHY FUTURE WITH WEARABLE SEMICONDUCTORS

With cost of medical care on the rise there is a need for solutions that allow patients to return home faster from the hospital. But patients also need the assurance that they are being remotely monitored through the period of step down treatment. Lightweight and inexpensive wearable medical devices that monitor remote patient conditions and transmit data securely to qualified teams and automated health systems are the solution. Such devices are increasingly becoming available, with innovation in the medical device industry enabled by the semi-conductor industry.

The changing pulse of medical care
Arrhythmias are transient events. Most arrhythmias – where the heart beats too fast, too slow or with an irregular rhythm – are reasonably harmless. But some can be life threatening. During an arrhythmia episode, the patient’s heart may not be able to pump enough blood to the body. The lack of blood is known to result in brain damage and other organ failures. Arrhythmias can be treated successfully and most patients can hope to lead a normal, anxiety-free life. The difficult part is in monitoring the condition. Traditional ECG monitoring of a cardiac patient may not establish a reliable diagnosis unless the patient experiences an event during the recording. For a reliable diagnosis, the patient must
be monitored continuously. Medical researchers have developed a range of ambulatory techniques to address the challenge. These are good techniques that have been around for decades. But are they great? Are they simple? Do they serve the best interests of the patient? So far, the answer has not been a resounding “yes”. If anything, it has been an uncertain “maybe”. Now, the medical device industry is addressing the challenge by creating simple wearable medical devices. Mobile development combined with advances in semiconductor technology are making these devices portable, accurate, reliable and in several instances, cheaper.

The medical device and the semiconductor industries have sensed that health costs in the western world are rising and there is a need for a solution that brings down cost of medical care. Today, with tremendous pressure on medical infrastructure, the average length of stay in hospitals is dropping. For nonfederal short-stay hospitals in the US it has fallen from 6.4 days in 1990 to 4.8 days in 2009-2010 across all ages. But patients benefit from continuous monitoring of critical signs, even after leaving the hospital, and allow doctors to respond quickly to situations and emergencies. Remotely monitoring the patient helps patients leave potentially-expensive hospitals faster and also improves the quality of step-down care.

Wearable Devices

There are several advantages of the new range of wearable medical devices that are emerging. They allow medical providers to offer preventive monitoring to the aged, for chronic disease management and general wellness. Remotely monitoring those who may be susceptible to illnesses like cardiac disorder before catastrophe strikes can bring down the need for hospitalization and subsequent medical costs.

Expectedly, the demand for these devices is growing. The market for them is forecasted to hit $20 billion by 2018. A major chunk of the revenues will go to manufacturers of semiconductor components and embedded systems like memory, displays, processors, sensors and connectivity solutions that go into these devices.

Technical parameters

Wearable devices that work outside the confines of the hospital without expert medical assistance must fulfill a number of characteristics:

- **Usability**: The device has to be worn on a continuous basis and must therefore be small and lightweight. The challenge is to compress the device size down.
- **Power consumption**: The device should have low power consumption, reducing the need for frequent re-charging and disruptions in monitoring.
- **Design**: The device must be elegant without the need to attach long wires and electrodes from the device to the patient and from the device to the mobile gateway that transmits data (to the remote medical care unit).
- **Cost**: If a patient is required to purchase the unit, it should cost sub US$200 to be affordable or for the hospital to give it away free as part of medical care.

Devices that fulfill these conditions can expect to become popular. Manufacturers will find that users are able to easily integrate such devices into their daily lives for maximum benefit.

The typical set of parameters that the device must monitor include heart activity, fetal heart rate, skin resistance, skin temperature, refractive index of blood etc. Based on what the device is required to measure and monitor, its components would include:

- **Bio sensors**: Application specific bio sensors that emit signals indicating measured parameters
- **Analog-to-digital converters**: Application specific analog front end to digitize the sensor signals. The device may also be equipped with signal conditioning circuitry.
- **General purpose micro controller**: To process signals for the device to function. Signals could indicate battery levels, failure, etc. or signals received from accelerometer, displays and switches, memory and connectivity solutions.

- **Wireless interface**: In most instances, the device will connect to a mobile gateway over a Body Area Network (BAN) or the newer Bluetooth LE (low energy) suitable for continuous transfer of medical data.

- **Memory**: In modern wearable devices, the data is sent in real-time to a mobile gateway (smart phone or a tablet) and then to the patient’s remote health care provider. These devices can also store data in off line mode, synchronizing the data when the device goes online.

- **Power management**: The device design must ensure that energy consumption is minimized for longer uninterrupted device deployment and stand by time.
SOCs (System on Chip) engineered for wearable devices have begun to emerge (ex: Cypress Programmable SOC and the Intel Quark). These SOCs are often application specific and integrate all the components and systems of the device such as processors and memory. The analog front end which incorporates application dependent signal conditioning functionality is the key to the wearable device. Bearing in mind the importance of the analog front end, semiconductor companies have begun to devise special front ends to meet industry needs. The next generation of programmable SOCs is also expected to integrate Bluetooth Low Energy (BLE) to complete the wireless communication layer.

Remotely monitoring those who may be susceptible to conditions like cardiac conditions before catastrophe strikes can bring down the need for hospitalization and subsequent medical costs.

As medical devices begin to cater to a number requirements, their data collection and processing power also needs to go up proportionately. However, implementation of such functionality using discrete components can result in an increase in the Bill of Materials (BOM), device size and power. This can end up...
killing the device during actual deployment as they will inevitably face resistance from users.

Can components be eliminated or minimized to bring down the cost and size of the device? Custom SOC solutions integrate an embedded CPU with a low energy wireless interface and application specific analog front ends. The solution involves significant upfront (NRE - Non-Recurring Expenditure i.e. One time development cost) investments as a part of the development process. Of course, solutions created using off-the-shelf components will involve a lower NRE but are clunky when compared to custom SOC solutions (which are typically small and lightweight). However, if the volumes for wearable devices increase, the custom SOC solutions become a preferred path to adopt.

In addition custom SOC solutions offer the advantage of being tamper-proof or copy proof. The critical algorithms that a medical device provider comes up with can thus be protected. It is also a very popular route to creating a solution because of the security it offers as talking to implantable devices is risk prone and requires the highest attention to data security.

The heartbeat of the revolution
The impact of an unobtrusive, easily usable, accurate, reliable and wearable medical device that can store/transmit high resolution data for long uninterrupted periods (approximately 30 days) over a mobile gateway to remote medical monitoring and analytical systems can be immense. If the device is capable of some local processing using applications on the mobile device, its value is further improved. And finally, if the application on the mobile device has intuitive audio/video capabilities that enhance intervention from the remote care giver, the solution is guaranteed to succeed. Amidst this, the growing role of researchers, chip designers and fabricators in the semi-conductor industry cannot be underestimated.

1. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics: http://www.cdc.gov/nchs/data/hus/hus12.pdf#097

By 2020, more than 30 billion devices will be connected through the Internet of Everything.

Source: ABI Research
As price pressures increase, medical device makers need to rethink product development processes. Design to Value can help get costs under control—and deliver exactly what customers value.

Sastry Chilukuri, Michael Gordon, Chris Musso, Sanjay Ramaswamy

DESIGN TO VALUE IN Medical Devices
“If medical device companies want to continue to make money as prices face continued pressure, their only option is to take cost out.” This comment from the head of procurement at a major US healthcare provider neatly sums up today’s situation in the medical device industry. The sector has always been challenging, with increasingly complex technologies and tough quality and regulatory hurdles. Until recently, however, device makers who overcame those barriers could sell their products at prices that made the effort worthwhile.

Today, medical device companies operate in a different world. In developed countries, healthcare systems are under acute financial pressure. Healthcare providers are responding by exploring every opportunity to increase efficiencies and reduce costs.

Developing economies are transforming the environment, too. As growth slows in established markets, opportunities are arising elsewhere. A rapidly growing middle class is demanding more medical devices of all types, but price sensitivity in these markets is acute. A sophisticated regional industry is growing to serve this demand, and ambitious new players from China and India are now keen to take their low-cost designs to enthusiastic hospital buyers in Europe and North America.

Now device makers have to find new ways to maintain their competitiveness. Like other industries before them—the automotive sector, consumer electronics and telecommunications, for example—they are paying new attention to the detailed design of their product ranges, looking for opportunities to eliminate excess cost wherever possible, to gain the flexibility to sell profitably in cash-strapped traditional markets and price-conscious new ones. History has shown that the winners will be those who can deliver exactly what the customer wants—nothing less, nothing more—at the best possible price.

As growth slows in established markets, opportunities are arising elsewhere. A rapidly growing middle class is demanding more medical devices of all types, but price sensitivity in these markets is acute.

Cheaper, but for whom?

This new game is challenging in developed and emerging markets alike. Success in emerging markets requires a deep understanding of stakeholders’ needs—which is hard to get from a design office halfway around the world. One maker of electronic pacemakers, for example, developed a low-cost device aimed at the potentially huge tier-II market of lower-income customers in developing countries. By replacing the conventional programmable control with a simpler electro-mechanical version, the company dramatically reduced the cost of the device. The device was a market failure, however. Few customers in target regions could afford the combined cost of the pacemaker and the surgery to fit it. Few local hospitals had the capabilities to implant the devices, and those that did were suspicious of the mechanical controllers, worrying that they would need to carry out expensive secondary operations if devices failed. The company has since launched a programmable device, aimed squarely at the richer tier-I market. Surgeons, the gatekeepers in pacemaker selection, were more comfortable with the programmable devices, which they knew from their training in western hospitals. The programmable pacemaker has performed much better, capturing three quarters of its target market.

Even companies that are close to customers can misunderstand their needs. A US maker of electrotherapy devices, for example, embarked on a clever modularization program that allowed one device...
to be configured in many different ways at the time of purchase, or upgraded later as user needs changed. When it launched the product, however, more than nine out of ten customers chose the same basic configuration, and then rarely came back for more modules later. In the end, the modular architecture simply added cost to the product, and it lost out in the market to competitors with simpler designs.

Companies that do attempt to match product features and capabilities more closely to their customers’ perceptions of value must answer a difficult question: Who are their customers? Fragmented decision-making in many healthcare markets makes it extremely difficult for companies to understand the requirements of all key stakeholders. To be selected for use, a device might have to be approved by a national or regional authority, selected by a healthcare provider, specified by a particular clinical team, and then chosen by doctors, often in consultation with patients. Finally, it may be the patient’s own reactions to the device that define its success in use.

Each of these stakeholders will have an incomplete picture of product attributes: payors might not understand the importance of usability in patient compliance, while a physician may be unaware of the ongoing cost of supporting a product in the field. As a result, the incentives to purchase in many medical device markets may be fundamentally different from the benefits ultimately enjoyed by end users.

Where does the value lie?
To overcome these problems, medical device companies need new tools and a new way of thinking about product design. In particular, they need to be able to do two things effectively. First, they must find ways to understand exactly which product features their customers need and, critically, how much they are willing to pay for them.

Second, they must identify the most cost-effective ways of delivering those features to maximize available product margin. For many design and engineering teams in the medical device sector, this second requirement is particularly challenging. Years of focus on extending the technical capabilities of their products, with relatively little attention to design for manufacture or other cost-reducing strategies, have left them ill-equipped to find the powerful insights that drive cost out of their designs. These teams must find new ways of looking at the whole product design process, adopting best practices from their own industry and beyond.

Today, some smart medical device companies are recognizing that, by making this link between the true cost of features and their customers’ perception of value, they can reliably deliver products that cost less and offer customers more. We call this approach Design to Value (DTV). Medical device makers have used it to deliver gross margin improvements of 20-25% over a typical 18- to 24-month period. Along the way, they have exploited quick savings that made the improvement projects self-funding. At the end of the process, they also have stronger product development functions, with departments working more effectively together and momentum in the organization for broader product and portfolio improvements.

Today, medical device companies operate in a different world. In developed countries, healthcare systems are under acute financial pressure. Healthcare providers are responding by exploring every opportunity to increase efficiencies and reduce costs.
What customers want

For all but the simplest products, purchasing decisions involve complex and subtle tradeoffs among features. Customers can rarely articulate the value they attribute to a particular feature in isolation. Fortunately, modern market research techniques can give a good indication of how the customer’s perception of value is built.

Medical device companies have developed approaches to tackle the complex, multi-stakeholder environment. They first identify critical stakeholder segments for each stage of the product lifecycle, and define the influence of each on purchasing decisions. Stakeholders can be divided into two basic groups: gatekeepers, for whom a product has to meet a basic set of feature and cost criteria, and decision-makers who will actually make the final selection based on the differentiating features of the product.

For example, one maker of patient-operated blood-testing equipment identified four key segments across its product lifecycle. During the reseller adoption stage, pharmacies were a key gatekeeper, important in choosing the product, as were payors, who would fund it in their insurance schemes. Decision-makers included the patients themselves, who made final selection but were heavily influenced by their personal physicians.

Interviews and conjoint studies with representatives from each key stakeholder group then help companies to understand their differing priorities. In the blood-testing example, pharmacies valued the opportunity to maximize revenues, through ongoing sales of consumables for the meter. Payors tended to assume that all devices were equally effective, and focused their attention on the price of the device and its consumables. Health care providers were interested primarily in features that would ensure compliance with the prescribed testing regime. Patients, meanwhile, varied greatly in their requirements according to the nature of their disease. To understand what really drove their decision-making, the company needed to dig a little deeper.

Conjoint analysis is one technique that can provide a rich understanding of consumer needs. Customers consider various hypothetical product configurations and price points and choose between them. Regression techniques applied to their responses isolate the effects of individual features on the customers’ perceptions of value. The results can be compellingly simple: an incremental “profit” value for each of a product’s features.

Some medical device companies are now using conjoint techniques to navigate their complex stakeholder environments. The blood-testing company, for example, used the conjoint technique to test various product configurations in four different customers, segmented according to the nature and severity of their disease.

The conjoint analyses with each stakeholder group allow
companies to construct a multi-attribute utility cost curve for each stakeholder. After including a basic set of product features to satisfy gatekeepers, this curve ranks each feature by the utility it provides to stakeholders and the cost of each feature. The curve can guide decisions about which features to include to maximize utility and minimize cost (See Fig 1).

A manufacturer of medical imaging equipment used conjoint studies in key customer segments to identify the factors most likely to build market share. The company found that price, brand name and image quality were the three most important decision attributes in the segment. Even though the company’s products already ranked among the best in its segment in terms of image quality, the conjoint demonstrated that a moderate increase in quality had the potential to lift market share by 11%. Likewise, reducing downtime from four to two hours per month could increase market share by 7%, as could a 25% reduction in radiation dose, which would offer health benefits for patients.

**What it really costs**
The second critical element in the design-to-value equation is cost. Leading companies strive to deliver the features their customers most value at the lowest possible cost, overcoming the limitations of conventional cost engineering by adopting a clean-sheet approach.

**Fig 1**

**Feature Cost vs. Utility**
USD

<table>
<thead>
<tr>
<th>Feature</th>
<th>Cost (USD)</th>
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<tbody>
<tr>
<td>Table stakes</td>
<td>10</td>
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<tr>
<td>Feature1</td>
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<td>Feature2</td>
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<td>Feature4</td>
<td>21</td>
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<td>Feature5</td>
<td>22</td>
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</table>

Cumulative feature utility/ probability of selection and compliance

Decide which profitable features to add based on technological and budgetary constraints.
While many companies invest heavily in product cost reduction, they usually do so by examining existing designs and identifying opportunities for incremental savings. Using Design to Value, companies first work to understand the likely limits of product cost reduction. Starting with a blank sheet and using knowledge of industry best practices for materials, processing and labor costs, they can build an estimate of the most efficient way to deliver the desired feature set (See Fig 2).

By comparing current or projected manufacturing costs with those in the clean-sheet model, companies can quickly gain insight into the areas of design most likely to yield the largest cost reductions. Opportunities identified in this way are often larger than those found in conventional cost engineering, since the technique encourages companies to consider changes to underlying product architecture and technology as well as individual components.

Clean-sheet analysis of its printed circuit board designs showed one device maker that it could reduce the eight separate boards in its existing design to just five, reducing the costs of the boards themselves, cutting assembly complexity and allowing the product’s casing to be streamlined and simplified.

**Tearing it down**

Competitive teardowns are an important activity in many industry sectors. Pulling a competitor’s product apart piece by piece and comparing it with one’s own is nothing new, but it continues to deliver insights into opportunities for improvement or a new competitive edge. Some, such as the automotive industry, have spent millions raising the teardown process to an art. As competition increases and cost constraints tighten, companies in the medical devices sector are beginning to use this approach more widely.

In the design to value process, teardowns take on a new and central role as a context for cross-functional discussion and decision-making by engineering and
marketing functions. Through teardowns of their own and competitor products, involving everyone associated with the product, including engineering, marketing, sales, manufacturing, quality assurance, and supply chain, companies can leverage all available expertise to optimize product design. Suppliers may even have roles to play in these workshops, as they may provide new perspectives on cost and functionality trade-offs (see sidebar: Medical device teardown case example).

The teardown process can be as useful with existing product lines as with new ones. In practice, comparisons of existing products often provide a range of ideas that can be implemented quickly into the current design, while helping to generate a “wish list” of changes for forthcoming models.

In a competitive teardown of blood pressure monitors, one company compared its product with two competitors from the same segment. In a daylong session, the company identified 22 separate improvement ideas that could reduce manufactured cost by 18% without impacting customer value. Some of the ideas were simple and easy to implement: reducing complexity in the packaging and printed materials, switching to unbranded batteries, or replacing sewn labels with screen printing, for example. Others required more fundamental changes to the product: eliminating PCBs, reducing the size and thickness of the housing, or introducing surface mount components to reduce manufacturing costs. Finally, the company identified areas where it could eliminate features that were less valuable to users, such as an external power supply connector that was rarely used on what was essentially a portable device.

Discussions among functions during the teardown can also drive improvements. Conversations between the sales and design in the same company revealed the users found the elegant design of the product’s accessories particularly appealing. Eliminating the drawers where these accessories were stored and mounting them on external hooks, the company cut costs and emphasized one of the product’s most compelling features.

The design to value approach is already helping medical device companies gain a much richer understanding of customer needs—and meet those needs more cost-effectively. While the approach has been proven in individual projects, some companies are now going further by building design to value skills and processes into their product development organizations (see sidebar: Making DTV happen). In a demanding but increasingly price-sensitive market, the ability to focus keenly on customer value can offer critical competitive advantages.

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Making DTV happen

Companies are using Design to Value tools selectively to cut costs, raise margins and build market share. A small group of companies are going further, increasing margins by 20-25% across their entire product ranges. These companies do several things differently from their more cautious competitors:

- They set transformational goals for their products, using clean-sheet models to identify the minimum possible product costs and challenging design teams to achieve these levels, rather than being satisfied with incremental improvements.

- They emphasize impact and execution, with robust targets to check the progress of improvement ideas, and regular management reviews to highlight progress and remove roadblocks. This approach helps to deliver impact rapidly; ideas are often executed within a month of their identification, but it can also ensure ongoing improvement, with continual idea generation and feature modification throughout a product’s lifecycle.

- They maintain an external perspective, understanding all decision-makers and stakeholders early in the product development cycle and revisiting the stakeholders regularly. They also repeatedly conduct teardowns on competitor products to understand design approaches, feature packages and cost positions. If customer insight or teardown skills are lacking, they train or hire external talent.

- They work to foster internal alignment, too. For example, one company encountered resistance to lower-cost products. Salespeople feared that the new products would cannibalize higher-cost alternatives. Once the sales team understood that the new product was aimed at a different customer tier, and that it gave them access to a new market and a competitive weapon to defend against new market entrants, they became fully supportive of the approach.

- They change their management systems and culture, with regular reviews of progress and incentives that encourage different functions to work closely together and ensure that quality, manufacturability and customer acceptance criteria are considered alongside cost.

- They implement a deliberate program to build Design to Value into their organizational DNA. Some companies establish a center of DTV excellence that provides specific skills and support to design teams. Others use specific projects as “gold standard examples,” helping to educate the wider organization on the power of the approach.
Medical device teardown example

A medical-products company planned a series of tear downs to improve the design of its therapeutic medical device. To generate new ideas, executives invited colleagues from purchasing, marketing, engineering, and sales to see how their product stacked up against four rivals.

Seeing the products together was an “Aha!” moment for the purchasers, who quickly identified a series of straightforward design changes that, while invisible to customers, would significantly lower the cost of manufacturing the device. Meanwhile, seeing the configuration of competitors’ circuit boards spurred the team’s salespeople, marketers, and engineers to discuss the manufacturing implications of the company’s modular approach to design. The engineers had long assumed that being able to mix and match various features after final assembly was advantageous and had emphasized this capability in the product’s design. Yet the salespeople reported that most customers hardly ever ordered more than a handful of modules at purchase and rarely ordered more after assembly.

The conversations ultimately led to simplifications in the product’s circuitry that lowered purchasing costs by 23% and helped marketers identify a new customer segment where the product might command a higher price.
8 of the top 10 US companies now have Usage-Based Insurance (UBI) programs or pilots underway.

Source: SMA (Strategy Meets Action)
TELEMATICS: DRIVING AN ACCURATE INSURANCE MODEL

Telematics presents new opportunities across industries. The insurance and automotive sectors can be the first to benefit. As users get more comfortable with devices and as attitudes to data privacy change, telematics and smartphones represent a major step in modernizing motor insurance solutions. In the race to deliver a win-win solution to everyone in the motor insurance ecosystem, the real winners will be those who partner, innovate and win the hearts and minds of the consumer.
The need to make motor insurance precise
A recent study by the Automobile Association (AA) found that of all the drivers who had been involved in car accidents, nearly 40% had crashes by the time they were 23 years old. For many, that may be a predictable metric. But it is also the reason why young drivers are forced to pay high insurance premiums. The other 60% of young drivers who drive safely want to know, “Why do I have to buy overpriced insurance products?” Now, new methods make it possible to price motor insurance premiums more accurately and without a bias.

Broadly, here is how: Breakthrough technology using smartphones provides insurers with accurate assessment of driver performance, behavior, trip data and other associated parameters; the technology with telematics at the core has the potential to improve motor underwriting insight and add to the services that can be offered to customers.

The smartphone-based solution ensures that premiums need not be limited only to calculations based on historic data or distance-driven “Pay As You Drive (PAYD)” models which are slightly more accurate. Instead insurance providers can now adopt better “Pay How You Drive (PHYD)” models.

The smartphone PHYD systems monitor precise driver behavior to calculate premiums. In addition, they bring unprecedented value to the driver by helping model safer driving behavior, reduce fuel bills and decrease automobile wear and tear. At the heart of the Usage Based Insurance (UBI) model, which works in favor of insurers and customers, is modern telematics.

UBI versus traditional insurance
The smartphone-based UBI solution does not merely track mileage. It also takes into account time of day the vehicle was driven, where it was driven (GPS), speed and acceleration, braking, cornering and swerving and correlates those insights directly to the underlying road network to provide underwriters with the ability to infer how a driver adapts his/her behavior to their environment. To extract even more value, live telemetry data can be mashed-up with other external sources of data.

Clearly, pricing for UBI can be radically different from that based on historic accident rates, driving records, vehicle type, zip code, age, gender, etc. As a matter of fact, in many countries, newly-enacted legislation is making it...
illegal to include gender to calculate insurance rates\(^2\). Whilst we haven’t seen any similar legislation relating to “age”, there is a growing belief that “age discrimination legislation” is inevitable. Once these ‘advantages’ are removed, historical rating proxies will become unusable. Underwriting will move to more insightful, real-time assessment of drivers.

For policy buyers who view motor insurance as an immutable annual fixed cost, this is great news. Converting insurance into a variable cost, with the promise of some savings, holds major appeal. Estimates vary, but UBI may reduce accident rates by 10%-40% with considerable benefit for the individual and society.

From an insurance provider’s perspective, telemetry data holds the promise of adjusting premiums based on the appetite for risk the business demonstrates. Insurance providers will be able to, as an example, be more selective in whom they provide insurance to (high, medium or low risk customers) and will be able to address the markets they believe yield maximum returns.

Insurers will also be able to lower their risk by ensuring the live telemetry data is converted into immediate feedback for drivers. This can reinforce positive behavior, reducing accidents and payouts. Finally, telemetry data can be used to identify, curb and reduce fraud. The abundant availability of data can act as a huge deterrent for customers who may be tempted to misrepresent facts about their claims.

Telematics is an entirely new route to building a more optimized business and of offering accurately tailored insurance products to customers. But it also holds an attractive opportunity for insurers to build new revenue streams and gain benefits from non-traditional areas such as using driving scores for claims predictions, using accurate data for third party capacity rationalization (like towing services, curb side assistance and replacement/replenishment of consumables such as batteries), and for cross-selling and upselling other insurance products. All this spells a major change for the insurance business which has always been an ‘unsexy’ pursuit. Insurance is a legal requirement and has become a commodity purchase. UBI and telematics offer the insurer a completely different way of engaging with their customers – a world entirely removed from the traditional process with little or no opportunity to build a relationship with the customer.

The key reason why insurance has been unable to change the game is because it could not improve customer interactions. A smartphone based solution alters this. Used intelligently, a smartphone solution increases the frequency and richness of customer interaction. It adds interactivity to the relationship with the customer and makes it possible to have a regular dialogue with them. The outcome is improved customer satisfaction and loyalty.

Insurance organizations that fail to embrace the opportunities being thrown up by telematics will become increasingly marginalized and irrelevant. This is because customers will migrate to smarter solutions that reflect their personal needs and preferences.

**UBI adoption: poised for growth**

In a few years from now we will regard the way we sell motor insurance today as quaint, wonder how we ever underwrote risk without proper behavioural insight and understanding.

Motor insurance was once sold through advertisements in mass media and print coupons. By the 1980s, it had migrated to direct sales over the telephone. When the Internet arrived, many felt that insurance could not be sold in such an impersonal manner and that it would require direct agent intervention. Yet, in many territories the majority of motor insurance today is sold over the Internet. In a similar way widespread adoption of UBI is inevitable.
Historically, the telematics approach has been to install a wireless device or a “black box” in the vehicle that stores data. The data is downloaded periodically (say every 15 days or every month) via a web portal. But customer uptake for black box solutions has been low as the hardware, by nature, does not interface with the customer (40% customers hate the black box). The black box approach has several drawbacks that include:

• Weak customer engagement
• Expensive hardware and installation

It is no surprise that the black box is already being usurped by embedded telematics and smartphones in vehicles. These are advanced systems. They allow the driver and the vehicle to connect wirelessly to a host of related services. A study by Strategy Meets Action (SMA) in late 2012 showed that almost 20 motor insurers in the US and Canada were running UBI programs and 8 of the top 10 US companies had UBI programs or pilots underway. A Ptolemus Consulting Group global study for 2013 estimates there are 5 million UBI policies already in existence (it also estimates that 112 UBI programs have been launched worldwide). The numbers are indicative of the future potential of UBI.
What the numbers tell us is this: Vehicle owners are warming up to the idea of using telematics for improving their drive experience. But let there be no doubt - after the first wave of early adopters, the larger market will look for the inexpensive solutions quickly making the ‘black box’ a relic of the past.

The smartphone type of solution offers several advantages to the end user:

- **Easy and quick to deploy:** simple downloadable application with expert driving benchmarks and local maps, fully hosted solution offered as Software as a Service(SaaS) or Platform as a Service(PaaS)
- **No hardware cost:** leverages existing smartphone investment, extract more value from it
- **Intuitive and immersive experience:** drives high user acceptance
- **Easy integration:** Bluetooth technology ensures different phones can be tethered to the vehicle. Tethering offers opportunity to facilitate multi-driver policies and more targeted offers
- **Geo specific:** driver data algorithms tailored for specific markets; algorithms and models can be dynamically updated
- **Access to more robust data:** the approach enables determination of driving behaviours and from a rating perspective, anticipation and consistency. By contextualizing GPS data to establish a driver’s speed in relation to the road and their location, against benchmarked “optimum” performance data, safe driving values can be determined. These rich data sets can be analyzed to develop more accurate risk profiles than has been possible with accelerometer data.

**The need for collaboration: The challenge ahead**

Vehicle manufacturers have been quick to see new and long-term revenue streams in UBI. But they believe they own the customer and the data and that a major part of the UBI pie belongs to them. Telecom players are also waking up to UBI opportunity, seeking to work with hardware providers to embed software that handles data and analytics and provides security and billing services over their networks. Third party services vendors are jockeying for a position in the value chain to provide better users experience, curbside assistance, live chat and a host of other social services. Amidst this customers remain wary about whom they share their personal information with. But they are very keen to be able to say, “You know what, my insurance is calculated in a fair manner – based on the way I drive and not on aggregated customer data, or gender.”

Can the key players in the UBI ecosystem – insurance companies, automobile OEMs, third party service providers, telecom players and customers – come together, share customer data and make life easier for everyone? Can the collaboration between them spark innovation and inspire everyone, to build a better consumer proposition, making predatory pricing a thing of the past?

Telematics is going to be at the center of this change and will drive accurate insurance models.

* * *


3D PRINTING: Improving Accessibility, And Protecting Intellectual Property

This article describes 3D printing - a whole new way of creating physical objects and also attempts to answer how manufacturers protect their investments in component design, ascertain only authorized number of designs are printed and what implications this model has on digital rights management.

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3D printing: A revolution
It is a technological feat that is going to change manufacturing more profoundly than we can imagine. 3D printing is being referred to as the Third Industrial Revolution, moving away from mass production that has marked industrialization, to intense one-off, on-demand, customization. This means you can print a number of components, spare part or objects by connecting to the Internet and downloading a file that contains the code for the object. And maybe one day you could download the 3D files for an Airbus or an Ilyushin aircraft and print as many copies as you wish. Airbus was one of the first to use 3D printing or additive manufacturing.

The process is equivalent to using an ink jet printer to create layers of a material to build 3D objects. The software renders the object as a sum of thin layers and then prints these layers one on top of the other to create
the whole object. Hence this process is also referred to as 'additive manufacturing'.

All kinds of materials are being used in the process – ceramics, elastomers, powder polymers, thermoplastics, polycarbonate, metallic powders, clays and even living cells. Grainy black and white ultrasound scans of fetus are being replaced by 3D prints with life-like bio texture of the unborn child. Janjapp Ruijssenaars, an Amsterdam-based architect, claims he will print a Mobius-strip shaped building by 2014 that would be the biggest ever 3D print. NASA is planning to send a toaster-sized 3D printer into space in 2014. It will print spare parts on demand, ending the nightmare of having to store vast amounts of spares in space stations or ship them each time one is required.

**Leveraging 3D printing: manufacturing scenario**

Let’s translate 3D printing into an everyday manufacturing scenario. When your car breaks down, an automobile technician attends to it, replacing worn out or damaged parts. The replacement was perhaps mass manufactured elsewhere in the world and shipped over a vast, complex, slow and expensive distribution system to your neighborhood repair and maintenance garage. In the next year or so, the technician could be printing that part in his store, using a downloadable '.sdl' format CAD (Computer Aided Design) file. The question that needs answering is, “How will the technician be prevented from printing more than the authorized number of copies of the spare part?” There are a number of solutions to this problem of which using an authorization ‘key’ to access the design for each print could be one.

3D printing is rapidly becoming an affordable technology. Printer models are proliferating and printer costs are
A recent Gartner report suggests that 3D printer shipments will grow at 95.4% and revenue at 81.9% from 2012 through 2017. The report says that the 3D printer market will grow from US$288 million to more than US$5.7 billion by 2017. The growth, suggest industry observers, will be led by businesses such as automobiles, peripherals, consumer products, medical, aerospace, government and military. This would indicate that a considerable amount of spare parts will be printed to harvest a variety of benefits from manufacturing on the spot. The upside includes reduction in labor costs, customization, efficient waste management, lower carbon footprint and efficient management of service level agreements. But effective DRM is crucial to the success of 3D printing. If IP and design costs are not protected, manufacturers may shy away from the technology. As a consequence, the benefits could remain frustratingly out of reach.

**Protecting design: The need for DRM**

This implies there is a need to build a content management platform for machine parts which will allow manufacturers to “publish” their drawings and manage the rights for the drawings. In that sense, think of it as an iTunes for machine parts. And just like customers search for music downloads, machine parts will have to be made ‘searchable’ with detailed descriptions and specifications. They will also have to be made
### Portal based content management and distribution

<table>
<thead>
<tr>
<th>Content owners/ publishers</th>
<th>Content users</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>File management and distribution:</strong> Create/ upload drawings; allow only authorized and verified designers to submit/ upload designs for approval; identify and delete files that do not conform to organizational standards.</td>
<td><strong>Discovery management:</strong> All search for parts by number and description.</td>
</tr>
<tr>
<td><strong>Access/ Policy management:</strong> Provide file access to target customers/ users matched against a database of registered customers/ users; policies and standards for design approval available to users.</td>
<td><strong>Knowledge management:</strong> View parts product specifications; check printer compatibility.</td>
</tr>
<tr>
<td><strong>Design for printing:</strong> Check 3D design compatibility of existing drawings.</td>
<td><strong>Payment management:</strong> Pay for file download.</td>
</tr>
<tr>
<td><strong>Support management:</strong> Assistance in sending 3D print ready file to 3D printing device.</td>
<td><strong>Service management:</strong> Download file.</td>
</tr>
<tr>
<td><strong>Security management and DRM:</strong> Protect IP, provide privacy and confidentiality, allow only authorized access.</td>
<td><strong>DRM:</strong> Access to use file as authorized.</td>
</tr>
<tr>
<td><strong>Enable efficient online system:</strong> To capture the feedback. Using CRM and Analytics we can understand/report the customer needs better.</td>
<td><strong>Provide feedback</strong> via online system.</td>
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Downloadable and compatible with various 3D printers (different file types). Finally, the customer will need to make the transaction online before downloading the file. From a publisher’s perspective, a complete content publishing and management system needs to be in place – one that allows the publisher (say manufacturers like Ford Motors, Boeing or Whirlpool) complete control over the content. The system should have granular control that lets the publisher decide who has access to the content. As examples, in the case of an auto manufacturer, it could be approved dealerships and designers, for an aircraft manufacturer, it could be fleet owners and spare parts manufacturers, and for white goods, it could be authorized service agents.

The value of an online system that makes spares available and prints them on demand is not difficult to envision. Consider earth diggers, excavators, and movers. Typically, their ROI is realized over an 8 to 10 year period. Manufactures may not be able to keep
spares available for such long durations. For them, it may be better to turn CAD drawings of spares into 3D print-ready formats. These could then be made available online for push button manufacture.

Enabling this value has deep implications on the design repository or the online portal. The primary requirement is that such portals make available 3D files compatible with printer models across OEMs. Underlying the capability is a compatibility checker for existing machine drawings and the ability to send drawings securely to printers. In essence, the drawings are encrypted and “shipped” directly to the printer. No copies of the file are available to the user. This prevents misuse.

As a corollary, owners of such portals must also ensure that there are no malicious designs made available to users. Owners must be able to prevent and take down designs that do not confirm to the organizational code of conduct. For the system to deliver file quality, authenticity, security and availability must be managed well. The system should be able to send alerts to users when file changes are made or new files are made available.

Design for Printing: Towards successful business models
Providers of such systems must keep several considerations in mind. Turning conventional engineering drawings into 3D printable files must be enabled through semi-automated tool chains. The tool chain validates the “Design for Manufacturing” files and suggests manual and automated changes to make it suitable for a “Design for Printing” objective. Designs must then be validated against the supported 3D printer models and published with specified tolerance levels.

The end goal of such a system is to ensure that the portal delivers designs that have been “purchased” by the customer and sends such designs securely to the designated 3D printer as per DRM specified limits (number of copies, duration of validity for print, printer model, etc.).

The ability to restrict unauthorized use of IP and protect investments in design, while simultaneously making them available on any 3D printer, based on business rules, is going to be the key to how the Third Industrial Revolution unfolds.


DATA CONVERGENCE & MULTI-SCREEN DISPLAY For Collaborative Work Environment

Systems and devices are evolving and becoming more intelligent by getting connected and passing relevant data to upper layers. Today, sensors in the plant floor can send data that helps in monitoring processes and plant performance in real-time. This data can be integrated with enterprise level business data to make optimum decisions. Such Real Time Data Convergence for Multiscreen Displays (RTDCMD referred to as 'RecoMaker' in this article) has the ability to optimize productivity, asset management, energy management and enhance safety and regulatory compliance. RecoMaker is set to become a critical component of business success.

Dr. Arup Ratan Ray
General Manager, Industrial Automation, Product Engineering Services, Wipro Limited

The evolution of industrial automation
It is history, but well worth re-visiting. The 2010 oil spill in the Gulf of Mexico was the largest accidental marine spill ever. An explosion at an oil and gas major operated oil well claimed 11 lives, sank an oil rig and a seafloor oil gusher flowed for 87 days.¹ The company lost millions of dollars paying for its liabilities and for the clean-up operations as a consequence of the accident. The company has since launched a program that integrates data from field devices in real time. It can now monitor field assets and plant health parameters so that it can prevent such disasters in the future.

Today, Real Time Data Convergence for Multiscreen....
Displays (RecoMaker) makes it possible to predict, isolate and respond to such calamities before they strike. Digital oilfields are making it possible to manage assets in remote and inaccessible locations. This is thanks to the fact that remote monitoring and automation have come a long way in the last few decades.

The change started with the arrival of semi-automated devices and systems. These devices and systems began to come with embedded intelligence (software) that could pass the data to upper layers and offer operators a variety of actionable information. More recently, full-fledged automation with wireless sensors has gone even deeper to ensure that devices and systems can pass data in real time. These systems can also send alerts to appropriate stakeholders based on operational

**Fig:1 From Machines to Operations to Enterprise**

End-to-End System Integration

**ENTERPRISE LEVEL**
- Remote Operations
- Middleware Adapters (Level 3-Level 4)
- MES
- Workflow modeling
- Remote Operations
- Analytics

**PLANT LEVEL**
- HMI, Visualization
- SCADA, Historian
- OPC Server & Client
- Interface Adapters (Level 3-Level 2)
- Monitoring, diagnostics & Scheduling
- Control Systems, PLC

**MACHINE LEVEL**
- Device Configuration Software
- Embedded Solutions
- Device Drivers & Protocol
- Field Controller Development

**CNC** – Computer Numerical Control, **CCLink** – Control and Communication Link, **ERP** – Enterprise Resource Planning, **HMI** – Human Machine Interface, **HPC** – High Performance Computing, **MES** – Manufacturing Execution System, **OPC** – Object Linking and Embedding (OLE) for process control, **PLC/PAC** – Programmable logic Controllers / Programmable Automation Controller, **SCADA** – Supervisory Control and Data Acquisition, **WLAN** – Wireless Local Area Network
thresholds or business rules.

**Arrival of RecoMaker – Managing the connected universe of machines**

The transformation in industrial monitoring and automation has been magnified several fold by yet another development – the use of multiscreen devices that are becoming popular with end users. Different stakeholders for the plant, as well as field personnel, use different visualization screens and hand held devices. The emerging IT and operational technology (OT) ecosystem consists of devices, sensors, real time data, analytic engines, always-on mobile networks and powerful mobile applications. The key to successfully using this ecosystem is to accumulate the data in a large and central database. The central database enables businesses to have access to a single source of truth. Above this is a layer of real time analytics that distributes actionable insights to different screens for consumption based on user roles and needs. This is the essence of RecoMaker.

Older plants may have obsolete devices that lack the ability to record events or pass data along to other machines in the network. Newer plants may have smart devices that are connected with a wireless architecture. However, every device can be made smart by retrofitting the devices with a wireless interface so that they adapt to a connected architecture. In most instances, this allows owners to bring all the elements of a plant to a minimum level of intelligence and connectivity via M2M platforms.

**Inherent Benefits of Connected Systems**

The value of connected devices in a RecoMaker environment is self-evident. Data is presented to users from a consistent database enabling reliable
collaboration. Data is filtered and in many instances analyzed before it is sent to the end user and this showcasing of only relevant data/alerts based on access levels drives quicker decision-making and adds to data security. There is a reduction in data duplication and a concurrent increase in data consistency which increases the reliability, speed and efficiency of data usage.

Remote monitoring of assets such as equipment, machines, fleets, etc. and automated event alerts ensure more efficient use of assets. Also, integrated operations can help in sourcing material and producing the end-product nearer to the consumer by optimized use of the production assets, thereby avoiding costs and logistics of transportation and warehouse management. Enhanced remote condition monitoring and control of equipment, assets, sensors and processes can optimize energy use and real-time data and remote tracking can enable better mobile work force management, implement better maintenance processes and can enhance security, leading to operational excellence.

There are an increasing number of scenarios where such a seamlessly connected eco-system of devices can be invaluable. Imagine for a moment data being picked up by sensors along the pipelines of a water utility. Data analytics will easily be able to predict leaks in such systems. When a leak is forecasted or detected, the information can be distributed to maintenance personnel in the field for a pro-active response; operations can be
alerted about possible changes that can impact water distribution, and CRM teams can be prepared to manage consumer queries and complaints. In effect real-time glues teams across functions to enable tighter and more effective collaboration.

Increasingly, plant level data is being integrated with business layers (ex: ERP) and with analytics. This allows the enterprise to arrive at the correct actions which are then sent back to plant level machines and devices.

**Technical competencies around RecoMaker**

The ability to integrate data and systems at all three levels (machine, plant, enterprise) is reliant on the strength of technical competencies and partnerships around the RecoMaker framework. The extensive ecosystem of partnerships required for this includes engineering and automation specialists and Information Technology providers (OT + IT).

The type of RecoMaker described here can enable automation and efficient management of very complex plants and globalized industrial/business environments. For example, a very large O&G major with global operations leveraged RecoMaker by creating a Collaborative Work Environment (CWE), and a major utility company is striving to establish a global control room as well as regional control rooms that could take independent decisions.

RecoMaker can be particularly helpful in complex environments where safety is a critical factor. M2M platforms and applications, with RecoMaker as the backbone, can orchestrate access controls and authorization levels to ensure accidents and security lapses are eliminated.

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**The truly connected business future**

The evolution of RecoMaker is inevitable. It will gather momentum as the benefits become evident. With its ability to contextualize data and constantly deliver integrated solutions – rather than point solutions – it is bound to see increasing adoption across industries. Most of all, it presents the tantalizing possibility of collaboration in real time and of using M2M to give businesses granular control over their operations.

ENABLING RATIONAL DECISIONS Through Digital Oil Fields
In today’s tough business environment, achieving production levels and replacing existing reserves are becoming challenging goals for upstream oil and gas organizations. Many of them are increasingly falling back on their existing asset base and making significant investments to improve production and recovery from them. In fact for organizations with sizable asset base, just 1% improvement on their expected recovery has potential to add many millions of barrels to their reserve base. Many successful efforts in this area have reported considerable benefits in terms of profitability and recovery.

Every oilfield has limited amount of hydrocarbons that can be produced economically. However producing that limited amount also requires constant asset vigilance and superior decision making that can identify and address potential threats to production and recovery throughout asset lifecycle.

Adoption of Digital Oil Fields (DOF) in upstream industry has been a widely practiced business improvement initiative focused on optimizing production and recovery through improved collaboration, streamlined workflows, right tools and better information management. Successful DOF programs have resulted in improved organization capability leading to better decision making and business outcome.

Based on our involvement in several industry DOF projects, a key success factor is the ability to identify right capabilities to pursue in DOF implementation. Many DOF programs have been started with poorly defined, misaligned or ambitious scope, resulting in lost opportunities or unclear benefits. A robust opportunity framing methodology is a must for organizations embarking on their DOF journey to generate maximum value out of it.

This article explores a decision-based framework to identify key decisions and capabilities (in new DOF programs) or ascertain if right capabilities have been included in the DOF roadmap (for existing programs). Framework can also be used to track benefits generated through DOF program in specific business areas. Fig 1 shows a high level summary of the framework.

Decision Making Challenges in Oilfields and Role of DOF

Traditionally upstream organizations have been structured in departmental/discipline silos (operations, subsurface, petroleum engineering, etc.) with limited and ad-hoc interactions between them. Shift towards asset based organization model hasn’t completely removed these silos as cultural, process and information barriers still exist. This has affected both quality and speed of decision making as each departmental silo has looked at different parts of the production system from their perspective and not from integrated production system perspective.
To illustrate how this impacts decision making, let's consider an example of an oil field where a high producing well has shown high water-cut and as a result oil production from the well has reduced. Fig 2 shows different parts of the production system, various stakeholders responsible for them and their decision considerations.

In this example decision considerations are influenced by departmental goals that need to be honored by individual disciplines. This creates a lot of complication when various decision options exist for the problem and when certain decisions need to be made in a fairly short term to avoid business impact (in this case production loss).

Table 1 presents an example of decision options common in such situations along with their associated timescales.

Traditional way of working in silos in this situation would delay the decision making as different disciplines may spend a lot of time to find all the relevant information, clarify their understanding of the problem with each other and identify various decision options. Also if the organization lacks sophisticated tools, they may not identify right decisions or effectively evaluate long term economic or recovery impact of these decisions.

The overall result is high production deferment, suboptimal recovery or high cost solution.
Role of Digital Oil Field (DOF) in Improving Decision Making

The example above shows typical decision challenges that may exist across the organizations and impact business performance. This is where organizations are increasingly turning towards DOF to develop response to these challenges.

DOF is generally defined as a business improvement program that aims at developing upstream organizations’ capability to make better decisions through a combination of collaboration, workflow improvement, data and technology.

Over the last few years, we have seen many DOF programs getting started across organizations with key objectives of optimizing production and recovery. All of these initiatives demonstrate capability building in a few or all of the following areas:

- **Collaboration**: Efficient and structured collaboration between different disciplines
**Table 1: An example of decision options**

<table>
<thead>
<tr>
<th>Decision Option</th>
<th>Decision Time-Scale</th>
<th>Decision Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Option1</td>
<td>Short Term (Hours- Days- Weeks)</td>
<td>Reduce production from current well to manage separator water handling constraint + increase production from other wells to maintain production</td>
</tr>
<tr>
<td>Decision Option2</td>
<td></td>
<td>Start gas lift in current well to maintain production + optimize gas lift in other wells to honor gas supply constraint</td>
</tr>
<tr>
<td>Decision Option3</td>
<td></td>
<td>Reduce production from current well to manage separator water handling constraint + Accept reduction in production</td>
</tr>
<tr>
<td>Decision Option4</td>
<td>Medium/ Long Term (Months-Years)</td>
<td>Shut-in and work-over current well to shut off water production + increase production from wells + optimize simultaneous operation to allow POB for work-over</td>
</tr>
<tr>
<td>Decision Option5</td>
<td></td>
<td>Expand separator capacity to handle increased water production</td>
</tr>
<tr>
<td>Decision Option6</td>
<td></td>
<td>Debottlenecking of gas compression to increase gas lift supply</td>
</tr>
</tbody>
</table>

- **Workflows:** Streamlined and well specified workflows
- **Tools:** Standard tools and visualization systems, Decision support systems
- **Data Management:** Good quality, real or relevant time data easily accessible

Multiple opportunities for capability improvement usually exist in each one of these areas and right capabilities need to be pursued by organizations initiating a DOF program. Based on our involvement in several industry DOF projects this is identified as a key success factor. Many DOF programs have been started with poorly defined, misaligned or ambitious scope resulting in lost opportunities and unclear benefits.

It's not uncommon to see organizations, starting on their DOF journey, grapple with questions such as “What capabilities should we pursue in our DOF roadmap to realize maximum value?” or “What specific decisions can and should be improved through DOF implementation?”

Hence choosing the right DOF strategy is vital for upstream organizations to maximize their return from it.

**Decision-Based Opportunity Framing Methodology for DOF Implementation**

Decision based framework looks at identifying organization capabilities from the point of view of key decisions that they support. These capabilities are then
translated into opportunities to be pursued in DOF implementation plan. This provides organizations a clear view of how their DOF investments would drive improvements in their decision making.

Following is a high level description of five key steps involved in the framework.

1. **Identify and prioritize key decisions from value drivers:** Value drivers need to be identified through engagements with key stakeholders. A value tree should be constructed to segment the value drivers to the level where decision nodes become apparent. Once a decision node is reached, the underlying decisions should be listed for a particular value driver.

Fig 3 shows an example of value tree and its segmentation to decisions for one of the value drivers. Similarly other decisions can be identified for other value drivers at their decision nodes.
Fig 4: An Illustration of capability identification to support various decisions occurring across various time-scales

**Short Time Scale Decisions**
- Close Well
- Continue producing with changed set points
- Reservoir Engineer
- Production Engineer
- Process Engineer
- Production Coordinator
- Production Supervisor

**Medium Time Scale Decisions**
- Well Work-Over
- Abandon Well
- Asset Manager
- Operations Manager
- Reservoir Engineer
- Production Engineer
- Integrated Activity Planner
- Well Service Group

**Long Time Scale Decisions**
- Convert Well into Injector
- Increase Gas Compressor Capacity
- Asset Manager
- Operations Manager
- Reservoir Engineer
- Production Engineer
- Process Engineer
- Production Planner
- Integrated Activity Planner
- Project Engineering Group

**Capabilities Required**
- Efficient on-demand collaboration between disciplines
- Streamlined and well specified workflows
- Quality data easily accessible
- Standardized tools

**Short Term Production Optimization workflow**
- Real Time Data
- Production History
- Integrated Asset Model
- Models
- Short Term Production Forecast
- Limit Diagram

**Medium Term Production Forecast**
- Production History
- Models
- Pressure Surveys
- Well Logs
- Reservoir Maps
- Well Event Register
- Medium Term Production Forecast
- Medium Term Activity Plan

**Well Review Workflow**
- Production Hiistory
- Models
- Well Model
- Long Term Production Forecast
- Long Term Activity Plan
- Asset Opportunity Register

**Facility Review Workflow**
- Production Hiistory
- Models
- Well Model
- Long Term Production Forecast
- Long Term Activity Plan
- Asset Opportunity Register

**Well Work-Over**
- Wellbook
- Reservoir Book
- Modelling Tools
- Excel

**Abandon Well**
- Wellbook
- Reservoir Book
- Facility Book
- Modelling Tools
- Excel

WINSIGHTS Volume XVII
Identified decisions should be ranked and prioritized based on various criteria such as criticality of value drivers, occurrence and complexity of decisions. For example in Fig 3, a decision like increasing gas capacity has very limited occurrence and can be pushed down the ranking list.

Decisions can be grouped into short, medium and long time-scale to identify their time-criticality and help in further prioritization.

2. Develop and prioritize capabilities required to support decisions: Organization capability requirements should be identified through extensive engagement with stakeholders. They can be categorized under various themes such as Collaboration, Workflow, Information and Tools. This should be done for all decision nodes. Fig 4 illustrates various capabilities required to support underlying decisions identified in Fig 3 for “Maximizing Recovery” value driver.

Once all capabilities are identified they should be further prioritized based on decision time-scale or capability areas. For example in Fig 4 only short time-scale decisions can be considered.

This step provides a final list of capabilities to be considered in DOF implementation roadmap.

3. Assess capability requirements against existing or work-in-progress solutions to identify DOF opportunities: Gap analysis should be done against existing or work-in-progress solutions in the organization and areas where solutions are not found can be identified as opportunities. Moreover where solutions exist, it is recommended to do a high level maturity assessment to gauge their effectiveness and suitability for inclusion in opportunity list.

4. Develop DOF opportunity roadmap: This provides an integrated view of opportunities and their implementation plan. Relevant criteria should be developed in collaboration with key stakeholders and applied to prioritize opportunities.

5. Create opportunity register for benefit tracking: Before starting with roadmap implementation, all the opportunities should be comprehensively documented along with their relationship with key decisions, key assumptions and business justification for opportunity selection. This serves as a baseline to track improvements against the expected benefits post implementation.

Summary
Throughout the asset lifecycle, many key decisions are taken that have significant consequences for production and recovery. Upstream organizations looking to maximize their performance in these two areas need to develop strong capabilities that can improve their decision making.

DOF has been emerging as a key platform to enable organizations to build those capabilities.

Given that multiple opportunities may exist for DOF implementation and each of which may require significant investment and change management, organizations need to pursue the right DOF strategy to identify and pursue relevant capabilities that address key decisions in the organizations.

A decision-based opportunity framing methodology can help in identifying key decisions and the right set of capabilities which can then be translated into an opportunity roadmap. This also allows tracing opportunities back to business value drivers and KPIs which in turn can help in tracking benefits from DOF investments.
In 2014, 220.1 million NFC enabled phones [13% of all handsets] will be shipped.

Source: iSuppli
3D VIRTUALIZATION for Plant Owners and Operators

Plant Owners and Operators (O/Os) want Engineering, Procurement, and Construction (EPC) companies to deliver 3D virtualization or plant models – immersive computer models that are becoming invaluable to construction of the plant, managing it through its lifecycle and for training. 3D plant models are delivering savings in time and effort while increasing productivity. Plant owners are able to extract previously inaccessible intelligence from these models. For EPCs, this is a naturally adjacent business. How can they leverage technology partners to deliver what O/Os want?

The rapid rise of 3D

Today’s plentiful and powerful computing power is having extraordinary impact in core engineering areas. Engineering, Procurement, and Construction (EPC) companies are one of its beneficiaries. EPCs are using ‘3D virtualization’* techniques to create intelligent plant drawings that can be manipulated, analyzed and used through the life of a plant by the Owners/Operators (O/Os). Readily available computing power and 3D virtualization has made manual drafting and 2D CAD drawings an intermediate step rather than an end in themselves.

3D plant models are virtual plant models that realize all the features across disciplines. They are immersive virtual blueprints that bring together key engineering disciplines such as structural, mechanical, electrical, instrumentation, and control. Users often report that working with 3D virtualizations is interesting, engaging, and easy.

Good 3D plant models can be as effective as a real plant. They can be used for a variety of simulations through the lifecycle of the asset. Today’s 3D plant models, largely used in industries such as oil & gas, utilities and shipyards, are invaluable from the design stage to construction, training, operations, maintenance, on-going alterations, reconstruction, re-purposing, upgrades and for dismantling of the plant.

Across the world, plant designers, suppliers, vendors,

* ‘3D virtualization’ refers to making a 3D model in virtual reality and virtualization leads to visualize.
and O/Os are using 3D models to take accurate and fail-safe decisions and 3D plant models are paving the way to future success. For example, imagine that a heat exchanger has to be positioned within a petrochemical plant. Now, using 3D models plant personnel can accurately demarcate the right position for the heat exchanger. The OEM can then verify and suggest changes if required. This precludes problems during plant construction. When repeated over other plant components (such as pipes, cables, ducts, and machinery), the resulting savings in time and effort and the increase in accuracy and productivity can be substantial.

**An opportunity for EPCs**

Given the upside of 3D modeling, O/Os are also investing in brownfield projects to capture and organize previously unstructured legacy data such as documents, drawings, lists, photographs, and even carrying out High Definition Survey (HDS) laser scans of their plants. Once these elements are integrated, they can be of assistance in future plant maintenance and expansion. O/Os know that capturing and organizing such information is an uphill task. But they also know that it can be crucial to extending the life of their plants and in reducing down time.

Can EPCs provide what O/Os demand? Fortunately for EPCs, 3D modeling is a naturally adjacent business. To help things along, they also have a captive customer base in addition to existing technical plant knowledge and domain expertise. They can turn 3D virtualization into an attractive revenue stream that extends over the lifecycle of a customer’s plant.

The good news for an EPC is that this does not require demanding work or content. EPCs can leverage a technical partner to deliver 3D models of plants, leaving their own teams free to engage with the O/Os.
In effect, 3D virtualization has created a sandbox for all stakeholders to play around with their operations, training, maintenance and decommissioning. It helps them build innovative ideas that may otherwise have been either impossible to think of or risky to execute in the real world.

3D Virtualization: Areas of impact

3D virtualization has several interesting areas of impact. These range from the initial design to the final dismantling and decommissioning of the plant.

**Construction:** One of the key advantages of the 3D model is during plant construction. Here, the virtual model gets built along with the design. While the design is traditionally done in line diagrams, isometrics and 2D, the model is built in 3D. So any interference between plant components immediately gets highlighted. Headway, clearances, and turning radii for equipment can also be measured and confirmed. All issues can then be sorted out, so that when physical construction hits the ground, everything progresses smoothly, across all disciplines of civil, mechanical, piping, electrical, and instrumentation.

“Last minute” problems such as re-routing, need for more material to accomplish the re-routing, re-work etc. are avoided. The proposed sequence of construction can be tried out using the model to ensure that the plan does not present maneuverability issues.

**Operations:** The age of 3D modeling tools being available to a limited number of designers is over. Today, plant operators with access to 3D models have begun to realize its value. These realistic, immersive models of complex assets allow operators to undertake a variety of simulations and quickly seek reliable answers to a number of “what-if” scenarios in a safe environment.

**Training:** 3D environments are invaluable for training purposes. Instead of training people in live plants that may impact day to day operations, 3D environments can be used for cost-effective off-site training. Aside from plant familiarization and standard operating procedures such models can provide accurate training for emergency procedures that cannot be recreated in a real plant.

**Certification:** 3D testing modules for plant activities can be designed. These can help evaluate personnel and certify them for a variety of procedures.

**Maintenance:** Planning and preparing for maintenance is a major activity for large plants. It often requires areas to be demarcated for material movement, storage and equipment repair; it could also mean shutting down parts of the pant. 3D models can help prepare for maintenance activity. The entire exercise can be simulated and enacted, confirming that there will be no surprises during actual maintenance.

**Reconstruction, re-purposing, upgrades and dismantling:** With plant information spread out over various departments, incorrect estimations are not uncommon. Sometimes, inadvertently, a group may begin work without comprehensive information – ignorant of other pieces of information locked elsewhere in the business. The lapse can prove expensive. A 3D model integrates all the required information from various disciplines, ensuring that teams don’t have unexpected clashes.

**Design re-use:** One of the outcomes of a 3D model is the ability of the O/Os to accurately reuse plant engineering concepts and details from one project to another. This can bring down project time as well as project cost. Reuse also brings predictability in plant construction and management.
Reviews: 3D models can be a valuable tool to present new ideas, demonstrate new capabilities, assess new approaches to risk mitigation and evaluate innovations that have not been tried or tested before.

In effect, 3D virtualization has created a sand box for all stakeholders to play around with their operations, training, maintenance, and decommissioning. It helps them build innovative ideas that may otherwise have been impossible to think of or risky to execute in the real world.

Challenges to brownfield plants
O/Os are investing in brownfield projects, turning their previously 2D blueprints to interactive 3D models. These are of immense value in plant expansion and can help reduce plant down time. In many instances, they can prevent cost escalation.

O/Os can simulate solutions for their expansion plans using 3D models without having to procure expensive equipment during the planning stage. But most of all, O/Os are realizing that with years of modification, they
don’t have an accurate idea about their plants. These raise safety concerns. They want access to the as-built plant so that they can run their plants as per design. The challenge here is of turning 2D models (and capturing the associated documents and data and actual installations) into as-built 3D.

Advances in laser scanning technology have made it possible to create accurate 3D models of existing plants. Laser scanners can capture plant details and render them in a photorealistic manner without disrupting existing operations. Once integrated with information management systems, the 3D visualization becomes a virtual plant. It provides access to historical data in one place. For example, if the heat exchanger we had discussed earlier were to malfunction, an engineer could identify it in the 3D model, pull up related information on the heat exchanger and simulate a variety of alternative solutions before sanctioning an action plan.

O/Os and EPCs, have begun to use laser scanning to create as-built models of their brownfield projects and have been quick to recognize the benefits of laser scanning technology.

The popular route to acquiring 3D models is through partnerships with technology service companies. This helps the O/Os and the EPCs keep cost down while meeting project timelines and gaining access to the latest technology for quality improvements.

The challenge for O/Os and EPCs

O/Os may not have the required knowledge to build 3D models. Neither would they have the resources to change the 3D model over the lifespan of a plant. EPCs, on the other hand, have access to the information and are well positioned to deliver these models and subsequently update them. However, EPCs are always strapped for resources. They rarely have spare engineering capacity. How can an EPC tap into this attractive opportunity?

There are other issues that an EPC faces in such engagements. While the 3D model is delivered, the O/Os are rarely able to exploit this asset due to issues of software compatibility and the availability of expertise.

It is therefore recommended that EPCs partner with technology service providers to deliver plant information management. The ideal technology partner would be one with specialized skills in engineering and the ability to remain product agnostic.

Further it would be desirable if the technology partner offered end-to-end 3D virtualization as a managed service, spanning 2D conversion, modeling, “as built” models, laser scanning, document management, data management, design reviews, training modules and configuration of systems to generate reports for various stakeholders (such as operations, maintenance, stores, safety, security, etc). Ideally, the strengths of a technology provider must be integrated with the domain and process knowledge capabilities of the EPC.

A revolution that is changing the future

3D models provide a cutting-edge approach to managing a plant and reducing risk throughout its lifetime. The technology underlying 3D virtualization is complex. However, the outcome is powerful simplicity that allows 3D models to be leveraged by teams across the lifecycle of a plant. It has the potential to change the way plants are built and maintained.

For decades, plant design software has remained useful at the elementary level of construction. At best it has helped in minor maintenance or alterations. For the first time, truly integrated 3D plant models can be used for value added activities like operations, training and reviews. Used to its potential, it is the single biggest revolution in plant information management.
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