TECHNOLOGY **TRENDS** TO WATCH

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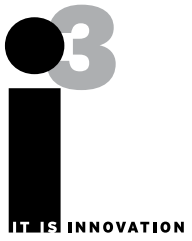
TECHNOLOGY **TRENDS** TO WATCH 5

2014



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MANAGER, PUBLICATIONS
Rachel Horn

SPECIALIST, PUBLICATIONS
Mark Chisholm

SENIOR GRAPHIC DESIGNER
Matt Patchett

PRODUCTION COORDINATOR
Mark Zacepilo

CONTRIBUTING WRITERS:
Mark Chisholm
Jack Cutts
Shawn DuBravac
Rachel Horn
Rick Kowalski

The Power of Technology

TECHNOLOGY **TRENDS** TO WATCH **2014** 5

Technology has the power to transform lives – our products and services educate, entertain and connect consumers. To identify some of the technologies poised to improve our world, the Consumer Electronics Association (CEA)® created *Five Technology Trends to Watch.* This annual publication looks at five areas that promise to have a dramatic impact on the $203 billion consumer electronics (CE) industry.

In the 2014 issue, using the latest consumer research and market forecasts, CEA looks at the Internet of Things (IoT), driverless cars, digital health care, robotics and content curation. Each of these advances holds the potential to enrich our lives, and in some cases, massively change them.

For example, eventually sensors will be embedded in everything – our clothes, devices, appliances, doors, lights, even cars. These billions of nodes will collect information digitally and use algorithms and ambient computing to talk to each other and "learn" about our preferences. Cisco predicts the number of connected things will grow to as many as 50 billion by 2020. You can imagine how this will affect our daily routines.

Another area examined in this report is driverless cars. Google was the first to demo one of these vehicles in 2009, but virtually every major vehicle manufacturer is now testing and refining their own driverless cars including GM, Nissan, Toyota, Mercedes-Benz, as well as automotive suppliers like Bosch and Continental Automotive Systems, just to name a few.

There is no better place to see the latest technology than at the 2014 International CES® – the global gathering place for next-generation innovation. Held January 7-10, in Las Vegas, CES is the largest event of its kind where you can have a hands-on experience with products coming to market within the next 24 months.

To see award-winning technology, check out the Innovations Design and Engineering Awards showcase that honors achievement in product and engineering design, Eureka Park that displays entrepreneurial new products, services and ideas, and the latest TechZones like 3D printing, the Digital Health Summit and Internet of Things. Come to CES and see the magic of technology in action. For the latest updates, visit CESweb.org. ■

GARY SHAPIRO
President and CEO
Consumer Electronics Asssociation (CEA)®

TECHNOLOGY **TRENDS** TO WATCH **2014** 5

A Hundred Billion Nodes

By Shawn G. DuBravac, CFA

Node: \nōd\ a point at which subsidiary parts originate or center - Merriam-Webster Dictionary
Node: something that can be digitally identified, can communicate, can actuate

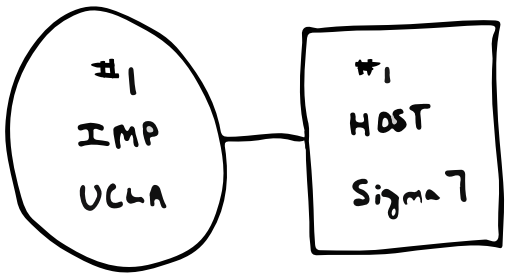
Right now, you are surrounded by billions upon billions of nodes. They are the chair on which you sit and the desk where you work. They are the clothes you wear, the light over your head, the doors and windows and walls surrounding you. Even this document, in whichever form you read it, is made of nodes. In fact, if you are reading this electronically, the device before you is also made of nodes.

Today, most of these nodes exist only in the strictest abstract sense and reside solely in the physical world. They are terminal points unto only themselves – to be acted upon but never to act. Some of them, a select few, like the device on which you may be reading this, have been incorporated into broader digital networks. We are only now beginning to connect these billions of nodes to digital networks. Slowly, steadily and with massive implications.

Connecting More than People

On Oct. 29, 1969, the first ARPANET link – the precursor of the Internet – connected the University of California, Los Angeles (UCLA) with Stanford Research Institute (SRI). The Internet finds its origin in what was a well-defined network for connecting known entities; both end points knew of the other's existence. On that day in October, UCLA's Professor Leonard Kleinrock attempted to communicate with the computer in Stanford remotely, sending it "login." Kleinrock described that first message as follows: "We set up a telephone connection between us and the guys at SRI. We typed the L and we asked on the phone, 'Do you see the L?' The response was, 'Yes, we see the L.' We typed the O, and we asked, 'Do you see the O?' 'Yes, we see the O.' Then we typed the G, and the system crashed."

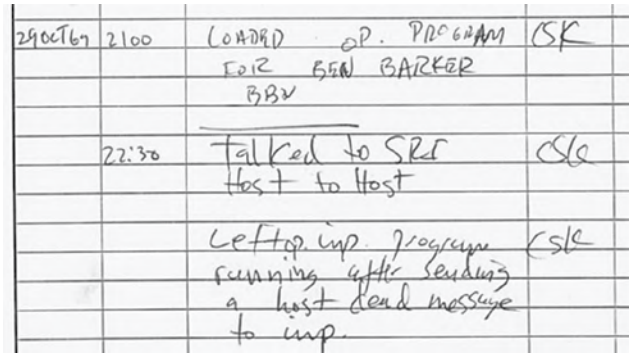
Diagram of the first two nodes on the ARPANET



Images courtesy of the Computer History Museum

But a revolution had begun, and from this simple message, additional nodes joined a young but burgeoning network. Nodes and digital information grew, but finding digital information across an increasing number of computers became problematic. To address this problem Tim Berners-Lee proposed and subsequently worked to build a more robust computerized information management system. In 1990 and 1991, Berners-Lee would write software for an information management system that ultimately became the first Web browser program. He named his software program WorldWideWeb and from this first Web browser the Internet as we know it got its name.These early digital networks primarily connected individuals to each other and to information. The origins of the Web were focused on organizing distributed data across diverse digital networks.

The UCLA IMP log book, showing the successful connection to SRI



Though today's digital networks grow at an incredibly rapid rate, in many ways, the purpose of these networks continues to revolve around organizing distributed data. However, that distributed data has moved from a small number of mainframes to a large number of personal computers, to an expansive number of small computing devices, and finally, to a massive number of widely distributed sensors. It is these sensors that define the Internet of Things (IoT).

In a 2008 paper in the *New Journal of Physics*, a team of researchers in China estimated the Internet doubles in size every 5.32 years following properties similar to Moore's Law or Kryder's Law. We create billions of digitally discernible data points, and Cisco projects the number of 'things' connected to the Internet surpassed the number of people on the planet in 2008.

In blending the physical and digital worlds we essentially extend the original concept of hyperlinking to include physical objects.

Even still, substantial opportunity remains for Internet-connected devices. By the end of 2012, eight to ten billion devices were Internet-connected, and Cisco predicts the number of connected things will grow from 15 to 25 billion by 2015 before exploding to 40 or 50 billion by 2020. Cisco also estimates the 99 percent of physical objects that may one day be connected are not connected yet today and, while that number might well grow to 50 billion by 2020, it would represent less than four percent of all things in existence.

The Web as we know it was designed as a tool for managing, finding and retrieving distributed information. In 1990 vernacular this meant linking to documents stored on different computers, or, the hyperlinking of distributed documents. In blending the physical and digital worlds we essentially extend the original concept of hyperlinking to include physical objects.

Extending Digital to Physical

Object hyperlinking, or physical world hyperlinking, offers a digital identity to a physical object. The earliest forms of physical world hyperlinking used tagging systems like radio-frequency identification (RFID), graphical tags like bar codes or QR codes (QRC), SMS tags and other virtual tags. These tagging systems make relevant information about a physical item digitally available or, conversely, make digital information available at the location of the physical object.

Early systems allowed access to digital information in conjunction with physical objects. The next step in this evolution is unfolding now – physical objects are being embedded with digital sensors to capture and transmit relevant information. The final phase of creating a seamless physical-digital sphere will require the physical objects to also receive digital prompts and cues which then alter the state of the physical object. Simple examples of this might include lights in a room being toggled on or off, or the temperature adjusted according to digital prompts. In the final state of evolution, physical objects will not only transmit digital information, but will also receive and process digital data.

Extending the digital realm to the physical world requires four primary elements:

1) **Replacing physical analog devices with their digital counterparts.**

2) **Embedding digital elements in the physical object.** These digital elements can be tags, like QRCs, that map the digital information to the physical location of the object, or they can be sensors that capture local information in a digital way. Essentially we are enabling these new digital devices to be uniquely identifiable.

3) **Extending communication links.** For a physical object to transmit or receive information, a communication link to the digital network is needed. This can be a 2G or 3G connection, or information can be disseminated through fixed or wireless (Wi-Fi) Internet. It can also connect via hub devices like smartphones and tablets using technologies such as Bluetooth and then be pushed further using connectivity links enabled by the hub device.

4) **Providing curation.** Curation is needed to translate digital information into actionable items. These are the algorithms that turn digital bits into physical outcomes. This is increasingly done remotely in the cloud. But adding intelligence to the equation can also happen at the device level.

There are a variety of synonyms used to describe these developments, including IoT, machine-to-machine communication (M2M), and the industrial Internet. These terms are all built off the same core elements: the digitization of technology, the 'sensor'ization of technology, the digitalization of information (i.e. big data), and ultimately, machine learning. Remember: curation is king.

Embedding Digital Elements in Physical Objects

As core analog devices are replaced with their digital counterparts, we also increasingly digitize physical objects by embedding digital elements. This essentially grants them a digital existence. The first rounds of these elements are tagging systems. For example, most of the items we buy today have bar codes that create a digital existence for an item. Bar coding systems are a digital portal to any number of data points in a myriad of databases: weight, size, price, nutritional information, alternative products to consider, etc. Anything that can be databased can be retrieved, which is true of all digital tagging systems.

The initial action to embed digital elements allowed for the retrieval of digitally available information. The extension of embedding sensors enables information to be captured digitally from the start. Much of this information existed previously,

but it wasn't being captured in a systematic, digital way. Sensor arrays are being deployed using multiple sensor types collectively to capture dimensions of a physical environment and craft a holistic picture. While one sensor might tell us something we want to know, multiple sensors deployed in conjunction might be able to tell us something previously unobserved. Recommendations derived from these sensor arrays can become more than the sum of their parts.

Ordinary things are now being digitized through the 'sensor'-ization of objects. Sensors are being embedded on objects as diverse as surfboards, shirts, TV remotes and toys. The next step in taking full advantage of the deployment of sensors is to provide connectivity to digital devices and the deployed sensors so the information captured can influence a wide band of decisions. Sensor data is only useful if it can be organized and examined.

IoT Pioneer

In 2009, Kevin Ashton, credited with first coining the term "The Internet of Things," wrote:

> Today computers – and, therefore, the Internet – are almost wholly dependent on human beings for information. Nearly all of the roughly 50 petabytes (a petabyte is 1,024 terabytes) of data available on the Internet were first captured and created by human beings – by typing, pressing a record button, taking a digital picture or scanning a bar code. Conventional diagrams of the Internet include servers and routers and so on, but they leave out the most numerous and important routers of all: people. The problem is, people have limited time, attention and accuracy – all of which means they are not very good at capturing data about things in the real world.
>
> And that's a big deal. We're physical, and so is our environment. Our economy, society and survival aren't based on ideas or information – they're based on things. You can't eat bits, burn them to stay warm or put them in your gas tank. Ideas and information are important, but things matter much more. Yet today's information technology is so dependent on data originated by people that our computers know more about ideas than things. If we had computers that knew everything there was to know about things – using data they gathered without any help from us – we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best.

Communication Links and Addressability

The next step in the physical-to-digital transformation requires uniquely identifying each item. Bar codes work well for a class of items that are essentially the same, but they can't identify each item within that class uniquely. Tagging systems like RFID get closer, but haven't yet scaled sufficiently to address the need for a complete overhaul of analog objects. Technology is evolving so that all devices will have a unique address someday.

Internet Protocol (IP) is the chief communications protocol for delivering network data packets from a source host to a destination host. This delivery is navigated by the IP addresses in the packet header. So every device on the Internet must be assigned an IP address to communicate with other devices across the network. The dominant protocol of the Internet today – the first major version of IP to be widely deployed – is IPv4. IPv4 uses 32-bit addresses which, then limit the universe of available addresses to 4,294,967,296.

The world is actually running out of IP addresses. On Feb. 3, 2011, the Internet Assigned Numbers Authority (IANA), a department of ICANN (the overseers of global IP address allocation), allocated the last five address blocks to the five Regional Internet Registries (RIRs) and in so doing exhausted the primary address pool of the Internet. On April 15, 2011, the Asia-Pacific Network Information Centre (APNIC), the regional Internet registry for the Asia-Pacific region and the organization responsible for allocating Internet Protocol addresses in Asia, became the first RIR to exhaust its regional pool.

The successor of IPv4 is the IPv6 protocol, which uses 128-bit addresses and consequently has 340,282,366,920,938,463,463-374,607,431,768,211,456 possible Internet addresses available; 18 quintillion blocks of 18 quintillion available addresses. After a technical testing and publicity day in 2011 known as World IPv6 Day, a diverse set of participating companies billed June 6, 2012, as World IPv6 launch day, when sites would have IPv6 permanently enabled. The majority of devices shipping today support IPv6 – though much work remains in converting websites and services to IPv6. As of the end of 2012, IPv6 traffic was roughly one percent of all Internet traffic.

Devices can be directly addressable through an IP address and some form of embedded connectivity like a 2G or 3G connection, Wi-Fi, or wired Internet connection. Devices or sensors can also connect via hub devices like smartphones and tablets using protocols such as Bluetooth and then pushed further using connectivity links enabled by the hub device. For most devices, even intermittent Internet connectivity can be sufficient, pushing information at given intervals.

IPv6 allows for more unique addresses which is important.

But from a consumer's standpoint, the large number of addresses allows us to largely do away with "network address translation" (NAT), where dozens of devices are assigned unique, local IP addresses behind a single public IP address, leaving it up to the home router to negotiate a packet's path from that point on. From a configuration standpoint, having each device possess and negotiate its own Internet connection and all of the network "handshaking" it needs to do without requiring consumers to understand NAT or even know how to login to their home router is a major leap forward in terms of reliable information gathering. NAT was absolutely necessary in an IPv4 environment, but is only required in a very limited number of circumstances in IPv6 (usually related to ultra-high security).

An increasing number of things connected to the Internet lack an interface entirely. Consequently, devices like smartphones and tablets are steadily becoming the interface for the Internet of Things.

For example, a smart meter connected to an M2M network with an embedded 3G radio can be addressed directly by the power company. Of course, connecting that smart meter to a home Wi-Fi network is possible but because the network configuration can change, and the power company can't always guarantee that it can reach the meter when it needs to, connecting in this way might not achieve the intended goals. A dedicated link to the wide-open Internet (without NATing through a home Wi-Fi) and a unique, addressable IP are both important in this scenario.

The power of these devices, in essence, is their ability to sample information millions of times more often than we as people can. For that information transfer (and synthesis) to be seamless, devices need to be connected without any intervention from the user – no manual synching, no Bluetooth pairing, etc. Hence, an embedded form of Internet access and unique IP (assigned without connecting through an unpredictable network node like home Wi-Fi) are ideal.

Curating Billions upon Billions of Digital Bits

A curation service translates digital information into actionable items. They are the algorithms that turn digital bits into physical outcomes. Curation, coupled with sensors, allows us to capture, extract and find meaning in data.

To truly make the Internet of Things relevant, the physical has to move from digital back to physical. The Internet of Things effectively lets something or someone in the physical space alter something else in the physical space by way of the digital realm. Today, one can lock a door or turn off lights in the physical world with the flick of a wrist. In the IoT world, these things will be done digitally.

Because humans are constrained by both time and capacity, we can't fully digest and translate the billions of digital bits created by sensors. As a result, we create and use algorithms to decipher this data on our behalf and in near real-time. Today, many digital health and fitness applications are essentially curation services. They take information like heart rate and movement from sensors and route that information through algorithms, which in turn provide feedback and recommendations to the end user. (Read more about health and fitness technologies in the "Consumer Digital Health Care" section.)

In this, we see a key element in how the Internet of Things is altering behavior through recommendations. As Zero2one Founder Monisha Perkash said, "We are at a unique moment in time where we can combine emerging technologies, data and intelligent algorithms to empower each of us to do the little things in life that can dramatically improve our lives." This behavior isn't just limited to humans it also includes the ongoing performance of any number of machines.

Given the digital nature of IoT and the breadth of available sensor data, most curation today happens on large computer and server systems far removed from the actual locale of the sensors. Feedback and recommendations are then pushed to interfaces which are often removed from the actual sensors. In fact, many things connected to the Internet lack an interface entirely. Consequently, devices like smartphones and tablets are steadily becoming the interface for the Internet of Things. Smartphones and tablets are the viewfinder into our digital life.

What the Future Holds

In considering the future, we tend to conceptualize its landscape far too myopically. The computer systems connecting the billions of physical and virtual nodes around us are never going to do everything we do. In turn, we obviously are not going to have a hand in every computer-aided decision, attempting to conduct an orchestra of hundreds of nodes in instantaneous time. The Internet of Things will create a natural division of labor.

Today, we spend a tremendous amount of effort attempting to transform computers into people. Nearly three decades ago, Honda set out to create a walking robot – "The World's Most Advanced Humanoid Robot." Since then, others have sought to create humanoid robots from REEM – a prototype of humanoid robot built by PAL Robotics – including NASA and GM's Robonaut 2. Hundreds of thousands of scientists and engineers continue to work to create computer systems that look, behave and think like humans.

We erroneously want computer systems to mimic the human mind. One of the great disconnects of technology is an irresistible human desire to compare artificial (computer) intelligence (AI) with natural intelligence. Recent research from Stellan Ohlsson, Gyorgy Turan and Aaron Urasky reveals that

some of the best semantic AI systems have the IQ equivalent of a four-year-old. But, the results also find that the IQ test results are very uneven. The AI systems scored extremely well on tests of vocabulary and ability to recognize similarities but scored low or dramatically below average on comprehension.

AI systems just aren't great with commonsense related questions – yet. There is clearly a difference between artificial intelligence and natural intelligence. The ultimate goal of these systems is to build intelligent, sentient and sapient agents – systems that are self-aware; systems that perceive their environments and take actions to maximize their chances of success. We want digital systems that self-diagnose and self-correct.

The 'sensor'ization of technology creates a deluge of connected devices digitizing information in near real-time and providing this data in troves to anything they can. Computer systems are far superior to humans for digesting large swaths of data, finding patterns and applying logic and statistical reasoning. In most instances, there are few reasons for computers to have humanist traits. Likewise, we shouldn't expect individuals to surpass computers' ability to provide recommendations from huge swaths of data just because they can now be mined digitally.

The ultimate goal of these systems is to build intelligent, sentient and sapient agents – systems that are self-aware; systems that perceive their environments and take actions to maximize their chances of success.

A more likely outcome includes a division of labor, wherein computer systems perform their unique functions superiorly and humans focus on their own relative advantages. Professor Peter-Paul Verbeek at the University of Twente in the Netherlands writes that technology already influences our moral decision making, which in turns affects human agency, privacy and autonomy. He advocates considering computers active agents rather than viewing technology merely as a human tool. Curation is about context, and this will require individuals and computer systems to work together.

Society is entering an age of extrapolation in which systems are more context-aware. We primarily use applications to achieve specific objectives. We open an email or SMS app to send a message. We check the weather forecast through a weather app. We use a traffic application to determine how long it will take to get from point A to point B and to determine the best route. However, we are shifting from an environment of taking action to one in which we are acted upon. For example, Google Now prompts you when it is time to leave for a meeting across town based on traffic and time to your destination.

There are already hundreds of ways sensors and computing partner with connectivity to create an Internet of Things. All of these systems can become a function of a series of data points captured from a wide swath of sensors. These systems become contextually aware and continuously updated as new information becomes available.

Imagine a day when your alarm clock setting is established by train times and traffic patterns. Today, Jawbone Up's Smart Alarm does not wake you up at a pre-specified time, but rather when you are in a light-sleep around the time window you specified. In the future, your shower might turn on based upon what it knows about your daily routine. Your vehicle might do the same to perfectly heat or cool itself at a setting you enter. Clothing options might be recommended based upon your activities for the day and health sensors will perceive your mood. Breakfast options might be driven by similar inputs – time, changes in outside influences like traffic, the weather, and how they correlate with prior selections, pre-specified health

Replacing Analog Devices with Digital Counterparts

The first compact disc (CD) player debuted at the 1981 International CES before being launched publicly in 1982. The coupling of CD players and PCs ushered in the opening stanza of a massive shift from analog devices to digital devices. Still, it would be another two decades before households began the uptake of digital devices in a significant way. In 1998, only 41 percent of households owned a PC, the only digital devices households owned were CD players and, a very small percentage of households had broadband Internet access. At the dawn of the 21st century, we were unconnected and operated almost exclusively in the physical, analog realm.

Then, in 1998, the truly digital decade began. In that year, a boutique retailer in San Diego sold the first HDTV, igniting uptake as consumers began to replace their analog devices with digital versions. Soon after came introductions and updates for digital cameras, digital music players (MP3), digital mobile phones and a legion of other devices. PC ownership increased over the ensuing years and as of 2013 is more than 85 percent.

Of those who had home Internet access in 2000, only three or four percent had broadband connectivity. Today, just over a decade later, the exact opposite is true. The Pew Research Center's Internet & American Life Project reported only three percent of those with a home Internet connection rely on dial-up services.

In a little over ten years a groundswell of digital ownership has unfolded in every corner of our lives.

goals, or even recently published research in the *Journal of Medicine* that you haven't yet read.

While driving to work, you might tell your autonomous vehicle to experiment with a new route while sensors simultaneously monitor your stress levels and provide feedback to the system. The traffic lights are synchronized and optimized based on traffic patterns, traffic incidents and the aggregate routes each vehicle is programmed to take. Your vehicle is connected with this information and continuously makes updates of its own.

While some of these things might seem far off, their foundations are already unfolding before us. We tend to think about linearly moving from point A to point B, but that is not the process through which tech adoption and innovation diffusion typically occur. These advancements – the little steps for man and the big steps for mankind – tend to occur through a series of hybrid periods. The hybrid periods tend to build upon themselves – one hybrid period building upon another hybrid period until society moves from point A to point B. Dutch start-up Sparked is using wireless sensors to monitor cattle and report on their location and health. One day these sensors could influence the price of beef or competing alternatives. Progressive – the large insurance provider – has implemented Snapshot, a vehicle insurance program that provides customized insurance rates based upon when and how a vehicle is driven by monitoring information like speed, miles driven and time of day. Sensors on the vehicle capture and communicate through an on-board telematics device connected to the vehicle's OnBoard Diagnostic (OBD-II) port.

There are many examples in the health and fitness arena. Corventis makes a wireless cardiac monitor that physicians can check remotely. AT&T created their Vitality GlowCap which replaces the cap of your pill bottle with a cap embedded with a chip to monitor when the pill bottle is opened and wirelessly relays alerts to the patient, a caregiver or a pharmacist when it is time for refills. Likewise, Abiogenix created the uBox, a connected medicine storage device that tracks when a user takes his medication, sends reminders when he does not, and, at the user's option, can send alerts to caregivers or relatives if a dose is missed. Verizon Telematics produces LifeComm, a wearable cellular device that monitors a user's activity for falls and other situations requiring emergency response. In addition, iHealth sells the Pulse Oximeter, which clips onto a person's finger and measures blood oxygen levels and pulse rate.

Koubachi offers Wi-Fi-enabled sensors that monitor indoor climates to optimize plant care. The Nest thermostat utilizes embedded motion, humidity, temperature sensors and current and future weather conditions to optimize temperature settings. Sensors on household appliances can alert manufacturers if an appliance needs to be repaired or undergo maintenance.

The Industrial Internet, a term coined by GE, refers to the integration of complex physical objects and machinery like jet engines, locomotives or wind turbines, with networked sensors and software. GE has deployed digital microphones and sensors to monitor the health of trains and to keep turbines online. Sensors, along with connectivity, computing and curation, will impact all aspects of our life. They'll alert us to predicted changes in our local weather, to the possibility of a natural disaster, or the long-run viability of resources like water. In all likelihood, the next World War will be fought with sensors, as autonomous drones are already increasingly used.

Naturally, many issues still need to be addressed such as reliability, security, privacy and control of the now digitally available data. It's critical that the digital data remains secure in order for this market to be viable. The first time a homeowner comes home to find their connected thermostat has been hacked and the temperate lowered to 50 or raised to 80, will challenge the value of having their life connected to the Internet. Or worse, if personal health information is hacked, sold, or used against them, consumers may reconsider 'sensor'izing their life.

There is an implied assumption that the Internet of Things will bring greater productivity. For the foreseeable future, the Internet of Things will toggle between the visible and invisible world and eventually, a large portion of the Internet of Things will slip into invisibility. Using sensors to collect information digitally, and employing algorithms and computing to utilize this information, a device's ability to self-regulate will increasingly take place in the background.

Sensors can monitor and measure what we often cannot. Certainly they can do it digitally and with greater frequency. From these data, algorithms can find what we can't see, helping us overcome behavior biases and other obstacles to efficiency. We are surrounded by billions of nodes, providing these with intelligence will in turn, influence everything we do. ■

APNIC	Asia-Pacific Network Information Centre
CD	Compact Disc
IANA	Internet Assigned Numbers Authority
IoT	Internet of Things
IP	Internet Protocol
M2M	Machine-to-Machine
NAT	Network Address Translation
QRC	Quick Response Code
RFID	Radio-Frequency Identification
RIR	Regional Internet Registries

TECHNOLOGY **TRENDS** TO WATCH **2014** 5

On the Road to Driverless Cars

By Jack Cutts

Sitting in traffic on I-95 on a busy holiday weekend can drive even the most avid driver mad. But imagine a future without the hassle of stop-and-go driving. Collisions and accidents and the resulting traffic jams are an unfortunate but accepted part of driving. While these traffic snarls may frustrate drivers while they're on the road, they can have very real, costly and long-lasting consequences.

Consider a future in which drivers merely sit and exist in a hunk of glass, steel and upholstery as computers perform the worst parts of our summer drives for us. Not everyone is, or ever will be, at peace with the idea of machines taking over control of the majority of vehicles on the road, but clearly the path is being paved for driverless cars.

On The Road: The State of the Industry

Already legal in some states, driverless cars do exist and can be driven on public roadways in certain places. California, Nevada and Florida have opened up their roadways to autonomous vehicles in recent months. Assuming calamity does not ensue between Miami-Dade and Marin, it is safe to surmise that other states will slowly begin taking steps to open up the roadways to our driverless future, lest they be branded Luddites by the vehicular trendsetters among us.

Google is a key player in this race. Its own driverless vehicles have been in testing since 2009, having logged more than half a million miles and suffered only two known accidents. Both collisions, Google reported, occurred when human drivers were in control of the vehicle. However, virtually every major vehicle manufacturer is currently testing and refining their own version of the technology as well. Joining Google in pursuit of the driverless future are GM, Nissan, Toyota, Mercedes-Benz, along with a coterie of "Tier 1" automotive suppliers like Bosch and Continental Automotive Systems.

Great Expectations

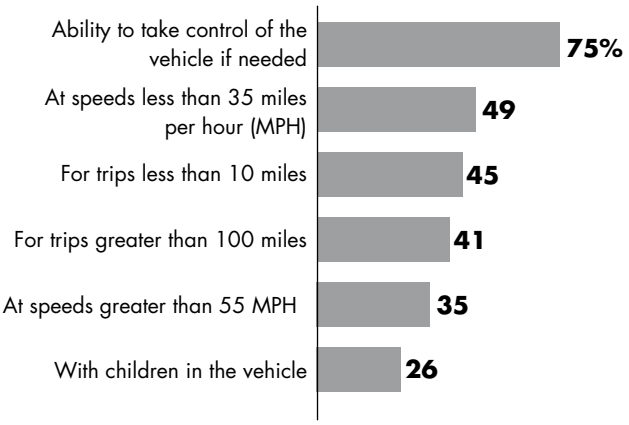
The driverless car elicits so much interest because it is easy for most people to imagine all of the things that we could do with our new-found leisure time once freed from the need to steer and brake. Imagine reading a book, playing video games, texting, or doing any of the hundreds of other things we do (and probably should not do) in our vehicles every day.

CEA consumer surveys suggest that drivers are willing to consider taking a back seat. When asked, 79 percent of those surveyed profess a willingness to be a passenger in an autonomous vehicle. The overall interest level seems high when respondents are reminded of their ability to take control of the vehicle any time they feel the need.

CEA consumer surveys suggest that drivers are willing to consider taking a back seat.

However, willingness to ride in a driverless car drops below 50 percent for both short and long trips as well as for driving at city and highway speeds. Introduce children into the equation and only 26 percent of respondents would be willing to ride in an autonomous vehicle in the company of a child. Data does not disclose, however, if unwillingness to ride with a child is primarily due to concerns for the child's safety or a general unwillingness to ride along with a child. Indeed, those respondents with children were no more or less likely to want to ride with a child in a driverless vehicle.

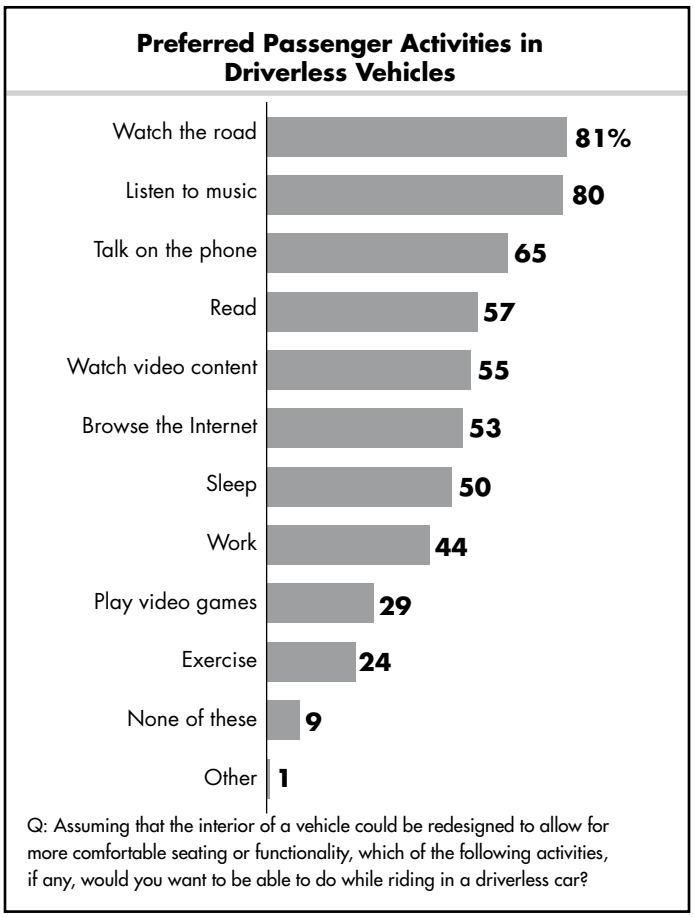
Willingness to Ride in Driverless Vehicles, by Scenario



Q: In which of the following situations would you be willing to ride in a driverless or self-driving wehicle?

Source: CEA Survey, July 2013

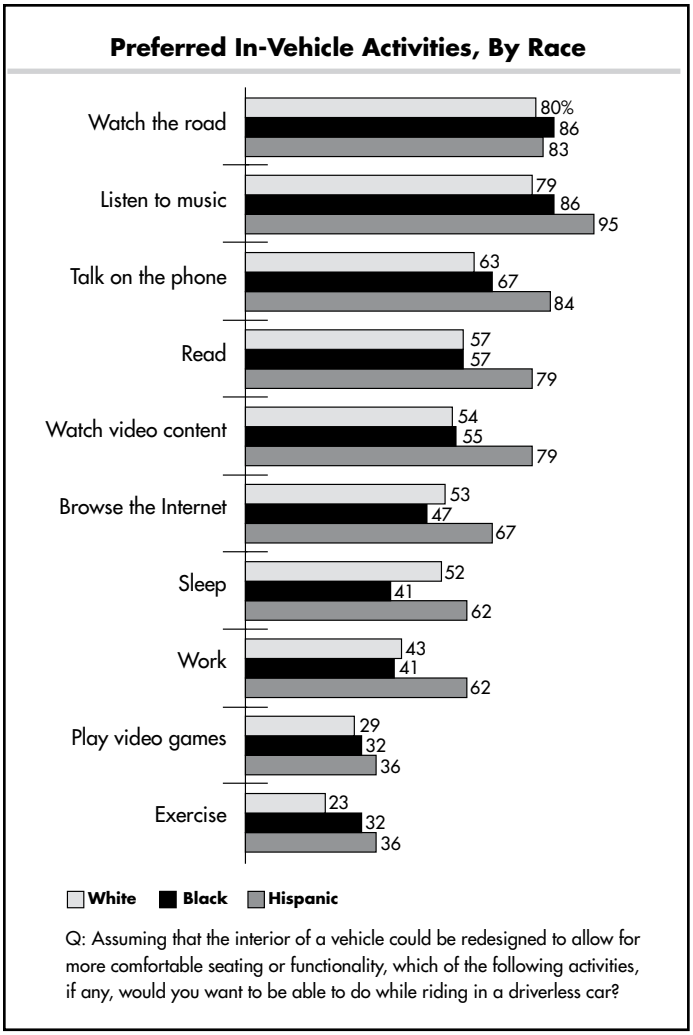
A subsequent question asked respondents to daydream about the range of activities they would like to undertake as a passenger of the future. Notably, many of the preferred activities, such as watching the road, listening to music and talking on the phone (hands-free, of course) are activities we currently enjoy as both drivers and passengers today. Other suggested activities are less obvious. The, ahem, sleeper among respondents was sleeping with 50 percent of respondents looking to catch Z's on the road. Meanwhile 24 percent of respondents said they'd like to exercise in autonomous vehicles. A handful of respondents admitted they wanted to "make love" in the vehicle, while a similar number were looking for the ability to eat an in-flight meal while on the road.



Source: CEA Survey, July 2013

Not surprisingly, younger adults (ages 18-24) are more willing to ride driverless, coming in at 98 percent, but dropping only as low as 88 percent willingness in the 55 and older cohort. Levels of education, household income and employment status appear to matter little. Interestingly, Hispanic respondents appear to be more enthusiastic overall about riding in an autonomous vehicle than their black or white peers. In every scenario listed, Hispanic respondents reported a higher willingness to ride driverless.

When broken down based upon the respondents' ownership of "smart" devices, choice of activities appears to have less to do with device ownership and probably more to do with age. Recall that those over 55 years old were less willing to ride in a driverless vehicle. Age, in this case, is probably acting as a stand-in for device ownership in terms of its effect on the numbers.



Source: CEA Survey, July 2013

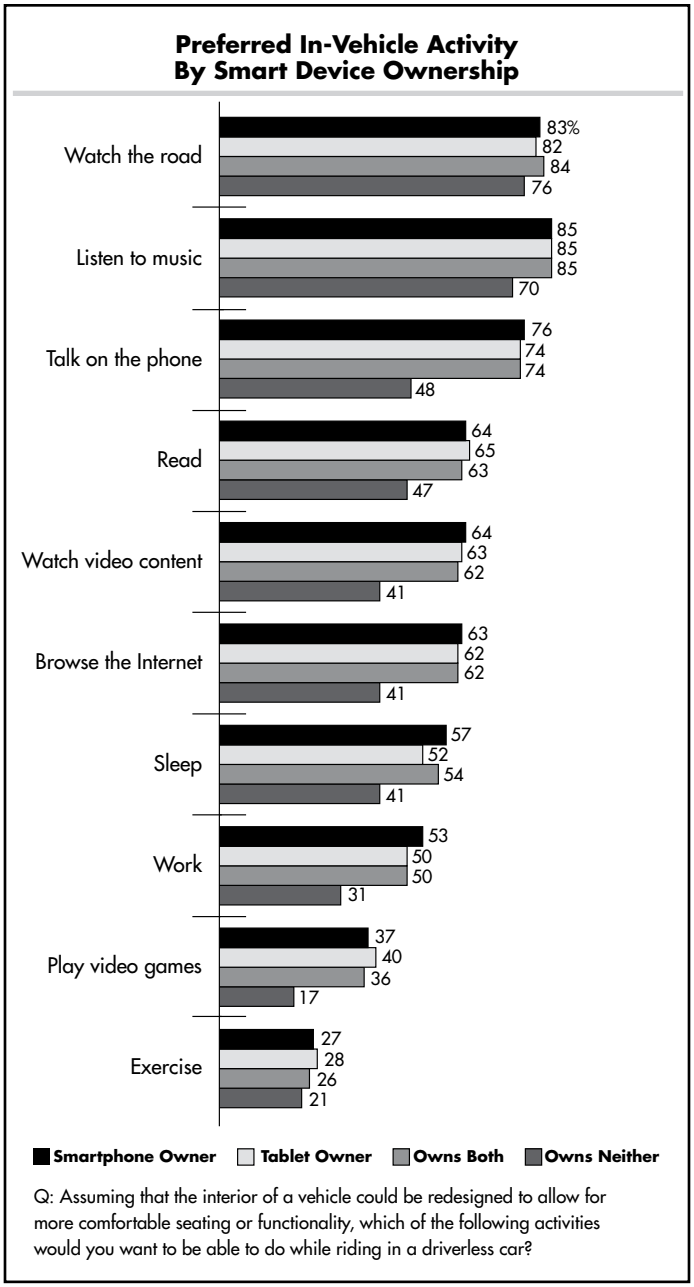
Vehicles today are fairly friendly to passengers who want to read a book or watch a movie in motion, but it will be interesting to see the ways in which the design of the vehicle's interior will evolve to suit our predilections.

Things Fall Apart: Industries in Flux

Moving beyond what happens inside the vehicle, there are a number of ways in which a large-scale shift to autonomous vehicle ownership might disrupt existing industries and business models. These upheavals will have drastic, negative consequences for some industries, while others will experience tremendous growth. Others will face daunting challenges and will rise or fall based upon how they respond to change. Here's an outline of a handful of the industries that could be turned upside down once driverless vehicles reach critical mass.

Telecommunications

In its inevitable future form, an autonomous vehicle will need to communicate both with other vehicles in its vicinity and also



Source: CEA Survey, July 2013

with roadside hardware. While a driverless car with cameras mounted on its roof can "see" a red light on the roadway ahead, the vehicle will also require a two-way wireless link to waypoints during the trip to learn about other types of information it cannot see. For example, a road crew could activate a beacon before beginning work on a busy highway to alert cars that enter the work zone to be extra cautious and to maintain safe speeds. Such scenarios bring to light a handful of as-yet-unmet needs in the world of telecommunications. The two primary constraints on such a future are the need for massive amounts of wireless spectrum at very low frequencies and the need for wireless radio technologies that can make efficient, practical use of low-frequency spectrum.

A vehicle communicating with another vehicle or with a piece of roadside hardware has very specific data needs. Of primary importance is a communications protocol that allows for very low-latency transmission. That is, your vehicle needs to have packets of information sent and received very quickly between itself and another device. Latency (typically measured in milliseconds) is the amount of time it takes a packet of information sent (wired or wirelessly) to travel to its recipient and back to the sender. In human terms, a latency of under 100 milliseconds is almost imperceptible. To a vehicle about to rear-end a dump truck, it might be too long. Current generation wireless protocols like Long-Term Evolution (LTE) and its successor (LTE Advanced) will continue to drive round-trip latencies well below 100 milliseconds. Note that this fast response time is still far slower than the neuron response of a human being, measured at under 10 milliseconds. Our brains will retain their relative job security for now, it seems.

A more pressing need, then, is the availability of a sufficient amount of low-frequency spectrum over which our vehicles can talk to one another. In an in-vehicle application, low-frequency spectrum is desirable for a host of reasons. First, low-frequencies generally travel farther (all things being equal), thus requiring fewer towers or access points. The need for fewer towers drives down the cost to deploy roadside hardware. A low frequency signal is also much more likely to penetrate a structure like a parking garage or tunnel, increasing range to places that currently see no wireless signal.

One innovative group is in the process of creating a new technological standard known as "Weightless." Operating in between the spectrum currently occupied by over-the-air television broadcasts, Weightless devices are able to make use of spectrum in the 700 MHz band. Weightless' technology represents what is known collectively as machine-to-machine (M2M). M2M technologies have broad uses in a variety of industries and applications. Weightless and other technologies like it are finding ways to strike a balance between cost of deployment, bandwidth, computing power and battery power requirements.

Computer Science

In the future, the only thing that keeps you from accidentally running a red light in your driverless car might be a well-placed line of written code. Most drivers do not realize that in addition to steel and leather, their vehicles are made up of millions of lines of code, governing everything from the check engine light to the electronic stability control that keeps them from spinning out of control in a rain storm.

Even fewer people realize that a computer can only do what its programmers have told it to do. Behind every action a computer takes, there is a line (or a few thousand lines) of code that help determine exactly how the computer should react to a given situation. As complex as it is to program a computer to drive a vehicle, imagine teaching that computer to drive a vehicle in

the midst of other vehicles constantly bombarding the on-board computer with information about other vehicles nearby. Even worse, imagine a computer driving your vehicle trying to anticipate the actions of a person driving a 1993 Toyota Previa with no built-in street smarts.

Today there are two main types of driverless vehicle intelligence systems. One involves attaching to the vehicle a series of well-placed sensors that are functionally "blind" but can communicate their relative positions and statuses to and among one another. The other type of driverless system involves a camera (or an "eye") that can see and detect things in its periphery. In software, the eye has been trained to avoid hitting certain things, to ignore other things and to use some objects (like lane markers) as guides. Like our brains, the eye takes in hundreds, if not thousands, of visual stimuli per second and processes them into an actionable map of the road ahead. Unlike our brains, however, it takes millions of lines of code to properly account for all manner of road hazards, crash avoidance scenarios, and other events, while our brains are able to process many times that number of stimuli without breaking a sweat.

Today there are two main types of driverless vehicle intelligence systems: sensor-based and camera-based.

It is not surprising, then, that the world's demand for computer programmers will skyrocket in the coming years. Far beyond just the need to program a smarter car, in twenty years a much larger proportion of our day will involve interaction with a computer of some sort. All of that code has to be written by someone.

Insurance

Automobile insurance is not the most fun or glamorous aspect of owning a vehicle but it is an important fact of life and one that is mandated by law in most U.S. states. The National Highway Traffic Safety Administration (NHTSA) estimates that 93 percent of all accidents are the result of driver error. The human element to driving, it seems, is a major money-maker for automobile insurers. Liberty Mutual made it official in 2012, basing a new advertising campaign around the fact that humans make mistakes (set to the song "Human" by The Human League). So what happens to an insurance policy written in an era when humans are doing very little (or none) of the actual driving?

In most crash scenarios, one or more drivers will be determined to have been at fault and their respective insurance companies will hash out who owes what to whom. The presumption in this scenario, it seems, is that human error is usually the root cause of most accidents. So who is at fault when a driverless car crashes into another vehicle and the accident is determined to have been caused by faulty code? Can the driver still be held liable? Ultimately, the judicial system and the court of public opinion will figure that one out.

The Metamorphosis: A New Normal?

Whatever your chosen distraction, the jury is apparently still out on the range of activities in which we as drivers will be allowed to indulge. In current iterations of autonomous vehicle technology, passengers are required to take the wheel periodically in situations when the vehicle's on-board computers determine it is unsafe or impossible to continue without human intervention. Think of an intersection made more complicated by the presence of road work crews and machinery or by a detour or other obstruction that requires some good old-fashioned brain power.

There is precedent for all of this, of course. Most travelers are aware of the fact that most commercial airplane pilots fly with the autopilot engaged much of the time. This system is also capable of landing the aircraft by itself if required. However many in the aviation industry have concerns about how overreliance on autopilot features affects pilots' skills. "There needs to be more hands-on, more physical awareness, and more initiatives," says David Jenkins, a 72 year-old retired pilot, in an interview with the *Sydney Morning Herald*. "Computers make great monitors for people, but people make poor monitors for computers."

The recent crash of a Korean Airlines flight on approach into San Francisco International Airport has renewed concerns about the downside of autopilot. In an article on the crash and the resulting controversy, *Bloomberg Businessweek* posits that overreliance on autopilot may have been the root cause of the crash. Citing industry sources, the report said Korean pilots are well-known throughout the industry for a tendency to be unwilling to assume manual control of an aircraft, even in situations that similarly experienced pilots find routine. It is safe to assume that Korean Airlines will review training procedures and augment existing training regimens if needed. But what about the drivers two decades from now who become over-reliant on their own version of autopilot? Will state governments continue to require driving tests and will they be as rigorous? Will they be updated to simulate taking control of a driverless vehicle after a tire blows, for example, or in the event that a failing alternator renders the vehicle's on-board computer useless?

Eventually, when we have all become well accustomed to riding rather than driving, will we look back and find that we have raised a generation of adults that cannot safely operate a vehicle in manual mode? Will future generations of drivers have successfully developed the sensory awareness and anticipatory skills that most drivers cultivate after a few years behind the wheel?

Beyond personal safety and road readiness, the great personal convenience of driverless vehicles has the potential to cause major problems for cities and societies if some predictions prove true. One of the most promising potential conveniences of the autonomous vehicle is the ability to send an unoccupied vehicle to pick up someone and drive them to another destination. Imagine a parent who realizes he will not able to pick up his child from daycare by closing time. Rather than incur usurious late charges, a parent could dispatch his own car from his office, retrieve the child, and have the child delivered back to the office (or home, into the arms of a waiting caregiver). Imagine a second scenario in which a pre-teen, unable to legally drive, pesters his mother to take him shopping. How convenient would it be to strap the kid into a driverless car, enter the destination and send him on his way?

The convenience scenarios are endless and the time savings could be substantial. But in many scenarios, this convenience might come at the cost of an extra vehicle trip, further adding congestion to our already packed roads. Will families of the future purchase a third, spare vehicle for just such ad hoc, child-only pickup runs? If so, what will that mean for areas that rely heavily on on-street parking?

Further, how will we obtain the fuel necessary for these extra vehicles? Admittedly, this prospect is less troubling today than it would have been five years ago. Fuel efficiency requirements for new cars have been quite successful, and the technology for hybrid and all-electric vehicles has improved tremendously since introduction. It is entirely conceivable, if not likely, that all or virtually all autonomous vehicles will also be all-electric by the time they are available for sale to the public. However, once electric vehicle penetration hits a tipping point, what does a legion of vehicles charging overnight do to our electric grid? It is possible that nighttime vehicle charging will help smooth the demand curve, which currently tapers up beginning at dawn, spikes between 5 and 7 p.m. and tapers off until dawn. And in switching to primarily electric vehicles, would we simply be trading one problem – pollution from internal combustion engines – for pollution from the generation of electricity?

A Brave New World

We stand on the precipice of a great advance in quality of life, enabled by the automation of driving – an activity that nearly all of us do every day. The degree to which technology improves our lives is heavily dependent upon how we as a society agree to craft rules, accept new responsibilities and respond to a shifting of the demand for scarce resources like parking, pavement and power. It will cause great upheaval in the lives of some while it produces new opportunities and conveniences in the lives of even more. ■

LTE	Long-Term Evolution
M2M	Machine-to-Machine
NHTSA	National Highway Traffic Safety Administration

The following auto makers will be in attendance at the 2014 International CES:

Audi of America
Chrysler LLC
Ford Motor Company
General Motors
Kia Motors Corp.
Mercedes-Benz Research & Development North America
Toyota

TECHNOLOGY **TRENDS** TO WATCH **2014** **5**

Consumer Digital Health Care

By Rachel Horn

For years, digital health technologies for consumers have been overshadowed by the popularity of fitness devices like calorie counters, heart rate monitors and pedometers. But as the aging Baby Boomer population requires more health care and health maintenance support, devices that can monitor their health and safety are garnering attention and growing capital investment. Apps, wearable sensors and remote monitoring devices are becoming integral tools for both clinical care providers and routine health maintenance. These technologies are transforming the doctor-patient relationship, expanding the reach of doctors into patients' homes, and empowering patients to take control of their own health and wellness.

Yet, in spite of the many clinical health benefits associated with emerging health technologies, there are some challenges that could inhibit the success of this market. In a recent CEA survey, consumers expressed concerns about the security and reliability of tracking and sharing their personal information. Federal agencies are also taking a closer look at these technologies to determine whether and how they need to be regulated. And encouraging behavior change so that the products are properly and regularly used could be the biggest obstacle of all in perpetuating the growth of health technologies.

Wearable Devices and Self-Tracking Apps

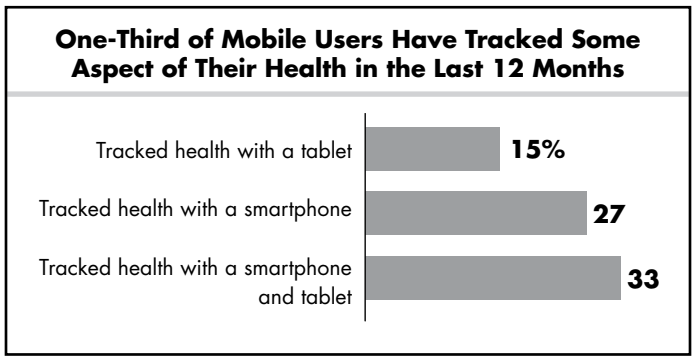
Consumer interest in the "quantified self," whereby every aspect of a person's life is captured and analyzed, is propelling the adoption of wearable health trackers. Smartphone apps and wearable, connected devices allow people to track all kinds of personal data – from activity levels and mood, to heart rate, blood pressure, sleep patterns and food intake – and then analyze and share that information wirelessly. Devices like the Jawbone Up, the Fitbit and the Nike+ FuelBand take the shape of wristbands that collect and sync biometric data with mobile devices or the Web. By 2017, there will be 169.5 million wearable health and fitness devices on the market worldwide, up from 21 million in 2011, according to ABI Research. About half (80 million) of these health and fitness devices will be health-focused, designed for home and remote patient monitoring.

One drawback to wearable devices is that they require people to actually keep the device on their bodies. "A lot of people don't like to wear things," says Dr. Brian Rosenfeld, chief medical officer for Philips Healthcare. "Some patients even find they don't like wearing a Fitbit [wristband] because they don't like the way it looks, or it potentially identifies them as being a patient with a chronic illness."

The next generation of wearable devices is likely to offer more discrete tracking options for those who feel self-conscious wearing a device. Medical technology company Vancive, for example, has designed the Metria, a small, disposable chest patch that can be worn for seven days and measures heart and breathing rates, steps taken, skin hydration and sleep patterns. Data is wirelessly transmitted via Bluetooth to a wireless device.

Smartphones are also an excellent tool for self-tracking since they're almost always within reach and always connected. Mobile apps can transform smartphones and tablets into sophisticated health trackers and transmitters. More than 97,000 mobile health apps are available in the major app stores, according to a March 2013 *Research2Guidance* report. Today, there are apps for tracking dozens of biometric indicators, including sleep apnea, heart and breathing rates, blood pressure, weight and even fertility. There are also apps for charting calories consumed and calories burned, steps taken and fitness routines.

A 2013 CEA survey found that one-third (33 percent) of mobile device owners have used their devices to track some aspect of their health in the last 12 months. Among smartphone owners who have tracked their health, one-quarter (28 percent) say they've shared that information with their health care provider.

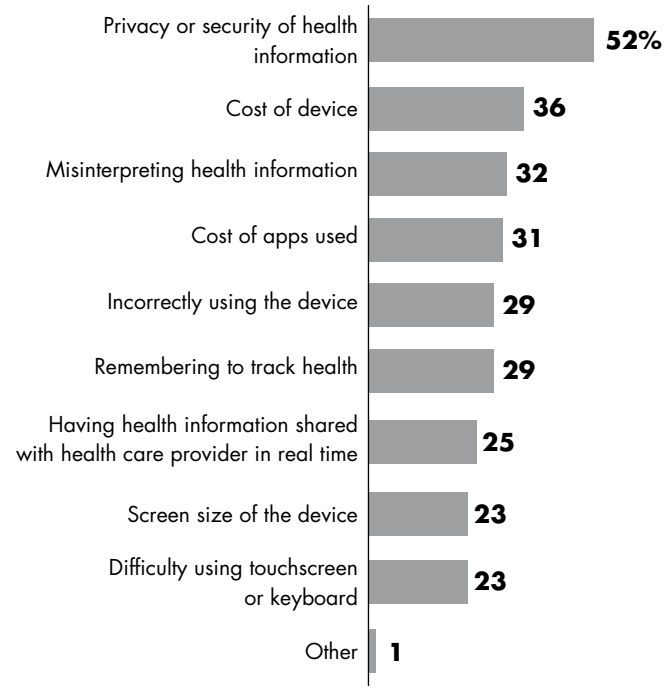


Source: CEA Survey, July 2013

Although biometric tracking is gaining mainstream appeal, more than three-quarters (76 percent) of survey respondents say they have concerns about tracking and sharing their own health data, according to CEA market research. The number one overall concern for people is the privacy or security of their health data, followed by the cost of devices, and concerns that they might misread or misinterpret their own data.

"Consumers are tracking more personal information than ever due to the increasing availability of health and fitness devices. However, in order to maximize the full health potential of this data, we need to make sure consumer data is protected and secure," says Kevin Tillmann, CEA senior research analyst. "Reading terms and conditions and privacy policies carefully should help consumers understand when and how their information can be accessed." Tillmann adds that product education is critical. "The amount of data that can be collected by these tools is powerful and can be overwhelming to consumers. Easy-to-navigate interfaces and clearly worded instructions will go a long way in making consumers feel more comfortable with these devices."

Survey Respondents' Concerns About Using a Mobile Device to Track or Monitor Health

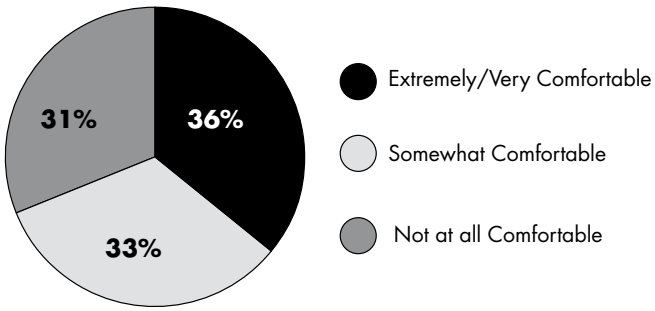


Source: CEA Survey, July 2013

Aging in Place: Integrated Technology Solutions for Seniors

Perhaps the biggest growth area in health technology involves helping seniors learn how to use devices to live healthier lives outside of hospitals and nursing homes. In 2012, the first of the Baby Boomers, born between 1946 and 1964, turned 65. By 2030, the number of U.S. adults ages 65 and older will reach 72.1 million, representing one-fifth of the country's population. Today's seniors are more tech savvy than ever. Eight in 10 AARP members own a tablet, computer or e-reader, and two-thirds of respondents say they're at least somewhat comfortable using technology. More, studies show that seniors overwhelmingly prefer to receive the health care and social services they need in their homes rather than in nursing homes or assisted living facilities. Nearly 90 percent of people ages 65 and older say they want to stay in their homes as long as possible, according to AARP.

Technology Comfort Levels Among Seniors Ages 50+



Source: AARP, 2012

Aging in place with the assistance of digital health technologies like motion sensors and tracking, connected health monitoring apps, and streaming video provides real emotional, physical and financial benefits. As more seniors choose to age in place, new digital health solutions must be designed with these users in mind. This means building products with touchscreens instead of keyboards and mice, easy-to-access navigation menus, and larger buttons and icons. These features are helpful to people with arthritis or hand tremors or those who have trouble seeing.

"The key is that we want to make [technology] accessible," said David Dring, executive director of Selfhelp Innovations at Selfhelp Community Services, a non-profit based in New York that offers comprehensive home health care and support for low-income seniors. Non-intuitive or intimidating technology tends to "collect dust," Dring says. "All-in-one, touchscreen devices have taken a huge step forward in technology," he adds, enabling seniors to move away from learning how to type and use a mouse and, instead, directly connecting them to a device's interface.

Selfhelp's tablet-based Virtual Senior Center connects home-bound seniors with each other and gives them a portal into a series of educational classes and activities throughout the week. The program, which is supported in part by the CEA Foundation, is in the process of expanding beyond New York City to Chicago, San Diego and Washington, D.C., and hopes to have between 250 and 300 systems installed in seniors' homes by the end of 2013. Research shows that people who are less socially isolated consume fewer acute care services, Dring says. Selfhelp is developing a pilot program with the state of New

York to quantify the benefits of aging in place as it relates to Medicare claims.

Remote Monitoring and Health Maintenance

Remote monitoring technologies allow doctors to monitor chronic conditions with more regularity, give seniors who want to age in place more independence, and offer loved ones and caregivers peace of mind. GBI Research expects the U.S. market for remote patient monitoring to expand from $104.5 million in 2012, to $296.5 million in 2019. These products and services wirelessly capture and analyze data collected by motion sensors and/or AV devices. Motion detectors placed throughout a home can alert care givers when someone hasn't gotten out of bed or if his movement around the house is abnormal. Motion sensors can also be synced with lighting to turn on hallway lights to prevent falls and other injuries if someone gets out of bed at night. Sensors can also monitor the frequency with which someone gets up during the night, which can be a sign of other ailments, such as a urinary tract infection or diabetes. Tracking daily in home activity can even indicate depression or serious physical illness. For example, a person moving around the house in an erratic way might be showing signs of dementia. It could also be a sign that a patient isn't taking her prescribed medications properly.

Some remote monitoring products combine software and hardware to track and transmit multiple data points and virtually connect people with doctors and loved ones. The GrandCare System, for example, incorporates daily living monitoring with health data capture technologies, socialization tools, video chat capabilities, entertainment features and medication management tools. "We're a platform that interacts with and engages with a ton of different technologies and different sensors," explains Laura Mitchell, vice president for business development at GrandCare. The system is designed to be fully customizable and very easy to use. "The system is as intuitive as an ATM or a microwave. It's very simple," Mitchell says.

Video technology is also opening up new avenues for testing vital signs and connecting patients to their health care providers. Philips' Vital Signs Camera App, for example, measures heart rate and breathing based on the changes in color in a person's face and the motion of his chest, using a mobile device's camera. Other services create intermediary points between doctors' offices or hospitals and people's homes. The HealthSpot Station, a pod-like kiosk that can be installed in clinics and drug stores, links patients to doctors via high-definition videoconferencing. Each kiosk contains a two-way HD video screen, a scale, and a series of interactive medical devices that can be remotely unlocked by doctors. In a 2013 interview with *i3*, HealthSpot CEO Steve Cashman said the company is looking to add new technologies like ultrasound and other services that can scan patients' eyes for signs of heart disease and diabetes.

Audio tracking is useful in home health technology, too. Patients suffering from emphysema or chronic bronchitis can use in-home sound sensors to track their nighttime coughing. "If you count their number of coughs at night, it turns out to be a very predictive event for identifying clinical deterioration," says Dr. Brian Rosenfeld, who adds that pairing cough counts with other parameters, like activity levels can help doctors determine when early intervention is needed.

Remote monitoring technologies could save the U.S. health care system $197 billion between 2010 and 2035, according to a Brookings Institute analysis by economist Robert Litan.

AV tools can also be used to track facial recognition patterns that will help doctors identify depression, especially for post-stroke patients who are rehabbing at home. "A combination of a certain facial look along with a tone of speaking can be helpful in making diagnoses," Rosenfeld says. "By enabling me to see certain movements and capture those for your electronic medical record, we can track your progress much more accurately and more effectively or appropriately than the two-page note in your record from when you last came into the clinic."

Remote monitoring technologies could save the U.S. health care system $197 billion between 2010 and 2035, according to a Brookings Institute analysis by economist Robert Litan, who adds that remote monitoring helps doctors spot health problems sooner, reduces hospitalization, improves life quality and saves money. "When treatment becomes less episodic and more continuously available, a holistic view of patient health becomes possible. This continuous treatment gives doctors vastly improved information from which to formulate recommendations," Litan writes. "Earlier detection of problems becomes possible, allowing for more aggressive treatment and reduced chance of disability." Looking ahead, Rosenfeld and his team at Philips are exploring new ways to collect, track and analyze data taken from patients in their homes – both physiological data and motion sensing information – in hopes of treating patients more proactively.

Patient Adherence

Perhaps the biggest obstacle to the success of consumer-oriented home health technology is getting patients on board and making sure they stick with their tracking and monitoring routines. Historically, doctors have applied a "one-size-fits-all" approach to home care, says Rosenfeld. Home monitoring plans must be tailored to individual patients based on how sick the patient is, how much data the doctor needs and the patient's personality, in order to be successful. "It's like the wild west when people go home," he says, explaining that many patients eventually stop self-tracking data at home the way they were tracked in the hospital.

Researchers are looking at ways to get patients to adhere to in home treatment and monitoring routines. Some have tried gamification tactics to make people stick with telehealth programs. But Majd Alwan, senior vice president of technology for health care non-profit LeadingAge, and executive director of the Center for Aging Services Technologies, says the best way to affect behavior change is through education and reinforcement, especially during teachable moments, like when a patient takes a measurement and the result is outside of the normal range.

"The more data [that's collected], the more opportunities there are for teachable moments and for engraining self-management skills," Alwan says. "Also, the more data, the more opportunities there are for early intervention." Biometric data, like weight and blood pressure, combined with medication management and lifestyle data including diet and exercise, can help doctors quickly and effectively adjust medication dosages before chronic ailments spiral out of control. "Without data capture and technology in the home, these kinds of things can go undetected for a long time," he says, since most patients typically see their primary care doctors once a year.

"Patient engagement and adherence are in many respects the keys."- Brian Rosenfeld

"Patient engagement and adherence are in many respects the keys," adds Rosenfeld. "If we can get patients to care for themselves or their loved ones to care for them, we're going to be much more successful."

FDA Approval for Medical Apps on the Horizon

Security and product reliability/accountability are issues that several federal agencies, including the Food and Drug Administration, the Office of the National Coordinator for Health Information Technology (ONC), and the Federal Communications Commission (FCC) are looking into as they explore how best to regulate health IT to protect patients while fostering innovation. The FDA has broken health apps into two categories – those that help consumers track healthy lifestyles, and those that turn a smartphone or tablet into a medical device, like a blood pressure monitor or EKG transmitter. The latter category is facing increasing scrutiny from the FDA and other agencies that want to make sure that these apps work as advertised.

In 2011, the FDA began looking at mobile apps that might also meet the definition of a medical device, and is expected to release more detailed medical app guidance by the end of 2013. In a hearing on Capitol Hill in March 2013, the FDA's Director of the Office of Device Evaluation Christy Foreman acknowledged that "the widespread adoption and use of mobile technologies is opening new and innovative ways to improve health and health care delivery" and added that the agency's regulatory approach would be "narrowly tailored" to apps that meet the definition of a medical device. "Focusing FDA oversight on a narrow subset of mobile apps will encourage the development of new products while providing appropriate patient protection," she says, adding that smartphones and tablets, mobile operating systems and app stores will not be regulated by the FDA.

Ahead of the FDA's guidelines, the agency made headlines in the spring of 2013 when it sent a public letter to Biosense Technologies, asking the company to provide evidence that its UChek mobile app was compliant with the Federal Food, Drug, and Cosmetic Act's definition of a medical device. The UChek app lets people with diabetes monitor glucose and protein levels through urinalysis, using the same technology that already is in use by FDA-regulated companies like Siemens and Bayer. "Since your app allows a mobile phone to analyze the dipsticks, the phone and device as a whole functions as an automated strip reader," the letter said.

GrandCare's Laura Mitchell says it makes sense for the FDA to get involved with software in the same way they get involved with hardware, to make sure these services work properly. GrandCare is in the final stages of securing FDA approval for its aging-in-place system. "We had to prove that our software is actually accurately reading those devices," Mitchell says. "Does it stop innovation? A little bit, definitely, but it's also sort of a necessary evil because we're dealing with someone's health and wellness. It makes sure that we're giving them the right information and sound advice."

Biosense, meanwhile, is in the process of developing its next-generation Uchek device, Uchek Universal, which will monitor 14 health parameters, including calcium creatinine, pH, and ascorbic acid. The company has turned to Indiegogo to crowdsource funding for its new device and for the application for FDA 510k clearance.

Implications of the Affordable Care Act

The Patient Protection and Affordable Care Act, slated to go into full effect in 2014, will shift health care outcomes from a volume-based model to a value-based model. Under this system, health information technology that creates efficiencies in care could play an increasingly valuable role in consumer care. "The Affordable Care Act is starting to pave the way for these kinds of technologies with the shift away from 'pay-for-service' to 'pay-for-performance,'" Alwan explains. "Tying outcomes and quality measurements to incentives is going to help in making the case for the adoption of these types of technologies."

The integration of digital health technologies by health care providers can improve the quality of care and quality of life. Patients can receive better, more timely care, and advancements in data mining and analytics will enable doctors and patients to optimize care plans that are both proactive and preventative.

While initial investment costs in these new technologies may increase out-of-pocket costs for patients and doctors at the outset, the long term benefits are clear. Digital health technologies have proven to keep people healthier and happier and in their homes longer. These technologies also help health care providers identify earlier when patients need care, enabling doctors to treat patients through small changes – like adjusting their medications – before more serious health consequences occur.

Home: New Hub for Health Care

The next generation of health care technology promises even more wireless connectivity, enabling patients to share their complete medical histories and detailed biometric data with their health care providers, and allowing caretakers to stay in touch with patients and on top of their health needs around the clock.

Ultimately, digital health technologies have the potential to drive down the costs associated with health care, offering new aging in place solutions for seniors and those with chronic health conditions, and benefiting quality of life care. The key to the success of these technologies is in the hands of consumers, who must be willing to make the life changes needed to successfully self-monitor and feel comfortable sharing this information with their health care providers. As concerns about data security and privacy are addressed, the positive impact that health technologies can have on consumers' wellbeing and longevity will shine though, and living rooms may begin to rival doctors' offices as a first choice for quality health care and treatment. ■

FCC	Federal Communications Commission
FDA	Food and Drug Administration
ONC	Office of the National Coordinator for Health Information Technology

Can't miss **Conferences and TechZones** at the 2014 International CES:

- Digital Health Summit produced by Living in Digital Times.
- Digital Health Summit TechZone, highlighting the intersection of technology, health and wellness. Located in the Las Vegas Convention Center, South Hall 2.

Less Invasive Monitoring

San Francisco startup Lively is exploring ways to keep tabs on seniors in a way that's less obtrusive than wearable devices. The company has developed motion sensors that can be attached to objects, like keys, bathroom doors, even pillboxes, rather than to people. These sensors transmit data back to the Lively hub, which is equipped with a built-in cellular connection that transmits the data to the cloud (no Wi-Fi needed), where it can be accessed by caretakers and loved ones online or through a mobile app. The Lively system is slated to launch in 2013.

Health and Fitness Technology Working Group Overview

CEA's Health and Fitness Technology Working Group explores the area of the industry where health and fitness technology meets consumer electronics. Through CEA's expertise in market research, government affairs, media outreach and the International CES, the working group is able to advance its goal of increasing consumer awareness of health and fitness electronics. The group is open to all CEA members interested in shaping the future of the consumer electronics, health and fitness industries.

TECHNOLOGY **TRENDS** TO WATCH **2014** 5

Robots Ahead

By Richard Kowalski

Science fiction's leading robots, like *Star Wars'* C3PO, *Short Circuit*'s Johnny V and *Star Trek*'s Data are inspiring researchers to consider an intriguing question: can we reverse engineer the human body and brain and build something similar? While robots are not yet as human-like as those found in books, television and film, engineers are making incredible progress toward creating machines that mimic human intelligence and capabilities.

The robots of fiction are fine examples, but the field of robotics is much broader in scope. A robot is defined as any mechanical device that can detect its environment, make decisions based on sensory information and execute a physical operation as a result of its decision. In other words, robots are machines that logically and physically respond to environmental variables. That said the intelligence levels and physical appearance of robots can vary greatly.

The first real robots were not human-like at all. They performed very basic tasks. Many consisted of one "arm" that repeatedly moved objects from one place to another. Gradually, robots took on more tasks, such as assembly and welding, but they remained confined to industrial applications and had very specific skills.

Industrial robots today are highly versatile, but they are a far cry from the popular expectation that a robot must look, talk, think and move like a human. Despite this, robots are also making inroads in consumer households. Like their industrial counterparts, many of these consumer robots will perform specific, dedicated tasks. But as the costs of components fall, and software capabilities increase, robots in the home will become more intelligent, versatile and personable. Recent developments by researchers are providing a glimpse of how our robotic future will look.

How to Build a Robot

Building a robot requires several technologies:

Sensors: A robot must be able to detect its surroundings. This is done through a variety of sensors. Visual sensors such as cameras allow robots to navigate their environment and to identify objects. Many sensors take the form of microelectromechanical systems (MEMS), electronic components that can measure and process physical data. Some of the most popular types of MEMS are accelerometers, gyroscopes, microphones, and pressure sensors (tactile sensors). (Learn more about the amazing world of MEMS technologies in "A Hundred Billion Nodes.")

Mechanics: Robots must be able to move around and interact with their surroundings. Engineers have to consider the range of motion, reaction time and movements needed to complete specific tasks. Different methods of locomotion can be used; bipedal robots are impressive, but wheels, continuous tracks (like a tank), and devices with more than two legs are also possible. Researchers have even implemented snake-like slithering as a way for some robots to get around.

Computer/Software: Software operates as the "brains" of the robot. It analyzes sensory data and initiates mechanical procedures in response. Further, software will handle any artificial intelligence operations such as natural language processing and learning. A number of open source software packages are available to developers for programming robots.

Power Source: Like all computing devices, robots need an energy source, most likely in the form of a battery.

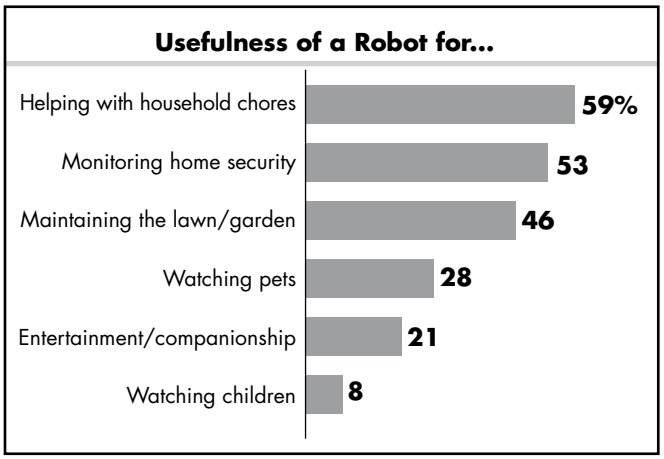
What Can a Robot do for You?

If you assemble these technologies together in the right way, you will have a robot that you can put to work. But what do you want it to do?

Consumer robots have the potential to do the things most people don't want to do. Professional robots have excelled at this: they perform dangerous and repetitive factory work, defuse bombs, work with radioactive materials, and photograph lions up close, to name a few examples. Robots in the household will have much less hazardous chores, but will relieve humans from tasks that are difficult to get excited about.

According to a CEA survey, 59 percent of respondents said a robot would be useful for household chores; 53 percent saw a need for one to monitor home security; and 46 percent

found maintaining the lawn or garden would be helpful. One in five respondents (21 percent) expressed an interest in the entertainment and companionship elements a robot could provide. And when it came to taking care of the house when the owners could not be at home, 28 percent said they were interested in having a robot care for pets, while eight percent said having a robot watch the children would be appropriate.



Source: CEA Survey, July 2013

The trends noted in CEA's survey highlight a few major opportunities for manufacturers. The most useful consumer robots will do at least one of the following:

- Save the owner time
- Perform a task in the owner's absence
- Perform a task that the owner does not want to do
- Perform a task that the owner is incapable of doing
- Entertain in some way

Today, manufacturers are beginning to find ways to meet these needs, opening up a growing market. According to ABI Research, the market for consumer robots was $1.6 billion in 2012, and they predict that it will grow to $6.5 billion by 2017. The International Federation of Robotics (IFR) said that by 2015, global sales of task robots such as vacuum cleaners and lawn mowers will reach 11 million units and $4.8 billion in sales. Meanwhile, the firm forecast that entertainment and leisure robots will reach 4.7 million units and $1.1 billion in sales.

Robots Among Us

Consumer adoption of robots in the home is still in its early phase, but a number of devices are available now. iRobot is one of the most popular names in consumer robotics. The company has sold more than nine million home robots worldwide and is known best for the Roomba, its vacuum cleaner robot. The Roomba has appeared on multiple television programs, and on YouTube is probably best known for its alternative use as cat transportation. But as far as robotics goes, the Roomba is remarkable for its ability to learn the floor plan of your house and to know when it has vacuumed every square inch of it. It also knows when to head back to its charging station for a battery boost.

Home cleaning robots are not limited to just horizontal surfaces. The ECOVACS WINBOT 7 is a window cleaning robot that debuted at the 2013 International CES. The WINBOT 7 detects the size of the pane of glass to map its cleaning path. It has enough suction to keep itself on the glass as it cleans windows, indoors or outdoors and even cleans shower stalls.

Robotic lawn mowers are also gaining traction. The Husqvarna Automower can mow up to three-quarters of an acre and handle uneven terrain. John Deere's Tango E5 and the Honda Miimo also tackle this time-consuming landscaping chore. These autonomous mowers have built-in safety features that help them avoid obstacles, and have anti-theft alarms and PIN codes that deter would-be thieves.

For the 21 percent of consumers who look to robots more for entertainment and companionship, Innvo Labs offers the PLEO. These dinosaur bots are reminiscent of Tamagachi pets because they require daily care. If a PLEO gets hungry, don't fret; just give it its feeding leaf. Like pets, they can be trained to follow commands and to perform tricks.

LEGO's Mindstorms NXT robots are robotic toys for older kids (or the young at heart adult). Mindstorms robots are constructed with custom LEGO bricks and controlled with a special "Intelligent Brick" that acts as a programmable brain for the robot. The latest Mindstorms EV3 incorporates three sensors and is controlled via smartphone.

There also are robots now in classrooms. Teachers are using VEX, NAO and Botball robots for hands-on education in the STEM fields (science, technology, engineering and math). The gaming- and competition-based curricula associated with these educational robots makes learning fun, and might inspire these young engineers to design future innovative robots.

Robots to Come

There are some robot features that we'll see in the near future, and others that may take several years to diffuse into the world of consumer robots.

Addressing consumer's desire for home security, ECOVACS is working on a home monitoring robot called the Famibot. The Famibot is a round cylindrical robot that stands about a foot tall and wheels itself throughout your home. While you're away, it can alert you if it detects smoke or discovers that someone has broken into the home and can monitor the on/off status of household appliances and lighting. Famibot also includes an air-purification system and a music player.

FoldiMate takes the next logical step in automated laundry by folding your clothes for you. Although the company has initially aimed its efforts toward the clothes retailing and laundry service industries, the company plans to enter homes in the future. The robot requires a human to feed it clothing items, but it excels at folding them. Moving a step further, researchers at Berkeley have designed a robot that can pull clothing out of a pile of laundry and fold it using two arms as a human would. Right now, the robot is quite slow, but researchers are better understanding the logical processes involved in efficiently completing this task.

According to ABI Research, the market for consumer robots was $1.6 billion in 2012, and they predict that it will grow to $6.5 billion by 2017.

The Japanese government is looking to robotics to help with elder care. Japan has an aging population and the government is concerned soon there will not be enough nursing staff to care for the elderly. The idea is not to replace nurses, but to offload some of the more physically demanding work. The government is investing 2.39 billion yen toward the development of robots to help nurses lift and move people from room to room, robots that can help patients walk on their own, and mobile self-cleaning bedside toilets. (Read more about health technology for seniors in "Consumer Digital Health Care.")

While these examples have highlighted robots taking on tasks that would be done by humans, there is ample room for robots to do tasks that we haven't even thought of yet. Take for example the tick killing robot. A group of engineers in Virginia wondered if there was a way to train a robot to protect people from getting bitten by ticks, which can carry Lyme disease. The engineers equipped a robot with a carbon dioxide emitting element to attract the ticks, and added a pesticide-laden cloth to kill them. Trial runs were very successful. The engineers envision exterminator companies using the robot to clear yards and hiking trails of these disease-carrying pests. The main benefit of this robot is that instead of blanketing an area with pesticide, the poison is confined to one place, which helps reduce pollution.

Not all robots in the pipeline deal with serious and arduous tasks. Some will entertain us. The Anki Drive, presented by Anki CEO Boris Sofman at the 2013 Apple Worldwide Developers Conference, is a small, iOS-controlled racecar toy with brains. The racecar contains artificial intelligence (AI) which makes driving decisions similar to those a human would make: it speeds up and slows down, passes other cars, and stays on the road. A human can only intervene by giving a particular car a mission – and that's where the fun comes in. When multiple cars with different missions are on the same track, watching the AI interactions is very entertaining.

Humanoid Robots

Why should robots mimic humans? They don't need to have human capabilities to perform many of the duties that we would like them to. But many tasks are complex enough to require human dexterity and intelligence. As robots gain more capabilities, they will become more useful at home and to society as a whole.

Consumer robots may soon incorporate features that professional humanoid robots use today. Baxter, the "collaborative manufacturing robot" by Rethink Robotics is notable for its learning capacity. Baxter can learn tasks on-the-fly, without needing its code edited by a programmer. A person can teach Baxter a new task by simply moving his arms and hands to mimic a process. Such a feature in domestic robots would make them trainable and adaptable to many households.

Honda's ASIMO (Advanced Step in Innovative MObility) is perhaps one of the best known humanoid robots. In 1986, ASIMO started as a study in human locomotion, focusing primarily on reproducing the movements of human legs and feet. By the mid-nineties, ASIMO took its more human form, adding arms, a torso and a head. However, the robot required a human to steer it with a remote control. The latest version of ASIMO, revealed in 2011, is the first autonomous version. It can walk on its own and recognize faces and voices. Its hands include pressure sensors so it can handle objects of varying fragility. For instance, it can pour water from a solid container into a paper cup without crushing the cup. A robot that can handle materials of varying shapes and delicacy would be very useful in a home, perhaps one day serving as a butler.

NAO, designed by Aldebaran Robotics, is an impressive humanoid robot that can see, hear, speak, feel and communicate. Researchers at more than 550 universities worldwide are using NAO's flexible software to learn more about the possibilities in human-machine interaction. Standing at just 58 centimeters, it is easy to write off NAO as a toy at first glance. But demonstrations show that NAO has a personality, and researchers are using it to tackle some big issues. The ASK NAO (Autism Solution for Kids) was started when Aldebaran noticed that children with autism would socially interact with NAO in a way that they would not normally interact with people. NAO is helping to open up a communication channel that teachers and parents of autistic children didn't have before, using games and vocal interaction to teach them social skills.

The Philip K. Dick (PKD) android, produced by Hanson Robotics and modeled after the late science fiction author, demonstrates significant progress in the human-robot interaction. Besides its physical resemblance to the author, the robot also uses realistic facial expressions as it talks. The PKD android uses text from the author's works and his life history as a basis for generating conversational content. The company hopes that

the PKD android evolves "super-human creativity and wisdom and transcends in a spiral of self-reinventing super-intelligence – what Philip K. Dick precognisciently described as a Vast Active Living Intelligence System, and what Vernor Vinge describes as the Technological Singularity." Put in simpler terms, Hanson Robotics would like PKD to have a mind of its own.

The striking thing about the efforts to design humanoid robots is the high-caliber engineering and problem solving involved. Our brains carry out many processes without our need to conscientiously think about them. Yet many of these processes – like walking or using our hands – have taken engineers decades to reproduce. It certainly gives one an appreciation for the complexity of the human body and mind.

Challenges

Societal perceptions, legal implications and technological limitations are major challenges that robots will face in the future.

Until recently, society's perception of robots has been shaped by books, film and television. The stereotypical portrayal of the humanoid robot in fiction has had some negative effects on society's views. The robot apocalypse in the *Terminator* movies has spawned a fear of machines-gone-wild. An easy counterexample is Data from *Star Trek* – an android with super-human intelligence. But positive portrayals such as Data have set high expectations in the public eye, which lead to disappointment that we don't yet have humanoid robots that do it all.

This type of technology could drastically improve the lives of amputees.

Ever since robots entered factories, the perception that robots steal jobs has been prevalent. While this remains a concern with industrial robots as unemployment remains relatively high, robots for the home will probably not receive as much scrutiny since they free up leisure time for their owners and perform unwanted household tasks.

Autonomous devices will eventually spark debate in the courtroom. If a robot harms someone while performing a programmed process, where does the liability fall? The manufacturer? The owner? Patients of failed robotic surgeries are now bringing doctors to court. Surgical robots are not autonomous; they are under the control of a surgeon. But the fact that robots are being used in situations where human well-being is at stake makes them a target for legal challenges. Driverless cars, which are traveling on American roads, are now making autonomous driving decisions. These cars already face legal roadblocks (pun intended) in being allowed on public streets in some states. If a driverless car is involved in a major accident, how would a judge rule? This is new territory that society will have to traverse in the years ahead. (Read more about driverless cars in "On the Road to Driverless Cars.")

Until now, technology has been a limitation in advancing the market for affordable and practical consumer robots. Sensors and processors were neither small nor efficient enough to put in an autonomous machine. The mechanics of motion (especially mimicking human locomotion) have been a challenge. But researchers have made impressive gains in this area, as Honda's ASIMO has shown. An emerging challenge into developing interactive robots is the realm of artificial intelligence, especially in the form of natural language processing. To become more personable, robots will need to understand voice commands and to communicate on a basic level. Apple's Siri personal assistant has shown what is achievable in vocal communications between people and their devices, but it has also shown us some of the areas that need improvement.

Robotic Ripples

The efforts that have gone into making high-functioning robots may seem frivolous, as engineers have been trying to recreate human capabilities for years now, with what appears to be little progress at first glance. But much like NASA's efforts spun off many technologies that found their way into American households, robotics research has given birth to technologies that could improve the lives of many people. Here are a few examples:

Researchers at Johns Hopkins University used mechanical technologies derived from reproducing the functionality of a human arm to create a bionic arm called the Modular Prosthetic Limb (MPL). The limb uses 100 sensors, 26 joints, 17 motors, and is controlled by the nerve impulses of the person wearing it. This type of technology could drastically improve the lives of amputees.

Meanwhile, developments such as Honda's robotic legs have inspired the Ekso Bionics Ekso, which is a wearable bionic suit that makes walking easier for people with paralysis, multiple sclerosis and Parkinson's disease. The suit uses sensors to detect the wearer's intentions and reinforces walking and standing. Ekso could offer a more liberating experience for those dependent on wheelchairs to get around.

Developments in artificial intelligence have led to some incredibly smart computers. IBM's Watson, famous for defeating Ken Jennings on the television show *Jeopardy!,* is one of the finest examples of computer intelligence. Today, Watson is being put to use in healthcare, helping physicians diagnose and treat patients by sifting through mountains of medical

literature and identifying the best paths to patient recovery. Robotics technology combined with Internet access has led to the development of telepresence robots. Double Robotics demonstrated the Double at the 2013 International CES. The two-wheeled self-balancing iPad stand can be your eyes and ears at a distance by using the iPad's Web camera. You can control the movement of the Double with any iOS device as long as you are using the Internet. Robots such as Double open up new opportunities for people to explore the world, but on a more practical level, they can also reduce the costs associated with air travel.

Coming Soon

Are there robots in your future? If there are chores around the house that you would rather not do, the answer to this question is probably 'yes.' But there are many other opportunities for robots to take a role in your life, as demonstrated by the technologies that are being developed right now. In the near term, the first robots in homes will be dedicated to one or two tasks. But watch for robots to become more sophisticated in the years to come.

In the not too distant future, robots in the home will be common. You will have more free time as they do daily chores and may even have a pleasant conversation with one. And, to paraphrase Ken Jennings when he was defeated by Watson, you may welcome your new robot overlords. ■

AI	Artificial Intelligence
ASIMO	Advanced Step in Innovative Mobility
ASK	Autism Solution for Kids
IFR	International Federation of Robotics
MEMS	Microelectromechanical Systems
MPL	Modular Prosthetic Limb
PKD	Hanson Robotics' Philip K. Dick Android
STEM	Science, Technology, Engineering and Math

Can't miss **Conferences and TechZones** at the 2014 International CES:

- Robotics Conference produced by *CE Pro*.
- Robotics TechZone, featuring robotics and intelligent systems applications. Located in the Las Vegas Convention Center, South Hall 1.

Keep up to date on robotics news

- *IEEE Spectrum: Robotics News* – Follow daily news on exciting discoveries in the world of robotics.
- Robocup – This annual competition challenges autonomous robots on their physical and cooperative abilities in a game of soccer.
- DARPA Robotics Challenge – The U.S. government is seeking robots that can operate in rugged terrain and in hazardous conditions.
- FIRST (For Inspiration and Recognition of Science and Technology) – This annual robotics competition shows students that science, technology and problem solving lead to successful careers.

TECHNOLOGY **TRENDS** TO WATCH **2014** **5**

The Curators of New Video

By Mark Chisholm

Over the last half century, consumers have gained a growing amount of control over the video content they consume and how they consume it. With the introduction of the Sony Betamax videocassette recorder in 1975, an entire new industry of home entertainment was born. Years later, when Jim Barton and Michael Ramsay presented their vision of a digital video recorder at the 1999 International CES® and later introduced TiVo, consumers' ability to time-shift content further evolved to include the ability not only to schedule and record their entertainment, but also to pause live broadcast television.

Today, due to the proliferation of broadband, wireless data transmission and devices like smartphones and tablets – consumers have become their own curators of content. The concept of "content curation" deals with the discovery, sorting and presentation of relevant or desired content. Thanks to a number of tools and services at their disposal, consumers are now empowered to handpick their entertainment from multiple sources. The age of video content is defined by new distribution schemes from new sources, delivered to new devices. With such a vast pool of video content, the most exciting area to watch will be how these silos of content are brought together to form a seamless, navigable ocean of content.

Source Progression

Just as the mediums by which consumers received their content shifted with the introduction of home video with Betamax, the progression of technology services and devices have altered the content landscape. In the mid-nineties, the 'Big Three' broadcast networks began to be threatened by cable networks. Similarly, traditional pay-TV services such as cable or satellite have seen new challengers entering the ring thanks to IP-based video content and new video-capable mobile devices that display untethered video from the living room television.

These challengers, whether paid services such as Netflix or Hulu Plus or free, ad-based services, are seizing the opportunity created by broadband Internet connections to offer alternatives to traditional business models. In much the same way that Apple's iTunes filled a void in the music industry by giving listeners a way to legally purchase music in a digital format, emerging video delivery options hope to make use of consumers' high-speed connections to deliver video content. While the original iPod® was the device that sparked consumer interest in digital audio, devices ranging from different size tablets and form factors to Internet-connected televisions are pushing Internet video forward.

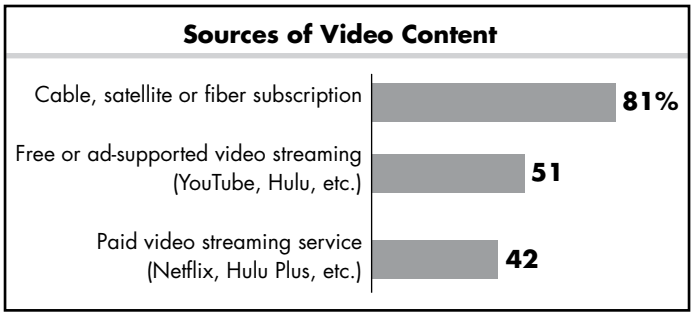
The lure of offering consumers a way to access video content instantly became evident with the last generation of gaming consoles. Realizing that many households had an Internet-connected device linked to their TVs, Microsoft, Nintendo and Sony all moved quickly to add console-based access to services such as Hulu, Netflix and Vudu as well as create their own digital storefronts where users could purchase or rent video content.

As content delivery methods evolve, so too does the list of content producers. Content is being produced by new sources as well as entities that previously focused on content distribution that are now testing the waters. Netflix made a splash in early 2013 with the debut of several original series, including *House of Cards* and *Orange is the New Black*. With its roots in delivering video entertainment to users – whether via mail or streaming video – Netflix made the jump to content creation. Who might be next? Will video game console manufacturers, after filling the distribution role, decide to jump in? A look at recent industry chatter suggests that they will.

When revealing the next generation Xbox One gaming console, Microsoft announced that its popular *Halo* franchise will be adapted into a live action television series, with Steven Spielberg serving as executive producer. It's not clear if the new series will be exclusive to the Xbox One or the Xbox Live online service, but it's safe to assume it will be available there. As the next generation of gaming consoles looms, related online services are poised to produce significant revenue streams for their respective owners, and they will fiercely compete based on value. PlayStation Plus – Sony's paid tier of service – is forecast by research firm IHS Electronics and Media to generate $1.2 billion per year. If Microsoft begins to offer exclusive original content through Xbox Live, a safe bet would be that Sony will respond.

Despite the growing sources of content, "conventional" methods of video delivery remain the most common with consumers.

In a recent CEA survey, programming delivered via a service provider such as cable, satellite or fiber to the home was the most common choice among respondents when asked where their video came from – with 81 percent indicating that they relied on such offerings. However, the popularity of new methods is clear – 51 percent of respondents said they watched content via free or ad-supported video streaming services such as YouTube, Hulu or network sites and 42 percent said they watched content from paid video streaming services such as Netflix or Hulu Plus.

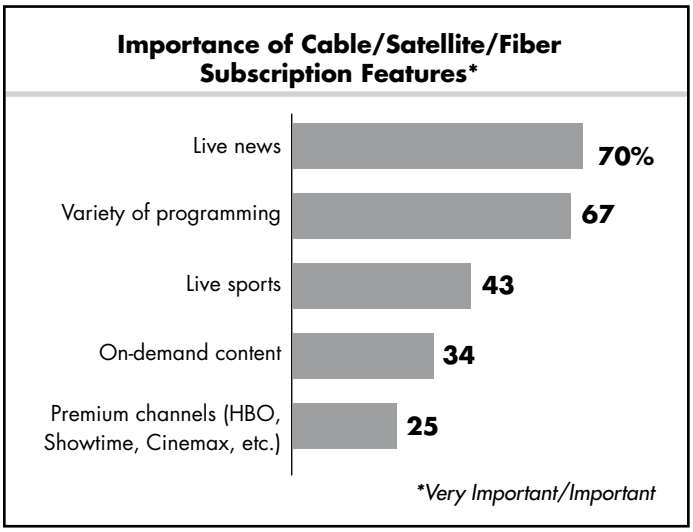


Source: CEA Survey, July 2013

It's clear that Consumers are taking advantage of these new services to supplement their traditional viewing, whether it's accessing content while away from home or via a mobile device such as a smartphone or tablet, watching videos on-demand at their own leisure or taking advantage of new recommendation and discovery schemes. Could these new sources replace conventional methods of video delivery?

In July's *U.S. Household Television Usage Update*, CEA found that only seven percent of U.S. TV households that currently subscribe to a traditional pay-TV service indicate they are likely to cancel these paid TV subscriptions in the next 12 months. However, the report found that households that receive programming from traditional providers have fallen to 83 percent from 88 percent in 2010. The concept of 'cord cutting' – where subscribers ditch their pay-TV subscriptions, replacing them with entertainment provided by other sources – has been gaining attention as home media servers, set-top boxes (STBs) and cheaper subscription services emerge.

What are the factors that are keeping viewers from abandoning traditional subscription models for a selection of new sources, whether free or paid? Interestingly, despite the growing options presented by the Internet, CEA's survey asked which features of pay-TV services were most important to viewers and found that live news programming took the top spot among respondents with 70 percent describing it as very important or important. Live news was followed by the 'variety of programs or channels' and 'live sports' with 67 and 43 percent of respondents saying these features were important respectively. Several major sports leagues offer package deals that can be purchased separately, allowing viewers to get their sports fix on a PC or through an app on a mobile device, gaming console or other display. However, many sports packages are subject to blackout policies where certain games become unavailable in specific regions because priority is given to local broadcasters. At what point does the geographical ambiguity of the Internet and IP-delivered video begin to erode these roadblocks to cord-cutting?



Source: CEA Survey, July 2013

Consumers' satisfaction with the variety of content offered by traditional pay-TV services, however, might not be the anchor it once was. With a mixture of services, possibly combined with the purchase of a STB or an Internet-connected TV, viewers can approach the same level of content volume and variety available via traditional methods.

However, as content sources multiply, each becomes a silo of video content separated by such factors as compatible devices, the types of content offered, or location-based accessibility. One source may function through an app on a tablet or smartphone, but not directly on a living room's television screen. Another source may be nearly ubiquitous but may not offer the desired content or correct format. The challenge will be to integrate these services and present consumers with their desired content without forcing users to reconcile the lines drawn between applications, sources or devices – all while keeping an eye on the horizon for the next wave of formats and services.

Device Progression

Device ownership is another factor in the shifting tide of video sources. Many of the benefits of new devices – most notably mobile devices and STBs – are being included into traditional video delivery methods.

According to CEA's *Consumer Outlook on Tablets* quarterly report, more than three in five (62 percent) of online U.S. adults own a smartphone and two in five (40 percent) own a tablet. While video consumption is not the number one use for these devices – 60 percent of those purchasing a tablet anticipate watching videos on their device compared to 43 percent of those buying a smartphone – their connectivity offers

consumers access to video services such as Netflix and Hulu. Amazon's Kindle Fire tablet, for example, becomes a powerful media consumption device when coupled with an Amazon Prime Instant Video subscription. An emerging category of smartphones – dubbed 'phablets' – feature larger screen sizes and should make smartphones even more appealing for video consumption. In August, Samsung announced the 6.3-inch Galaxy Mega, a smartphone with a screen that is less than an inch smaller than the iPad Mini, Kindle Fire, Nexus 7 and other seven-inch tablets.

These ownership and usage trends haven't gone unnoticed by cable and satellite TV providers, who have made efforts to extend their content onto mobile devices. Mobile apps from service providers, such as the XFINITY TV app from Comcast and Time Warner Cable's TWC TV app allow subscribers to watch on-demand video on smartphones and tablets, but often stop short of streaming live programming to these devices (TWC's app allows for streaming of more than 300 channels of live TV).

Internet connectivity and IP-based video are one of the most touted and valuable features of the seventh generation of gaming consoles.

Some providers, however, are looking to go one step further. Third-party devices such as Sling Media's Slingbox and TiVo's recently-announced Roamio hook into a customer's subscription service and allow video content to be streamed to mobile devices. By incorporating such technology, service providers may increase the relevance of traditional pay-TV subscriptions in a mobile world. The Hopper from DISH, winner of Best of Show at the 2013 International CES, incorporates Sling Media's streaming technology into a DVR to allow subscribers to watch live and recorded programming on mobile devices. Keep in mind, however, that such streaming options once again create their own private silos tied to their individual mobile apps.

In addition to bringing traditional television programming to mobile devices via Internet connectivity, the equation of new content also includes bringing IP-based video to traditional TV sets. New innovative devices open up the living room to the stream of IP-based video sources. While Internet connectivity has been an available feature on HDTVs for many years, CEA estimates that just 15 percent of all U.S. households owned an Internet-enabled TV as of January 2013, according to the *U.S. Household Television Usage Update* report. However, 28 percent of U.S. TV households report receiving television programming on their TVs via the Internet. Since a new HDTV set is a major purchase decision for many households, many new devices have entered the market to bring connectivity to living rooms that don't have connected TVs.

Internet connectivity and IP-based video are one of the most touted and valuable features of the seventh generation of gaming consoles. The Microsoft Xbox 360, Nintendo Wii and Sony PlayStation 3 all use their Internet connections not just for update and multiplayer capabilities, but also to supply video entertainment to the living room. Other devices offer content over-the-top (OTT), including dedicated STBs and connected dongles. Google in July announced Chromecast – a Wi-Fi-enabled dongle that plugs into a TV's HDMI port to stream audio and video content from a smartphone, tablet or a Web browser on a PC. Perhaps in recognition of the swelling amount of apps and silos present in the IP-based video ecosystem, Chromecast doesn't require its own app on a smartphone or tablet. Instead, the dongle is built to work with existing apps on mobile devices such as the official Netflix and YouTube apps, and additional apps will be supported down the line. Resisting the temptation to add yet another silo to the landscape, Chromecast benefits from the existing, fragmented sources of content and takes a step toward offering viewers a unified, simplified solution.

The industry should pay close attention to what sources will be supported in Chromecast's future. Support for such sources as HBO Go, Hulu Plus and Redbox Instant is coming, but Google has faced difficulties in this area before. Google TV, a smart TV platform co-developed by Google, Intel, Sony and Logitech, stagnated after Google TV devices were blocked from accessing content from ABC, NBC, Hulu and Viacom subsidiaries.

Microsoft may also be moving toward consolidation of video sources with the introduction of its next generation gaming console, the Xbox One. The console, equipped with a new version of Microsoft's motion- and voice-controlled Kinect, acts as a receiver for other video sources in the living room. For example, cable or satellite TV STBs can plug directly into the console, which, thanks to an HDMI pass-thru, can then be connected to a display. Upon receiving the "Xbox, watch TV" voice command, the Xbox One switches to live television without the need to change inputs on the display. Not to ignore the large installed base of the previous generation, Microsoft inked a deal with Time Warner Cable to bring more than 300 live TV channels to the Xbox 360, provided the user subscribes to cable TV service. This partnership is similar to previous agreements with Comcast and Verizon.

The Future of Content

Planning for the future of content curation requires attention to not only the evolving content sources, producers and delivery methods of the new video environment, but also to the technical progression of video content itself. The introduction of Ultra High-Definition (Ultra HD) video will require new displays as well as new delivery pipelines. In a report published in August, *Ultra High-Definition: State of the Industry*, CEA examined the existing and approaching devices and delivery options for Ultra HD, and offered a forecast for the display technology.

The move to Ultra HD has begun, and beyond the adoption of Ultra HD displays, this transition will have a ripple effect across the entire content industry. From the creation of Ultra HD content – CEA's recent report notes that "studios have deep archives of analog film and even 35mm can be sufficient to support Ultra HD resolution when digitally scanned" – to the peripheral devices that will enable such content in the living room, watch this space.

Total Ultra High-Definition TV Shipments Sales to Dealers		
	Unit Sales (Thousands)	Dollar Sales (Millions)
2012	1	$22
2013e	57	314
2014p	450	1,411

e:estimate p:projection

Source: CEA, U.S. Consumer Electronics Sales and Forecasts July 2013

While the industry waits for physical media formats like Blu-ray to build out their Ultra HD catalogues, a number of other options are emerging for higher resolution content. Upscaling, or up-conversion, will again play a part in this transitional period just as it did with DVD during the shift to HDTV. For the Ultra HD content that exists, the industry has a number of options for delivery. CEA's report notes that Ultra HD media servers have arrived from both Sony and RED, with devices from other manufacturers sure to follow. Sony's PlayStation 4, hitting the market this fall, will include support for playing Ultra HD video content.

Internet-delivered video will become even more significant as Ultra HD content becomes increasingly common. According to CEA, "Internet delivery of Ultra HD content is already feasible. Higher-end broadband service plans from U.S. Internet service providers are generally fast enough to support Ultra HD streaming delivery."

Some sources will be better positioned than others to add Ultra HD content. Internet and streaming sources require only the bandwidth and a capable display to bring Ultra HD into the home. The cable industry may require a bit more attention. "There is a great deal of studio and distribution hardware that will have to be changed out," the CEA report notes. "This includes monitors, graphic overlays, satellite links, cameras, control rooms and switchers. These upgrades may coincide with upgrading from an existing real-time circuit switching infrastructure to an all-IP infrastructure."

A Guide to New Video's Port

The relevance of cable TV infrastructure to the curation of content might not be immediately clear. As we wait for traditional video distribution to step up to the Ultra HD plate, however, we're left with more fragmentation in the video entertainment world. As it stands, consumers are the curators of content, regardless of whether they are best suited for this role. With a seemingly ever-expanding horizon of sources, devices and formats, however, the experience of new video might be better served with a tour guide.

In an ideal future, a consumer can sit on the couch and enjoy a film without having a clue where it comes from. It may be served from a streaming video service such as Netflix, or their cable provider, or recorded on their streaming DVR or requested on demand. More, that video will able to be paused and picked back up again on a mobile device while the viewer sits in the waiting room at the doctor's office. Viewers don't need to be mired in content source and delivery methods, and it will be bliss when someone takes the reins and unites the wide array of available content in a meaningful way. ■

HEVC	High-Efficiency Video Coding
MPEG	ISO/IEC Moving Picture Experts Group
OTT	Over-The-Top
STB	Set-Top Box
TWC	Time Warner Cable
VCEG	ITU-T Video Coding Experts Group

Don't miss the **Entertainment Matters Program** at the 2014 International CES including the Content and Disruptive Technology conference track.

Ultra HD Becomes Standard

CEA recently updated its CEA-861 standard, *A DTV Profile for Uncompressed High-Speed Digital Interfaces,* to include Ultra High-Definition formats.

The future of Ultra HD will depend on standards related to data compression, specifically the *High-Efficiency Video Coding (HEVC)* standard developed by the ISO/IEC Moving Picture Experts Group (MPEG) and ITU-T Video Coding Experts Group (VCEG).

Learn more about Ultra HD in CEA's *Ultra High-Definition: State of the Industry report*, released in August 2013.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