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Predicts 2014: The Emerging Smart Machine Era

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Significant competitive advantages await early adopters of smart advisors, starting in 2014; contextually aware intelligent personal assistants, starting in 2015; and, by 2020, advanced global industrial networks and early autonomous vehicles. IT leaders should act now as laggards will lose.

Key Findings

- The great continuous push in artificial intelligence (starting in the 1960s) is on the cusp of delivering extremely useful and practical capabilities that can benefit almost everyone — and help protect people from at least some of their own fatal foibles. Gartner prefers to use a less loaded term, "smart machines."
- The combination of statistical algorithms (deep learning), Internetwide seas of big (nonregular) data and Moore's Law are succeeding where earlier attempts fell short.
- The shortest-term opportunities for most enterprises lie with smart advisor technologies (SATs) such as IBM Watson.
- Virtual personal assistants (VPAs) will be ready for broad and deep end-user experimentation in the 2015 to 2017 period. Beyond mobile, VPAs will fuel the first major leap in knowledge worker productivity this century.

Recommendations

- Enterprise IT and business leaders should jointly and actively explore both use of and co-development of new business opportunities around SATs such as IBM's Watson.
- Enterprise IT leaders must work with the rest of the business to establish policies and procedures that will enable users outside IT to experiment with multiple VPAs that will monitor what each user does (at work and not) and develop individualized predictive models; aiming to raise user effectiveness and act on behalf of their users.

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By 2016, Microsoft will offer virtual personal assistants in Microsoft Office 365.

By 2017, consumers who use networked endpoints daily will allow smart machines to make at least 20% of their personal decisions.

Analysis

Gartner initiated coverage of smart machines with the publication (this quarter) of "The Disruptive Era of Smart Machines Is Upon Us" and "Smart Machines Mean Big Impacts: Benefits, Risks and Massive Disruption." (We have been covering components of this area for decades.)

What You Need to Know

Smart[1] machines[2] promise to be more disruptive[3] than any of the prior technology generations.[4] Starting in the second half of this decade, we expect to see dramatic growth in the availability, sale and use of smart machines — technologies that:

- Do what we thought only people could do[5]
- Do what we thought machines couldn't do
- Do what we thought neither people nor machines could do

Smart machines can make people more effective, empowering them to "do the impossible." For example, physicians can stay up to date on tens of thousands of new scientific research papers published in their discipline every year, while still engaged full time in an advanced medical practice. Smart machines can also encroach on what people do, displacing them. Think of the long-term impact on truck driver employment of automated trucks, which are already in commercial use on private property in limited numbers today.[6]

Some smart machines are little more than just "clever": brute force automation, as in semiautonomous vehicles like the self-driving cars demonstrated by Google or the automated crash-avoidance braking systems (such as optional equipment available now on new Mercedes Benz cars) that will autonomously apply the brakes when the car's systems detect an imminent threat to which the driver has not properly responded.[7,8]

Other smart machines are genuinely smarter. They are built to exploit self-learning, machine-learning and deep-learning algorithms.[9] They behave autonomously (see Note 1) and adapt to their environment. They learn from results, create their own rules and seek or request additional data to test hypotheses. They are also able to detect novel situations, often far more quickly and accurately than people. The criteria defining smart machines will continuously advance as well (see Note 2).

Apple's 1987 Knowledge Navigator vision and IBM's Watson of today represent two (of many) different instances of smarter machines.[10,11] (Watson is exemplified by the Clinical Oncology Advisor, jointly built by WellPoint and IBM to stay on top of the huge body of medical and scientific literature and provide advice to clinicians when presented with a patient's electronic health record.)

We expect individuals will invest in, control and use their own smart machines to become more successful. Enterprises will similarly invest in smart machines. Tensions between consumerization and central control will not abate in the era of smart-machine-driven disruption; if anything, smart machines will strengthen the forces of consumerization once the first surge of enterprise buying commences.

Strategic Planning Assumptions

The first three of the following five Strategic Planning Assumptions were first published in October 2013, in "Gartner Top Predictions 2014: Plan for a Disruptive, but Constructive Future."

Strategic Planning Assumption: By 2020, the majority of knowledge worker career paths will be disrupted by smart machines in both positive and negative ways.

Analysis by: Tom Austin

While there are several smart machine categories, two that will directly impact knowledge workers' careers during this decade stand out: smart advisors and VPAs.

- Smart advisors such as IBM's Watson are specifically focused on a particular content domain, a particular class of user, or both. They excel at evaluating new evidence and finding where and

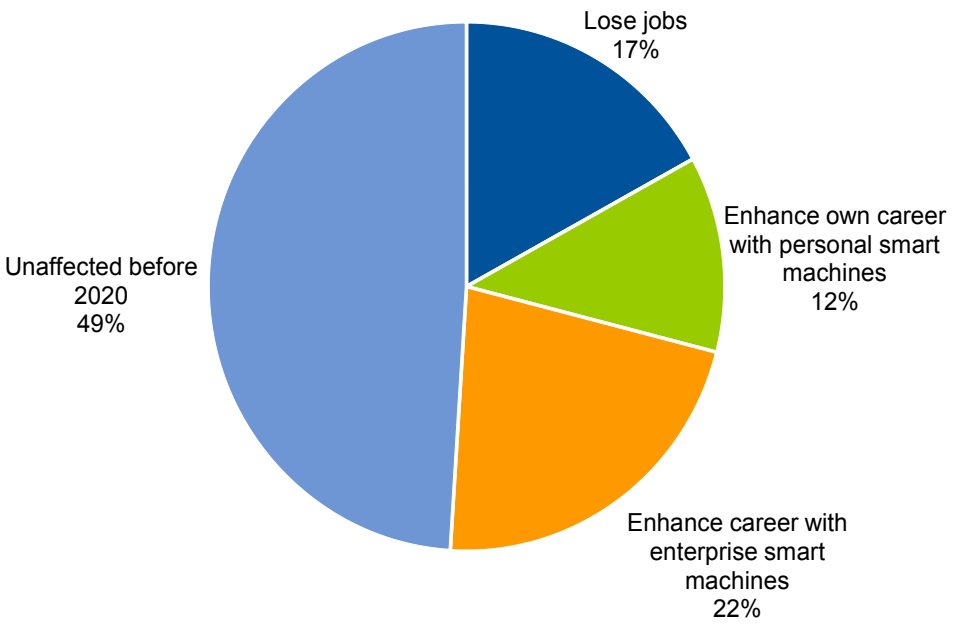
how it may fit with existing content, offering the user a shortlist of best matches based on all the available information. They make smart people smarter.

- VPAs are focused on the behavior (habits, activities and needs) of a user or small set of users, independent of the content domain they work in. They are context experts that learn by watching their users and finding opportunities to help them be more effective in dealing with the huge volume of information pouring into their world. They make smart people more effective.

Key Findings:

- Smart advisors are now beginning to enter the market in relatively small numbers, based in large part on the work of IBM and its many co-development partners.
- By 2015, there should be a large and growing market for Watson-derived smart advisors. Crédit Agricole is predicting that these systems will account for more than 12% of IBM's total revenue in 2018.
- Google, Apple, Microsoft and others are actively developing VPAs, of which Google Now is one example. We expect individual consumers working for enterprises to begin to drag their VPAs into work — in both professional and personal activities, to make themselves smarter, more efficient and, in business, more competitive. This consumerization pattern should emerge clearly by 2017. Enterprise investments in VPAs will lag individual investments.
- Smart machines will upend the majority of knowledge worker career paths by 2020. Some will gain, some will lose, but those that ignore smart machines do so at tremendous long-term risk. We expect there will be more winners than losers, but there *will* be a lot of losers and the numbers of both winners and losers will climb during the next decade. Figure 1 illustrates our prediction.

Figure 1. A Graphical Representation of Our Prediction for Smart Machines



Source: Gartner (November 2013)

- By 2020, SATs and VPA technologies will have begun to merge into one another, blurring the lines between them.
- Most smart advisors and VPAs will be delivered from cloud-based services (to exploit economies of scale and the deep learning benefits of working with huge pools of data). We expect suppliers to provide internal implementation alternatives as well, although those on-premises implementations will probably still require the use of cloud-based services without requiring enterprise-specific information to be exposed to the cloud-based service.

Near-Term Flag: Watson will account for at least 1.5% of IBM's revenue by the end of 2015, and 10% by the end of 2018.

Near-Term Flag: VPA usage in business will grow more quickly in 2017 and 2018 than iPad usage did in 2010 and 2011.

Market Implications:

These new technologies promise the first major leap forward in personal effectiveness and productivity this century. They will help people exploit unfathomably large bodies of knowledge (initially in written form), cope with enormous flows of information, and be smarter than the people they are competing with both inside and outside the enterprise. This poses challenges and opportunities.

Recommendations:

- IT professionals need to recognize that smart machines can create substantial competitive advantages, as well as entirely new businesses. It may be fine to lag behind the leading edge regarding commodity technology, but with smart machines the laggards lose.
- IT executives need to get up to speed on the capabilities of smart advisors immediately, and start a dialogue with other key executive committee members to scope out the places where these technologies might leverage existing or potential bodies of knowledge that the enterprise possesses.
- On VPAs, enterprises that lock into the technology of one vendor's end-user device, and lockdown devices to a limited set of approved applications, run the risk of having the best, modern, mobile, go-anywhere graphical user interface implementations of the Nth generation of 1980s office automation tools — IBM PROFs or Wang Office with modern communications extensions — and they will be doubly handicapping themselves by denying end users the opportunity to work with the broad range of VPA technologies coming from a wide variety of suppliers. Do not bet that any single vendor visible now will have the best tools to maximize your users' effectiveness. We're no longer talking about tiny changes in productivity applications; VPAs will have a powerful impact on user productivity and effectiveness.

Related Research:

"Smart Machines Mean Big Impacts: Benefits, Risks and Massive Disruption"

"The Disruptive Era of Smart Machines Is Upon Us"

"Google, Apple Siri and IBM Watson: The Future of Natural-Language Question Answering in Your Enterprise"

"Artificial Intelligence Finally Delivers Real Value for Business Applications"

"Maverick* Research: Judgment Day, or Why We Should Let Machines Automate Decision Making"

"Maverick* Research: How Technology Is Ending the Automotive Industry's Century-Old Business Model"

Strategic Planning Assumption: By 2024, at least 10% of activities potentially injurious to human life will require mandatory use of a nonoverridable "smart system."

Analysis by: Ken McGee, Steve Prentice

The increasing deployment of smart systems capable of automatically responding to external events is increasing all the time, but there remains deep-seated resistance to eliminating the option for human intervention. At least in the more litigious Western markets, this is heavily influenced by questions of liability and the need for someone to, ultimately, be responsible for every event. At the same time, it reflects a highly subjective (and usually incorrect) assessment of real versus perceived risk that appears to be inherent in the human psyche. Simply put, most people believe they can react faster than they actually do, that they can accurately assess risk and predict outcomes

(generally untrue), and that automatic smart systems cannot perform as reliably and effectively as they can. In the past, that may have been partially true, but with the ever-advancing power of microprocessors linked to a growing array of real-time sensors, allied with vastly improved analytics, the superior capabilities of smart systems (compared to humans) is increasingly a reality.

In the transportation sector, there is a long-established track record of the deployment of smart systems and an increasing tendency to make them nonoverridable standard equipment, even in midmarket models. Examples include anti-lock braking systems, seat belt tensioners, air bags and the new generation of active crash avoidance systems, which will automatically apply the brakes to prevent a frontal collision if the driver fails to act in time. In aviation, automated landing systems and automatic pilots are in daily use around the globe; although the tradition of a human pilot (or several) in the cockpit remains valid, trials have already demonstrated that this is technically unnecessary. However, the assumed market resistance to fully automated air travel, combined with current regulatory requirements, means that the human pilot will remain — at least for now. At the same time, fully automated (driverless) "people mover" transit systems are commonplace and the autonomous vehicle is slowly appearing on public highways (albeit with an onboard human ready to take over control, just in case).

Key Findings:

- The capability, reliability and availability of appropriate technology is not the issue. The willingness of the general population to accept initial widespread deployment and increasing removal of manual override options *is* the issue.
- Mandated deployment of automated systems requires changes in legislation and regulation, and will also most likely require limitations of liability, such as those that are currently applied in the aviation sector, to encourage manufacturers to implement these systems as standard equipment.
- Regions where a high level of "blame culture" encourages a high level of legal activity and punitive damages, will have delayed mandated deployments of nonoverridable systems; thereby eliminating the potential savings in human life that such systems have been shown to deliver.

Near-Term Flag: Midpriced cars with automated assist technology added as standard equipment will increase through 2014, as an indicator of adoption.

Near-Term Flag: The cost of insurance premiums will decline through 2015, as an indicator of acceptance that automated assist systems improve safety.

Near-Term Flag: At least one legislative representative will broach the topic publicly in 2014, about starting legislative discussions on automated assist technologies that will include a tentative debate on increased demands for limits of liability.

Market Implications:

We see no issues with the development and deployment of appropriate technology to meet the requirements of this prediction well within the time scale. The stumbling block will be the legal requirement for mandatory use that will, necessarily, take time to achieve. In industrial and manufacturing environments, where potentially hazardous situations arise, current safety regulations require organizations to demonstrate a duty of care and deploy appropriate solutions to minimize risk. Many of these will be automatic, nonoverridable systems (for example, safety interlocks). As microprocessor control and sensor deployment advances over the next decade, such systems will be increasingly applied to a wider range of situations. For example, the likely deployment of automated (robotic) systems on the shop floor will spur additional legislation to protect the human workforce. Organizations will, therefore, increasingly implement and feature these systems for the purpose of competitive advantage.

In consumer-oriented markets, increasing deployment will result in falling prices. As such, systems will become standard equipment in a wider range of situations and reducing risk without overly increasing costs will drive competitive differentiation and advantage.

Calls for, and acceptance of, mandated use may be significantly impacted (both positively and negatively) by high-profile instances in which such systems demonstrably saved lives (or failed to do so). Ultimately, mandatory use will be a politically-driven decision.

Recommendations:

- CIOs and IT leaders should utilize their knowledge of current and forthcoming technological developments, to assist the organization in identifying where and how the deployment of automated systems might improve product safety and/or enhance competitive attractiveness across the entire range of organizational products and activities.
- Monitor falling technology prices and advances in data collection and analysis to highlight when new potential opportunities might become financially viable or affordable for more widespread deployment.
- The growing digitalization of our everyday environment and the widespread use and acceptance of digital devices as interfaces to more complex systems should be monitored to assess the social zeitgeist and potential customer acceptance (even as a premium feature) of automated systems; this insight should be used to drive product development and release schedules.

Related Research:

"The Disruptive Era of Smart Machines Is Upon Us"

Strategic Planning Assumption: By 2017, 20% of computers will be learning rather than processing.

Analysis by: Adib Carl Ghubril

Key Findings:

In 2014, deep neural network algorithms will be applied in collision avoidance systems. Deep neural networks are currently being applied in speech recognition systems as well as some object recognition applications. Current avoidance systems on vehicles entail recognizing preprogrammed shapes. Deep neural networks trained to distinguish between humans and inanimate objects will prove more adaptable to real-life scenarios. Furthermore, the 1-billion-euro human brain modeling project (out of Switzerland's École Polytechnique Fédérale de Lausanne) will generate neuromorphic computing techniques intended for medical diagnostic applications.

By 2015, a burgeoning ecosystem of developers will use IBM's library of 150 (or more) corelets — neuromorphic macros each characterizing a specific task — to produce third-party applications based on the Corelet programming language. An important milestone in IBM's endeavor to build a new computing architecture and programming, or training, language was marked in 2012, when 100 trillion synapses — equivalent to the amount estimated for a human brain — where simulated on the Sequoia Blue Gene/Q supercomputer. This proof of concept was achieved using 2 billion of the newly synthesized neurosynaptic cores.

By 2016, IBM'sTrueNorth architecture neurosynaptic chip will be in the first stages of mass production. This chip architecture will likely compete with developments from other projects that are also funded by the Defense Advanced Research Projects Agency (DARPA), such as HRL (formerly Hughes Research Labs) or the University of Michigan (UM). Intel and even HP also have a neuromorphic chip project and, like HRL and UM, seem to have taken to a memristors-based chip architecture that is more unconventional and will therefore take longer to mature. The broad range of neuromorphic, neurosynaptic and similar highly parallel processing concepts inspired by biological (neurological) models represents a departure from classical Von Neumann architecture where bidirectional data and instructions flow sequentially between a central processing unit and a memory unit. (See, for example, CogniMem Technologies in "Cool Vendors in Semiconductors, 2013.")

Market Implications:

Quality of life improves when society is able to derive useful information from the copious amounts of unstructured data collecting on the Internet. Medicine, for example, stands to improve significantly if decisions taken by healthcare practitioners are derived from clearer diagnoses. But performing data analytics by scanning for artifacts that computers are preprogrammed to identify requires sophisticated, complex algorithms necessitating bulky and power-hungry computers. Signal processing based on neural networks is a strong step in the right direction, but it is still limited by the conventional computing architectures on which it runs.

A system built to handle multiple and concurrent threads of data, while incoming information alters the state of a cross-matrix of programmable connections (effectively reprogramming it), is learning to make more accurate assessments with subsequent exposures. The most important implication of a learning computer is that it expends much less energy to recognize more complex patterns. Thus, the neuromorphic computer becomes a vital assistant to the user in several scenarios, including:

- Medical diagnostics — Assisting medical practitioners identify disease
- Facial and biometric recognition — Investigative work and access control
- Machine vision — Driver assistance and robotics
- Mood recognition — Ascertaining state of mind in social settings, customer service and digital marketing

The computing hardware that currently supports the Nexus of Forces consists of central processing units, digital signal processing units and graphical processing units. All three architectural types have been tuned for slightly different processing tasks. These cores are also being combined to form powerful multicore processors, but their programming is accomplished using common development tools. That will not be the case with neuromorphic computers.

Recommendations:

- Enterprises must prepare for a new method of programming — nay, training — computers and should work on developing in-house workshops for a "programming by example" approach (see "Hype Cycle for Human-Computer Interaction, 2013").
- Regular interaction must also be had with the leaders among the participants of the DARPA SyNAPSE project and the European Human Brain Project, to better set expectations for a development ecosystem.
- Forming alliances with Google and Microsoft, which have been strong proponents of deep neural network technologies, would be useful to develop an understanding of how such algorithms may be incorporated in end-user applications.

Related Research:

"Hype Cycle for Human-Computer Interaction, 2013"

"Exploit the Intersect of IBM's Social Business and Solution Selling Strategies"

"Cool Vendors in Semiconductors, 2013"

Strategic Planning Assumption: By 2016, Microsoft will offer virtual personal assistants in Microsoft Office 365.

Analysis by: Tom Austin

Google, Apple and many others already have underway visible efforts at delivering tools that function as VPAs. They have early examples of tools in the market (such as Google Now and Siri).[12] Current players will render their current offerings obsolete by introducing far more capable VPAs during the next three years.

Microsoft has no official VPA offering and it has made no public statements committing to developing VPAs. However, we believe the evidence is there that Microsoft has the ability to enter

this market and understands the impact, benefits and business justification for fully competing in the VPA segment.

We have two primary pieces of evidence:

- Eric Horvitz, distinguished scientist and co-director at Microsoft Research, gave a TEDx talk (on 19 February 2013) on "Making Friends With Artificial Intelligence,"[13] in which he talked about VPAs that Microsoft Research has built. He uses one to help manage matters in his office and support people who want to work with him. He demonstrates the agent and examines how it works (starting at 18:40 on the video referenced above and in the Evidence section). The video demonstration and discussion provide viewers with a valuable perspective on how far along these capabilities already are.
- On Monday 15 July 2013, Microsoft co-founder and chairman Bill Gates gave a keynote speech at the Microsoft Research Faculty Summit in which he spoke about contextual awareness and personal assistant technology. The Wall Street Journal's coverage of the presentation is instructive.[14] In part, Gates speaks of "personal assistants that can help us get things done, help us drive deep insights" — from opt-in observations of the user's context and history by the user's personal assistant. Information sources cited included sensors in mobile devices, scheduling software, social connections and activity patterns collectable by the Microsoft Office suite. Gates said he foresees "really unbelievable progress" in the next five to 10 years, despite misgivings about the impact of privacy concerns on progress. That view is consistent with Gartner's perspective.

We expect that no later than 2015, Microsoft will begin to brief customers (under nondisclosure agreement terms) of its plans to deliver VPAs in Microsoft Office 365 by the end of 2016.

There are factors that may slow Microsoft's progress on the timeline we are predicting:

- User privacy concerns (which Microsoft is currently trying to exploit with its "Scroogled" anti-Google attack advertisements).[15]
- Fear of rekindling memories of earlier adverse reactions to Microsoft's "Clippy" Office Assistant feature (which it shipped as part of Microsoft Office 1997 through Microsoft Office 2003).[16]
- Microsoft's progress may be slowed by decision making on the platform coverage of its VPA offerings. (Notably, we predict that Microsoft's VPA tools will initially operate only in Microsoft Office 365, and then only when used on Windows-based devices. We are also predicting that, at least initially, Microsoft's service and support for other tools and platforms will be either second-rate or nonexistent.)
- Microsoft's progress may also be slowed by mixed emotions inside Microsoft (and with some of its largest customers) on use patterns in a personal cloud style, as they ponder the question, "Will Microsoft be so bold as to introduce a virtual personal assistant that will work seamlessly across personal, family, social, professional and work contexts?" (Our position is that the most effective VPAs must operate across all those contexts to understand their user's needs and to act accordingly.)

On the other hand, factors that may accelerate Microsoft's VPA action include:

- Bill Gates' observations on the business value of personal assistants, along with the other evidence cited above.
- The growing risk that Google's could deliver opt-in VPA tools that cross the boundaries between personal, family, social, professional and work activities. (We expect that risk to materialize no later than 2015.)

Key Findings:

- We expect most VPAs to operate at the personal-cloud level, observing (with their user's permission) their user in all his or her uses of relevant technology to form a better predictive model for what is important to that user.

Market Implications:

There are at least 40 potential VPA providers in the market already; however, focusing on the three who are potentially the most powerful:

- Microsoft has a key advantage in that it dominates the world of office productivity suites.
- Apple has a key advantage in that it dominates the high end of the smart mobile device market in developed economies.
- Google has a key advantage in that it dominates Web search and personal email and has taken over Microsoft's once-dominant position in Web browsers.
- Each of these three have other strengths as well.

The ultimate "winner" in VPAs will be the one that best meets the needs of individuals, whether at work or at play, mobile or stationary, and on any device the user has in hand at the time.

Recommendations:

- Enterprise IT leaders must work with the rest of the business to establish policies and procedures that will enable users outside IT to experiment with multiple VPAs that will monitor what each user does (at work and not), develop individualized predictive models aiming to raise user effectiveness and act on behalf of their user.

Related Research:

"The Disruptive Era of Smart Machines Is Upon Us"

"Smart Machines Mean Big Impacts: Benefits, Risks and Massive Disruption"

Strategic Planning Assumption: By 2017, consumers who use networked endpoints daily will allow smart machines to make at least 20% of their personal decisions.

Analysis by: Brian Blau

Key Findings:

- Smart machines (for example, apps and services such as personal assistants and agents) are playing an increasingly important role in computing: enabled by a proliferation of connected mobile devices combined with local and cloud-based advanced analytics, data-producing sensors, and systems that translate interest and intent into goals and direction.
- As trust in platforms, ecosystems and app providers builds they will in turn transition from providing passive recommendations to more active decision-making apps and services.
- Smart machines will help dispense with time-consuming and uninteresting tasks, in favor of making users more productive and spending more time in creative and fun tasks.

Market Implications:

There will be an increasing demand for apps and services that facilitate a more automated and intelligent approach to managing daily decision making in commerce, entertainment and work. The drivers for these new behaviors are rooted in a need to consume and experience more information and content, to make smart decisions faster, and to produce more and better products. Simple tasks — such as creating schedules, shopping lists, or sorting through resumes — are time consuming and the end result means that more actions are needed so, decisions made by smart machines will make that work and pathway through life more efficient and less time consuming.

Companies such as Google, Amazon and Facebook all rely on a constant and direct connection to your everyday activities and will increasingly come to rely on smart machines to help them bridge the gap between what you say online with how you act in the real world. Smart machines will help consumers to be efficient and productive, it will help them get through the more mundane aspects of life and work and will help them focus on what's enjoyable or productive.

For technology companies this means creating new products and services that are fundamentally different in how they approach their underlying technology and support, and that includes not only the decision-making system itself but also the user interfaces and experiences. Being "smart" means not only having the resources to help a user move to a higher level of functionality, but will also provide experiences that create trustful relationships as people allow these smart machines to help run part of their daily lives. Technologists will need to create self-balancing, decision-making systems that autocorrect based on feedback on the quality of that decision. These systems will need to collect data streams from, for example, quantified-self products such as Nike's Fuel Band or Hapilabs' HAPIfork, and then apply that to knowledge and information that is already stored — changing and adapting as that information becomes more precise and meaningful over time. Types of decisions will be classified, where some outcomes are inconsequential yet others could be critical and affect not only an individual but also the collective.

Today, we can already see the effects of smart machines and how they make decisions. Some automated decisions exactly match their purpose, such as route navigation recommendations or the automatic reordering of maintenance prescription medicine. However, not all types of decisions

fit neatly into categories. For example, there are work decisions that must be made every day and others that are optional; so, technologists will need to consider culture, geography and even taboos to help craft systems that best match the decision-making environment and purpose.

An example of a real-world smart machine, Anki Drive is a new type of slot-car-like racing game. The cars and track are real and the cars drive themselves autonomously with only high-level direction from the game players. Cars take on a personality that is retained for the life of the car and they can be traded and collected. Different types of races can be played, and the cars learn and gain their own knowledge to perform better over time. Automation, artificial intelligence and sophisticated physics algorithms give the cars real-world qualities. Virtually all decisions made come from the cars themselves, with only high-level strategy coming from the game player.

Recommendations:

- Design smart machine capabilities into your products and services.
- Incorporate real-time decision making in your plans for exploiting smart machines.
- Design your offerings to appear to be smart, taking on an intelligence perspective that customers will come to rely on.
- Measure and improve on the amount of trust from users in an effort to convince them that your services can meet their needs.

Related Research:

"Cool Vendors in Wearable Electronics for Health and Fitness, 2013"

"Market Trends: Enter the Wearable Electronics Market With Products for the Quantified Self"

A Look Back

In response to your requests, we are taking a look back at some key predictions from previous years. We have intentionally selected predictions from opposite ends of the scale — one where we were wholly or largely on target, as well as one we missed. This topic area is too new to have on-target or missed predictions.

Evidence

[1] We are using the term "smart" despite our aversion to needlessly anthropomorphizing technology. Smart is arguably the least offensive adjective that still indicates some of the capabilities we expect to emerge.

[2] In this usage, the word "machine" includes physical devices like a self-driving car, as well as logical entities like software. Software without hardware does not perform useful work, so a software-based machine logically incorporates some physical representations.

3 The rate of change and level of disruption will vary across many dimensions, including sector, industry and job role.

4 Smart machines leverage a combination of technologies and it is the integration and aggregation that makes them disruptive.

5 Many of these smart machines will do things no human ever could. For example, detecting new signal patterns in global industrial networks.

6 "Daddy, What Was a Truck Driver?" The Wall Street Journal, 23 July 2013

7 "Self-Driving Car Test," Google Jobs

8 "Distronic Plus With Pre-Safe Brake," Mercedes-Benz

9 "Deep Learning," MIT Technology Review, 23 April 2013

10 "Apple Knowledge Navigator Video," YouTube, 1987

11 "Watson for Engagement: Learn How Watson Is Transforming the Lifetime of Relationships Between People and Companies," IBM

12 "Google Now," Wikipedia

13 "Making Friends With Artificial Intelligence: Eric Horvitz at TEDxAustin," YouTube Video, 19 February 2013

14 "Bill Gates Touts Contextually-Aware Computing," The Wall Street Journal, 24 September 2013

15 "Microsoft's Google-Bashing TV Campaign Is Actually Working," adage.com article, 15 October 2013

16 "Office Assistant" entry in Wikipedia

Note 1 Autonomous Behavior

Smart machines are autonomous (or semiautonomous) in that they appear to control themselves and to make their own decisions under most conditions. They are not under direct, continuous and complete remote control. The Mercedes-Benz automated crash avoidance braking system acts in a semiautonomous fashion; if the driver ignores warnings to apply the brakes, the car does it for the driver. Prototype cars that automatically drive trips of distances of tens or hundreds of miles under typical public road conditions without human intervention are an even better illustration of autonomous behavior. The operator could take control, or the car's automatic driving system could turn over control to the operator; but the car can, under many circumstances, behave in an almost totally autonomous way.

Similarly, virtual personal assistants and smart advisors (and other helpers) function without human intervention.

Note 2 A Rising Bar

The smart machine requirements' bar will continuously evolve as smart machines are developed, commercialized and become commonplace. Roombas (self-guided vacuum cleaners built by iRobot) are losing their status as smart machines because it's no longer surprising in many societies to see such devices moving around a room, cleaning the floor as they go. Roombas do not build maps of their environment as they move; navigation is based on path randomization and detection of discrete events such as collisions and loss of contact with the floor. To the knowledgeable, they're simple stimulus-response machines with no real autonomy.

More on This Topic

This is part of an in-depth collection of research. See the collection:

- Predicts 2014: Don't Try to Prevent the Digital Revolution, Exploit IT Now

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