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DEFTECH Update

June 2017

Dear Reader,

This document summarizes emerging technology signals related by Strategic Business Insights' (SBI) Scan and Explorer services that the Technology Foresight Research Program from armasuisse Science + Technology subscribes to.

For each trend, we try to anticipate what could be the implication for the armed forces. Each trend is also related to the original signal of change elaborated by SBI that the interested reader finds at the end of this document.

The intent is to stimulate strategic technology forward thinking in a form that is pleasant and quickly readable.

We hope you enjoy the journey!

Best regards,

Dr. Quentin Ladetto
Research Director – Technology Foresigh

P.S. For any comment, suggestion or discussion: quentin.ladetto@armasuisse.ch

ChatBot Interfaces

Although some chatbots are novelties, serious applications such as customer-service automation and payment processing are emerging. In fact, chatbots using AI and natural-language processing could serve as an efficient user interface for many services and may end up faster and more effective than interactions with humans in certain cases.

Implication for Defense and Security*: Chatbot technologies are progressing and could serve a wide variety of user interface applications in defense and security. Examples include automating administrative services, technical support bots, and controllers for robots and other remote equipment.*

Timing of Implication: ***now/5 years****/10 years/15 years*

Capabilities: *Conduite, Instruction (5.4), Gestion du personnel (5.3)*

Ensuring the Global Food Supply

Novel research and technologies could help ensure that the global food supply will meet food demand. Approaches include new genetically modified organism (GMO) applications, soil management, and sensors for monitoring livestock.

Implication for Defense and Security: *Food scarcity is a security threat. Better application of food technologies could ease the challenge.*

Timing of Implication: ***now/5 years*** */10 years/15 years*

Capabilities: *Logistique (5.1)*

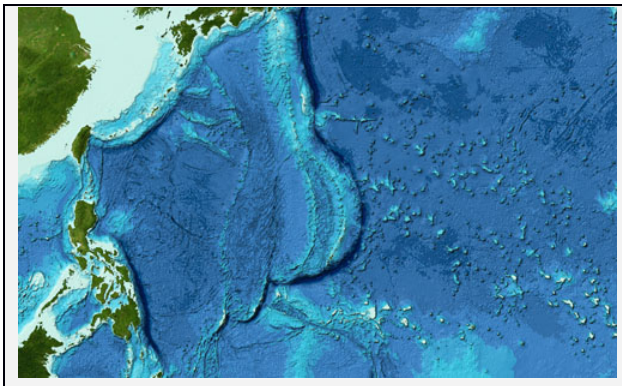
Biobased Material

A growing number of companies in various industries are embracing the use of biobased materials in their products and even changing the types of biobased materials they use to address resource considerations.

Implication for Defense and Security: *Defense and security equipment manufacturers, like manufacturers in other industries, face environmental pressures. New biobased materials and related processes can reduce fossil fuels in the production of plastics and other materials.*

Timing of Implication: ***now****/****5 years****/10 years/15 years*

Capabilities: *Possibilité d'impacter toutes les Capabilities.*



Mapping the Unmapped

Whether it is the seabed or the human genome, the adventure of mapping everything that is now possible thanks to the new technologies allows us to draw the premises of the applications of tomorrow. From a more efficient maritime transport to a better understanding of which gene codifies what information of the human being, the hope is that the amount of data harvested still delivers many secrets.

Implication for Defense and Security: *A better knowledge of the seabed would allow the storage of sleeping military equipment in suitable locations. New phenomena, processes and materials may be discovered through better observation of the seabed and its inhabitants. Understanding the human being to improve its capabilities is the dream of any soldier modernization program; the democratization of the CRISPR technology, allowing the modification of the DNA at will, makes it even more closer.*

Timing of Implication: *now/****5 years****/****10 years****/15 years*

Capabilities: *Sanitaire (5.2), Logistique (5.1)*

Wasted Opportunities

Companies are now turning to technology to reduce waste and / or extract a new value from it. For example, the US Department of Defense is looking for methods to manufacture biodegradable ammunition containing seeds and eatable for animals.

Implication for Defense and Security: *The US Armed Foces are specifically researching biodegradable ammunition for training exercises. These exercises currently leave hundreds of thousands of rounds worldwide, ranging from small arms fire to grenades, mortars and large artillery. The DoD wants the bullets--in addition to being biodegradable--to contain seeds that can use the material in the biodegradable bullet and be safe for animal consumption. A reduction in the costs of production is also expected*

Timing of Implication: *now/**5 years**/**10 years**/15 years*

Capabilities: *Instruction (5.4), Effet au sol (3.1)*

Augmented Reality

Augmented-reality products including Microsoft's HoloLens and Upskill's Skylight platform have added capabilities and applications that will make the products appealing to enterprises

Implication for Defense and Security: *Software for augmented-reality headsets and smart glasses is progressing and targeting enterprise applications. Although defense and security organizations have used augmented reality for years in niche applications, commodity hardware and software should broaden the appeal of the technology.*

Timing of Implication: *now/**5 years**/10 years/15 years*

Capabilities: *Service de renseignement, Conduite, Instruction (5.4)*

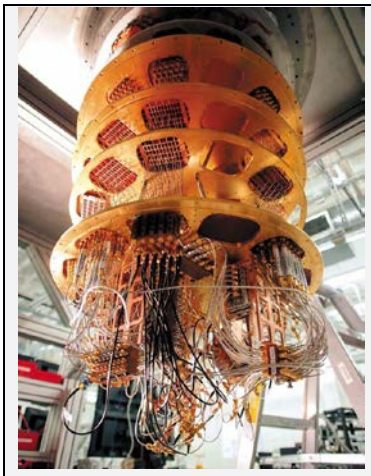
Mobile Power Solutions beyond Batteries

Despite advances in conventional power solutions—notably, rechargeable lithium-ion batteries—concerns exist that current common energy-storage solutions will be unable to support the power requirements of increasingly advanced portable electronic devices. Potential options include energy harvesting, solar cells, fuel cells, and nuclear batteries

Implication for Defense and Security: *Considering the battlefield increasingly connected and invaded by microprocessors and more or less autonomous robots, the quest for a high-performance portable power source may be the key to tomorrow's victory.*

Timing of Implication: *now/**5 years**/**10 years**/15 years*

Capabilities: *Logistique (5.1),*



The Quest for Quantum Supremacy

In March 2017, several organizations, including the US Rigetti Computing, Google and IBM have confirmed their commitments in the development of quantum computing technologies. Also in March, John Costello, an analyst of the "New America Foundation", testified before the US Congress that "Chinese advances in quantum information science have the potential to surpass the United States." The countries of Canada and the European Union are also involved in the development of quantum computing.

Implication for Defense and Security: *Opportunities exist for defense and security organizations to leverage quantum computing for cybersecurity and for high-performance computing. Although hopes, not secret discoveries, are perhaps fueling the current wave of optimism about quantum computing, countries and organizations are concerned to stay ahead of their competitors. Full-scale quantum computing would give a significant commercial—and perhaps military—advantage to its creator.*

Timing of Implication: *now/5 years/**10 years**/**15 years***

Capabilities: *Effet dans le cyber-espace (3.5), Service de renseignement, Sécurité des informations et des données (6.4)*

Resilient Infrastructure Materials

New materials and technologies have the potential to make infrastructure more resilient. Examples include a bendable concrete composite by the University of Nevada, Reno, Earthquake Engineering Laboratory and biocement by Newcastle University and Northumbria University in England. Other developments include materials that change color to indicate potential failure.

Implication for Defense and Security: *Resilient materials can help build infrastructure and buildings that can withstand some bombs and other attacks as well as environmental threats such as earthquakes.*

Timing of Implication: ***now**/**5 years**/10 years/15 years*

Capabilities: *Sécurité des ouvrages (6.3)*

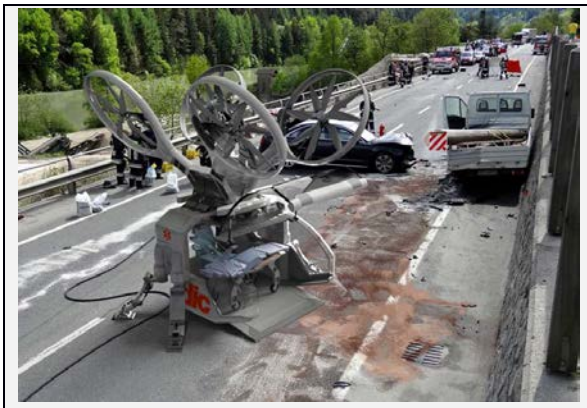
Snooping Technologies

As software enable increasingly advanced customization and personalization, technologies' increasingly intrusive approaches to gain an understanding of users generate criticism. The line between customer service and privacy infringement is becoming narrower.

Implication for Defense and Security: *Commercial efforts to personalize information for consumers (for example, Amazon's Alexa and Facebook's targeted advertisements) create profiles that security organizations can perhaps utilize to identify potential terrorists. However, significant privacy issues exist.*

Timing of Implication: ***now****/5 years/10 years/15 years*

Capabilities: *Information et communication (1.5), sécurité des informations et des données (6.4)*



High-Tech Emergency Response

New technologies that support emergency-response efforts at local and national levels are under development. Connected cars could decrease evacuation times, drones can provide surveillance and communications, and flexible communications software can integrate cell phones and walkie-talkies (NIST's Rapidly Deployable Public Safety Research Platform).

Implication for Defense and Security: *As the world of defense and security has a lot of similarities with the one of emergencies, technology advances in civilian interventions can be quickly adopted in a militarized context.*

Timing of Implication: ***now****/5 years/10 years/15 years*

Capabilities: *Logistique (5.1), Sanitaire (5.2), Déploiement et repli des forces et de moyens(4.1)*

STRATEGIC BUSINESS INSIGHTS

EXPLORER

Viewpoints

April 2017

Artificial Intelligence

By Michael Gold (mgold@sbi-i.com)

The Quest for Quantum Supremacy

Why is this topic significant? Innovators in the high-risk, high-potential-reward field of quantum computing are committing development funds and expressing ideas about how they hope to use the technology.

Description

In March 2017, several organizations detailed their commitments to developing quantum computing technologies in an effort to surpass the performance of conventional computers:

- Start-up Rigetti Computing revealed that it had raised about $64 million in venture-capital investments during 2016. The company has built a 5-qubit quantum computer and reportedly expects to commercialize its technology in about two years.

- Google's quantum computing team published an article in *Nature* titled "Commercialize Quantum Technologies in Five Years." Google reportedly plans to build modules with 49 qubits that would each maintain computational integrity much longer than those of existing quantum computers. The modules would also be capable of arbitrary computations, not just the application-specific tasks that current quantum computers perform.

- IBM announced that it would build commercial, cloud-accessible quantum computing systems. IBM already has a 5-qubit version that members of the public can use for free; IBM indicated that peer-reviewed journals have already published five third-party research reports authored by researchers who used the computer.

Regarding potential quantum-computing application domains, announcements in March tended to emphasize key areas including artificial intelligence, drug discovery, materials discovery, and physical chemistry. IBM also mentioned financial services and cloud security; the Google authors identified many additional possibilities such as finding solutions for advertising placement, generating search results, and recommending products. Both IBM and Google also mentioned logistics.

Implications

The Google authors defined *quantum supremacy* (paraphrasing physicist John Preskill) as "the ability of a quantum processor to perform, in a short time, a well-defined mathematical task that even the largest classical supercomputers...would be unable to complete within any reasonable time frame. We predict that, in a few years, an experiment achieving quantum supremacy will be performed." But the authors also indirectly acknowledge that they (like Preskill and others) lack definitive proof-of-concept evidence when they assert that "a lack of theoretical guarantees need not preclude success." Notably, one of the authors is John Martinis, a leading quantum-computing researcher who has tempered his optimism with caution in the past.

Somewhat similarly, when investor and tycoon Sam Altman introduced Chad Rigetti, CEO of Rigetti Computing, at an event in September 2016, Altman initially bragged, "They are getting close to a quantum supremacy machine," but immediately followed this remark with "I have a particular love for the start-ups where they're trying to do something; it's not clear if it's technically possible, but if they do, they change the world." IBM's omission of a time frame for commercializing quantum computing further suggests that hopes, not secret discoveries, are fueling the current wave of optimism about quantum computing.

Impacts/Disruptions

US companies are not alone in developing quantum computing. Canada has a significant competitive effort (note that Canadian researchers were instrumental in the initial development of deep learning). Countries in the European Union have invested approximately €550 million over the past two decades, and plan to initiate a €1 billion, 10-year development program for "quantum technologies" (including quantum computing) during 2018. Furthermore, in March of this year, New America Foundation analyst John Costello testified to the US Congress that "Chinese advances in quantum information science have the potential to surpass the United States." Although quantum computing is the goal of a race that no one is certain can be won, no contestant wishes to see anyone else take the prize first.

Scale of Impact	**Low**	**Medium**	High	
Time of Impact	Now	**5 Years**	10 Years	15 Years

Opportunities in the following industry areas:
Theoretical computer science, superconducting materials, refrigeration systems, cloud services

Relevant to the following Explorer Technology Areas:
• Artificial Intelligence • Big Data • Nanoelectronics

STRATEGIC BUSINESS INSIGHTS

EXPLORER

Viewpoints

April 2017

Artificial Intelligence

By Sean R. Barulich and Michael Gold (mgold@sbi-i.com)
Barulich is a research analyst with Strategic Business Insights.

AI Start-Ups Specializing in Health Care

Why is this topic significant? The health-care sector appears to offer some of the best prospects for the commercialization of AI beyond the clique of elite web-scale players such as Google, Facebook, and Microsoft.

Description

Several start-ups that have raised at least $25 million in venture capital investments concentrate exclusively on the health-care sector and make extensive use of AI:

- AliveCor sells a $99 finger pad that is about the size of a pack of gum and that transforms a smartphone into an electrocardiograph. The company, which has received $43 million in investments so far, is developing software that uses machine learning to detect when heart readings indicate irregularities in heart rhythms.

- Apixio seeks to make sense of unstructured data in medical records by applying machine learning to improve natural-language processing. The company has reportedly received about $42 million in venture-capital investments.

- BenevolentAI uses machine learning to predict the behaviors of molecules that are under evaluation in drug-discovery projects. The company is worth about $1 billion, according to CB Insights, and has raised about $141 million in investments.

- Babylon Health is reportedly developing a virtual-doctor app that will interview patients, capture data from wearable sensors, and generate medical recommendations. The company, which currently operates a service that includes smartphone-based consultations with human doctors, has received $25 million in investments.

- Butterfly Network is developing an ultraportable ultrasound-imaging system and plans to use deep learning to recognize features in images and to automate diagnoses. The company has raised $100 million in investments.

- Gauss Surgical provides a platform that uses computer vision to monitor blood loss during surgery. The company has received about $31 million in investments.

- Ginger.io combines smartphone data with online psychotherapists to help people who are stressed, anxious, or depressed. The company reportedly uses machine learning and a database of 1.4 million standardized mental-health assessments to infer states of mind. The company has received about $28 million in investments.

- Roam Analytics uses machine learning in its data-analytics software suites for sales and business development teams in organizations that sell drugs, medical devices, and other goods in the life-sciences sector. The company has received about $31 million in investments.

Implications

Patients will see the greatest impacts of AI at the point of care, especially if that point consists of a smartphone, as in the cases of AliveCor, Babylon Health, and Ginger.io. Providers of care in clinics, emergency rooms, and hospitals might see the greatest effects from new tools such as those from Butterfly Network and Gauss Surgical. Yet from an industry-wide perspective, AI might have its greatest near-term impact in back offices, as in the cases of Apixio and Roam Analytics, and in medical research, as in the case of BenevolentAI.

Impacts/Disruptions

Entrepreneurs want to have a positive impact on a potentially very profitable business, so they are naturally attracted to the health-care sector. The use of AI to solve hard problems in medicine is worth trying because the rewards are potentially very high. But entrepreneurs need to be realistic about the risk that they might still be years away from establishing decisive roles for AI in extending lifespan and keeping health care affordable. Preparation of treatment plans commonly involves justification—a weak point for AI, which typically produces results with no explanation. AI still has a mixed track record in solving difficult nonmedical problems in domains where success is not a life-or-death matter, such as in robotics, education, and language translation.

Scale of Impact	Low	**Medium**	High	
Time of Impact	Now	**5 Years**	10 Years	15 Years

Opportunities in the following industry areas:
Health-care providers, pharmaceuticals, insurance, electronics manufacturing, cloud services, software development, data science, data-center engineering and operations

Relevant to the following Explorer Technology Areas:
• Artificial Intelligence • Big Data • MEMS/Micromachining • Nanobiotechnology • Pervasive Computing • Portable Electronic Devices • User Interfaces

Explorer provides up-to-date evaluations and analysis of business opportunities arising from technology commercialization. Explorer filters information, provides perspectives on developments, and allows users to focus on what they need to help their decision processes. For more information about Explorer, visit our website at www.strategicbusinessinsights.com/explorer , or email: info@sbi-i.com.

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April 2017

P1053

Resilient Infrastructure Materials

By Marianne Monteforte (Send us feedback.)

New materials and technologies have the potential to make infrastructure more resilient.

Abstracts in this Pattern:

SC-2017-03-01-090 on bridge
SC-2017-03-01-074 on biocement
SC-2017-03-01-058 on sensors
SC-2017-03-01-045 on magnetic ink

The use of innovative materials in construction may enable significant advances in infrastructure resiliency. For example, the Washington State Department of Transportation (Olympia, Washington) is testing an earthquake-resilient bridge in Seattle, Washington. This test follows 15 years of research at the University of Nevada, Reno (Reno, Nevada), Earthquake Engineering Laboratory. An important feature of the bridge is its advanced columns, each of which comprises a bendable concrete composite that contains integrated shape-memory-alloy rods. During lab tests, the columns "were able to return to their original shape after an earthquake measuring 7.5 on the Richter Scale." A new type of biocement is another material that could see use to mitigate the risk of damages to infrastructure. Researchers from Newcastle University and Northumbria University (both Newcastle upon Tyne, England) genetically modified *E. coli* bacteria to create a biocement capable of responding to pressure and strengthening the soil that surrounds it.

The ability to sense impending critical failure in materials will guide maintenance efforts and therefore play an important role in making structures more resilient. Manufacturers can benefit from the use of sensors to monitor the structural integrity of infrastructure; however, using sensors can require a costly investment because of the need to power the sensors and process the data they collect. Researchers at the Vanderbilt University (Nashville, Tennessee) Laboratory for Systems Integrity and Reliability have developed an alternative to electronic sensors: By incorporating fluorescent nanoparticles into a clear polymer resin, the researchers created a material that changes color when it takes damage or is about to experience failure. Although this color-changing material will not enable remote diagnostic testing as some electronic sensors can, such nanoparticle-based sensing technologies can find use in the preventive maintenance of infrastructure elements and make visual inspections faster, cheaper, and more reliable. For such sensors to play an important role in establishing infrastructure resiliency, they must be reliable. Researchers at the University of California, San Diego (La Jolla, California), have developed self-healing magnetic ink for use in printing self-healing devices. Such magnetic-ink-based devices can "repair tears as wide as 3 millimeters—a record in the field of self-healing systems." The ink could find use to create self-healing electrochemical sensors, textile-based electrical circuits, and batteries.

Signals of Change related to the topic:

SoC913 — Making…Environments Smart
SoC853 — …Infrastructure Sensors
SoC704 — Incredible Materials

Patterns related to the topic:

P0996 — Biological Material in Architecture
P0813 — Infrastructure Sensors
P0693 — …Smart Infrastructure

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May 2017

P1065

Wasted Opportunities

By Rob Edmonds (Send us feedback.)

Companies are turning to technology to help reduce waste and to extract new value from it.

Abstracts in this Pattern:

SC-2017-04-05-001 on space junk
SC-2017-04-05-102 on electronic waste
SC-2017-04-05-084 on ammunition
SC-2017-04-05-040 on sewage

Waste is a challenging by-product of population growth and increasing prosperity. Even space has a waste problem that requires new remediation strategies. On Earth, waste of all kinds is increasing, and some new forms of waste are particularly problematic. According to a recent report by United Nations University (Tokyo, Japan), an agency of the United Nations (New York, New York), electronic waste in Asia has increased by 63% in five years, and the amount of electronic waste that China generates has more than doubled. Increasing affluence in Asia has enabled consumers to purchase phones, tablets, refrigerators, computers, and televisions, thereby fueling the increasing generation of electronics waste. In 2015, each person in Hong Kong, China, generated an average of 21.7 kilograms of electronic waste—the highest average in Asia.

Manufacturers and governments need solutions to the growing waste problem, and increasing the use of biodegradable materials is one potential solution. In late 2016, the US Department of Defense (DoD; Arlington County, Virginia) released a solicitation for proposals for methods to manufacture seed-containing biodegradable ammunition. The effort focuses on ammunition for use in military training exercises because such exercises currently account for the use of hundreds of thousands of ammunition rounds at training facilities around the world. The DoD envisions biodegradable ammunition that contains bioengineered seeds that eventually grow into plants that consume the biodegradable ammunition. Plausibly, this effort by the DoD could benefit manufacturers in other sectors that aim to reduce the environmental impact of their products.

Improving recycling and developing new methods for extracting value from waste may also play important roles in addressing the waste problem. Researchers from Ghent University (Ghent, Belgium) recently found a way to extract energy from wastewater by using bacteria that feed on organic substances in domestic sewage. The process involves using bacteria to collect the trace amounts of organic matter in wastewater and then harvesting the organic matter that the bacteria have not digested. This organic matter can see use in the production of energy and various products. The researchers estimate that their process can recover as much as 55% of the organic matter from sewage—an increase over the 20% to 30% that existing processes achieve.

Signals of Change related to the topic:

SoC913 — …Urban Environments…
SoC769 — Sustainable Cities
SoC676 — Reevaluating Soot

Patterns related to the topic:

P0899 — Waste as a Resource
P0672 — Extracting Value from Waste
P0644 — Goods from Garbage

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May 2017

P1066

Mapping the Unmapped

By Martin Schwirn (Send us feedback.)

Cartography is an enabler of a wide range of applications. New initiatives look at mapping nautical, oceanic, and biological information.

Abstracts in this Pattern:

SC-2017-04-05-062 on nautical mapping
SC-2017-04-05-006 on oceanic mapping
SC-2017-04-05-052 on biological mapping

Because of diminishing sea-ice levels, the Northwest Passage—a sea route that connects the Atlantic Ocean and the Pacific Ocean via the Arctic Ocean—is opening up for maritime traffic for longer periods of the year. Use of the Northwest Passage could reduce travel time for cargo ships substantially, but reliable information necessary for navigating the route safely is still lacking. Researchers from the Fraunhofer Institute for Communication, Information Processing and Ergonomics (Fraunhofer Society for the Advancement of Applied Research; Munich, Germany) and Canadian colleagues are working on PASSAGES (Protection and Advanced Surveillance System for the Arctic: Green, Efficient, Secure)—a project that aims at "conducting the preparatory work for a safe navigation through the icy waters." The project has two major goals. First, the researchers need to develop an understanding of what technologies could see use to gather missing data. Second, the researchers need to develop an algorithm that enables the fusion of data from multiple sources.

Efforts to map the topography of the floors of Earth's bodies of water are also under way. For example, General Bathymetric Chart of the Oceans (GEBCO)—which operates under the joint auspices of the International Hydrographic Organization (La Condamine, Monaco) and the Intergovernmental Oceanographic Commission of UNESCO (United Nations; New York, New York)—"aims to provide the most authoritative, publicly-available bathymetry data sets for the world's oceans" (www.gebco.net). GEBCO is working with the Nippon Foundation (Tokyo, Japan) and other organizations from around the world to create a complete map of Earth's ocean floor. A thorough map of the ocean floor could benefit navies and companies in a broad array of industries.

And medical scientists are trying to combine large biological data sets to create maps of networks within the human body. For example, researchers are trying to gain an understanding of the interplay among the genome, proteome (the proteins of an organism), and metabolome (the metabolites produced by biological processes). Detailed maps of biological networks that show "the intertwining routes between genes and outcomes" and the various factors that can alter those routes could see use to advance personalized medicine, enabling doctors to treat patients on the basis of the specific network dynamics responsible for their condition, for example.

Signals of Change related to the topic:

SoC862 — Cartography's Next Frontiers
SoC594 — Ultimate Cartography
SoC153 — Democratizing Cartography

Patterns related to the topic:

P0944 — Map Enablers
P0867 — New Cartography
P0702 — Cultural Cartography

STRATEGIC BUSINESS INSIGHTS

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May 2017

P1067

Ensuring the Global Food Supply

By Ivona Petrache (Send us feedback.)

Novel research and technologies could help ensure that the global food supply will meet food demand.

Abstracts in this Pattern:

SC-2017-04-05-030 on rice
SC-2017-04-05-035 on insects
SC-2017-04-05-049 on soil
SC-2017-04-05-013 on cows

Food scarcity is creating safety issues. For example, in Nigeria, the government banned rice imports to boost local production, and inflation has significantly increased the cost of rice. Some people used the combination of high demand, high prices, and food scarcity as an opportunity to sell food forgeries. Nigerian authorities have seized more than a hundred bags of plastic rice that is unsafe for human consumption.

Organizations are looking at the widest range of approaches conceivable to ensure food protection globally without the need for extensive or extreme food-protection solutions. In this context, genetically modified organisms (GMOs) can find application in novel ways. For example, the US Department of Defense's (Arlington County, Virginia) Defense Advanced Research Projects Agency (DARPA; Arlington, Virginia) launched Insect Allies—a new program that aims to use insects to transmit genetically modified plant viruses capable of protecting plants during a growing season. The program is very innovative, but the use of GMOs in plants will likely evoke environmental, health, and safety concerns.

Interventions such as the use of GMOs might be unnecessary to maintain the global food supply if organizations develop technologies that keep the soil healthy. Organic components in soil are critical for plant health and the absorption of nutrients into plants. A healthy soil can decrease the effects of drought on and ensure nutrient availability for crops. In an article in the journal *Ecohydrology & Hydrobiology,* Rattan Lal, a professor of soil science at the Ohio State University (Columbus, Ohio), highlights the importance of maintaining soil health to secure the global food supply and to adapt to the effects of climate change.

Technologies that focus on the health of farm animals also play a role in maintaining the global food supply. SmaXtec (Graz, Austria) developed a sensor device that monitors the vital statistics of cows on dairy farms. Farmers position the battery-powered device in the first of a cow's four stomachs. The device then collects and transmits data about the cow's health—for example, the cow's temperature and the pH of the cow's stomach, how much the cow moves, and how much water the cow drinks. The device enables farmers and veterinarians to monitor the health of individual animals and reduce the spread of diseases through the herd. At the end of 2016, 350 farms in nearly 24 countries were using SmaXtec's sensor to monitor 15,000 cows in total.

Signals of Change related to the topic:

SoC904 — …Efficiencies in Food Production
SoC782 — Food Production…
SoC629 — Feeding People…

Patterns related to the topic:

P0884 — Food (of) Concern
P0700 — Regional Food Battles
P0228 — Focusing on Food

April 2017

SoC933

Snooping Technologies

By Peter Batty (Send us feedback.)

In part because of its ability to address users individually and to customize results and uses to individuals' interests and preferences, the internet has become an enabling technology for communication, applications, devices, and services. Such customization requires an understanding of individuals' interests and preferences. As technologies enable increasingly advanced customization and personalization, technologies' increasingly intrusive approaches to gain an understanding of users generate criticism. The line between customer service and privacy infringement is becoming narrower as technologies improve and novel approaches emerge.

Facebook (Menlo Park, California), for example, is showing users advertisements for products and services that the users searched for elsewhere on the web. To deliver such targeted advertisements, Facebook makes use of scores of data points to describe each user on the basis of what he or she "likes" and shares. A smart, expansive advertising network is also key to Google's (Alphabet; Mountain View, California) business, which makes the majority of its revenue through advertising on its search engine. The search engine and the company's additional products and applications extract user information, and this user information enables highly targeted advertising, which attracts advertisers. Some companies are less subtle, despite essentially chasing the same goal. SilverPush (Gurugram, India) created a technology that listens for ultrasonic sound from TVs and then uses the data to identify and track a person's watching habits. However, in early 2016, the US Federal Trade Commission (FTC; Washington, DC) warned app developers to cease using code that listens for inaudible sounds. SilverPush ceased development of its technology in March 2016 but claims it did so for business reasons, not because of the FTC's warning and various privacy concerns.

The line between customer service and privacy infringement is becoming narrower.

In February 2017, the FTC announced that TV manufacturer Vizio (Irvine, California) had agreed to pay a $2.2 million settlement relating to charges that it installed tracking software in its TVs without the consent and knowledge of users. The technology enabled Vizio to monitor what people were watching in real time and then aggregate and sell these viewing data to third parties without the knowledge and consent of the people watching the TVs. Similarly, LG Corporation (Seoul, South Korea) came to the attention of the UK Information Commissioner's Office (Wilmslow, England) in 2013, after information-technology consultant Jason Huntley noticed that his LG smart TV sent LG a variety of data, including information about his watching habits and even the names of files on any USB drives he connected to the TV. LG later modified the TV software to enable users to turn off the data-collecting function.

But some consumer segments may believe that exchanging some personal data and therefore privacy for better services that provide increasingly relevant information may be a worthwhile trade. Amazon.com's (Seattle, Washington) Alexa intelligent personal assistant is akin to Apple's (Cupertino, California) Siri, Google's Google Assistant, and Microsoft's (Redmond, Washington) Cortana. Alexa is at the core of the Amazon Echo smart speaker and a crucial feature of Fire tablets, other devices, and even some appliances. Like other intelligent personal assistants, Alexa aims both to answer common queries (about weather forecasts, for example) and to act as a gateway to the ecosystem

of products and services of the company that developed it. Alexa is creating a more seamless shopping experience by reducing the number of hurdles between consumers' searching for a product or service and making a purchase, and it is collecting a wealth of information about consumers' interests and shopping habits as it does so. Amazon.com can also tie this information to information it collects from other services such as its video-streaming service. Google recently released the Google Home smart speaker, which is similar to and therefore competition for the Amazon Echo.

Recent advances in artificial intelligence (AI) and speech-recognition research are leading to breakthroughs that will improve related services even more. In October 2016, a system of neural networks under development by researchers and engineers at the Microsoft AI and Research Group set a new record in speech-transcription accuracy. The Microsoft system listened to conversations between humans on the telephone and achieved a word-error rate of 5.9%—a noteworthy improvement over the system's previous record of 6.3% from about one month earlier. The system now performs as well as humans do and could eventually replace professional human transcriptionists. Such advanced speech-recognition technologies could see use to equip Cortana and other intelligent personal assistants with speech-to-text functionality that could find use in snooping applications. Other researchers are developing technology that also could enable snooping. For example, researchers from Alphabet's DeepMind AI subsidiary and the University of Oxford (Oxford, England) developed an AI system that can lip-read TV shows better than humans can.

The better AI becomes at using recognition technologies to identify individuals, the more challenging the privacy trade-off will become for companies and individuals alike. Augmented-reality (AR) company Blippar (London, England) is adding a facial-recognition function to its visual-discovery AR app. The new function enables users to scan the face of a person (whether the person is physically present or in a photo or video) with a smartphone camera to prompt the app to provide links to information about that person—for example, social-media profiles and entries on *Wikipedia* (Wikimedia Foundation; San Francisco, California). Blippar's app can already recognize more than 70,000 so-called public figures, and users will be able to add their own information and details to the app's database. According to Blippar, AI will determine whether someone is trying to add a person to the database without that person's permission, although how effective this system will be is unclear. Moreover, because Blippar uses links to *Wikipedia* entries, which essentially anyone can create and edit, the potential for abuse exists. Russian online service FindFace (N-Tech.Lab; Nicosia, Cyprus) demonstrated that facial-recognition technology is now effective enough that it can work with a social network to reveal the name of and other details about a person from a single photograph. Users upload a photograph of a person, and FindFace uses Russian social-networking service VK (VKontakte; Saint Petersburg, Russia) to identify the person in the photograph.

Although analysts tend to overestimate the potential negative impact that privacy intrusions can have on a company's success and longevity, new concerns about privacy, safety, and security will likely emerge as technologies capable of snooping on people advance. At the same time, consumers will expect improvements in the quality and personalization of applications, products, and services. In 2008, SoC295 — Privacy Trade-Offs highlighted that trade-offs exist between privacy on the one hand and factors such as utility, efficiency, and convenience on the other. Such trade-offs will become only more delicate as technologies advance and new approaches emerge.

SoC933

Signals of Change related to the topic:
SoC729 — Surveillance Activities…
SoC586 — From Face Recognition…
SoC295 — Privacy Trade-Offs

Patterns related to the topic:
P0849 — Privacy in Public?
P0843 — Privacy and Security…
P0722 — Privacy Fallacy

STRATEGIC BUSINESS INSIGHTS

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April 2017

SoC937

Mobile Power Solutions beyond Batteries

By Cassandra Harris (Send us feedback.)

Novel power-generating technologies can enable a wide range of mobile devices and overcome many of the shortcomings of traditional battery technologies. These novel power-generating technologies could support the technological and commercial advancement of a variety of emerging applications. Despite advances in conventional power solutions—notably, rechargeable lithium-ion (Li-ion) batteries (see P1013 — Making the Most of Lithium-Ion Batteries)—concerns exist that current common energy-storage solutions will be unable to support the power requirements of increasingly advanced portable electronic devices (for related examples, see SoC891 — Smartphone Apps as Product Features).

Concerns exist that current common energy-storage solutions will be unable to support the power requirements of increasingly advanced portable electronic devices.

Energy-harvesting (or energy-scavenging) technologies convert various types of energy into usable electricity. Because such technologies do not require recharging and have the potential to produce power continuously, they represent an attractive alternative to Li-ion batteries as a power solution for electronic devices. Researchers at the Pennsylvania State University (University Park, Pennsylvania) have developed a flexible and transparent polymeric diode that converts low-frequency mechanical motion into electricity. The device could find use as a touch screen for electronic devices and convert the mechanical energy from a user's touching the screen into electricity for device batteries, thereby reducing the batteries' need for recharging. The researchers hope that the diode will be able to provide 40% of the energy a next-generation smartphone requires of its battery. The limitations of current power-generation technologies may represent a critical barrier to the adoption of various wearable technologies, so many organizations are looking at new ways to provide energy in mobile environments. For instance, start-up Matrix Industries (Menlo Park, California) has created what it claims is the world's first smartwatch that does not require charging. The PowerWatch smartwatch relies on a thermoelectric generator for power, and the generator uses the differential between the temperature of a wearer's body and the temperature of the watch's metal housing to create an electric current. Because the watch never needs recharging, it has a distinct advantage over Apple's (Cupertino, California) Apple Watch and similar devices that use Li-ion technology and therefore require frequent recharging.

Electronic implants for use in medical and human-augmentation applications are garnering interest (see P1007 — Medical Implants); however, a need exists for power solutions capable of increasing the life span of implantable electronic devices. For example, a typical cardiac pacemaker contains a battery that is not rechargeable and therefore needs replacing after five to ten years. Replacing the battery usually involves replacing the entire pacemaker unit, which can lead to medical complications. Scientists are looking for ways to generate electricity at or within the human body. For instance, researchers from the University of Bern (Bern, Switzerland) and other institutions recently conducted a study that confirmed the viability of implanting solar cells under human skin to power medical devices continuously. The miniaturization of microelectronic devices will enable more widespread use of technologies such as sensors and medical implants. Researchers

at the University of Oulu (Oulu, Finland) are studying the perovskite material KBNNO, which can simultaneously convert solar energy, temperature changes, and mechanical energy into electricity. The researchers claim that KBNNO could pave the way for advances in device miniaturization and find use in novel multifunctional sensors and multisource energy harvesters that could improve the efficiency of power-consuming devices.

To appeal to a large number of commercial users, drones must have long flight endurance and be capable of transporting equipment for operations such as surveillance and remote sensing. Combustion-engine-powered drones are noisy and large and pollute the environment, and battery-powered drones have limitations because of the shortcomings of the batteries they use. Fuel-cell-powered drones have lower noise, heat, and vibration signatures than do combustion-engine-powered drones, and fuel cells have higher energy densities than do Li-ion batteries. Fuel-cell technology could enhance the flight endurance and functionality of drones and benefit commercial users of the technology. H3 Dynamics (Singapore, Singapore) recently unveiled Hywings—a prototype fuel-cell-powered drone that weighs only 7 kilograms. The drone can fly for ten hours without refueling, which gives it a flight distance of 500 kilometers. To enable a variety of applications, H3 designed the drone to work with three payloads: a high-definition video camera, a thermal-imaging camera, and a multispectral camera. A telemetry system enables an operator to control the drone remotely from as far as 290 kilometers away.

Developments in long-duration power-storage solutions could enable space-system operators to conduct longer missions. Researchers at the NASA (Washington, DC) Jet Propulsion Laboratory are developing skutterudite thermoelectric materials for use in the agency's next-generation nuclear-battery system. Nuclear batteries use thermoelectric materials to convert heat from the radioactive decay of plutonium-238 into electricity. According to the researchers' analyses, the skutterudite-based nuclear-battery system will generate 25% more power than do the nuclear-battery systems currently in use and require smaller amounts of expensive plutonium-238. Batteries with millennia-long life spans could eventually become a reality. Researchers at the University of Bristol (Bristol, England) claim that radioactive graphite waste from nuclear reactors could see use to produce batteries with life spans longer than 5,000 years. When in a radioactive field, synthetic diamonds produce an electrical current. According to the researchers, synthesizing diamond from radioactive graphite—which is rich in radioactive carbon isotope carbon-14—encloses a radioactive field within the diamond itself, causing the diamond to produce an electric current until the carbon-14 has radioactively decayed (about 5,730 years). This technology has potential uses in a variety of remote and unmanned terrestrial and space applications.

SoC937

Signals of Change related to the topic:
SoC815 — New Batteries…
SoC763 — Innovations in Battery Technology
SoC626 — New-Battery Beginnings

Patterns related to the topic:
P1043 — …Thermoelectric Materials…
P1013 — …Lithium-Ion Batteries
P0924 — Better Batteries

Strategic Business Insights

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May 2017

SoC942

High-Tech Emergency Response

By Cassandra Harris (Send us feedback.)

The economic cost of natural disasters can be substantial, and such disasters can affect thousands of people within seconds; the availability of advanced disaster-relief tools to governments and relief organizations can save precious time, costs, and—most important—lives. New technologies that support emergency-response efforts at local and national levels are under development.

During disasters, evacuation efforts can quickly lead to traffic congestion, and the reactions of panicked motorists can greatly inhibit evacuation and emergency-services efforts. Brian Wolshon—founding director of the Center for Evacuation and Transportation Resiliency, which is a joint effort by Louisiana State University (Baton Rouge, Louisiana) and the University of New Orleans (New Orleans, Louisiana)—believes that the deployment of large numbers of connected cars could decrease evacuation times and save lives, because the cars would provide drivers with routing information to help them make better use of road networks. Connected cars would also provide drivers with information about nearby food, shelter, and medical services. Although fully autonomous vehicles are many years from commercialization, automakers, researchers, and technology companies are developing concepts for advanced autonomous-vehicle technology. For example, in September 2016, Google (Alphabet; Mountain View, California) filed a patent application for a technology that enables driverless cars to detect emergency vehicles automatically. The technology uses sensors to identify the lights of emergency vehicles and then causes the car to respond accordingly by moving to the side of the road.

The availability of advanced disaster-relief tools to governments and relief organizations can save precious time, costs, and—most important—lives.

In the chaos that follows a major disaster, ground-based communications networks may be out of operation, which makes locating survivors and knowing what infrastructure is accessible difficult for emergency responders. China's National Earthquake Response Support Service (Beijing, China) is deploying drones that use visible-light, infrared, multispectral, and hyperspectral sensors to survey regions affected by earthquakes. The drones then relay data and images to monitoring centers, enabling response teams to use this information to help them locate survivors and identify rescue routes more efficiently, thereby increasing their chances of retrieving survivors. Organizations in nations other than China are also using drones for emergency-relief efforts that follow major disasters. The Central United States Earthquake Consortium (Memphis, Tennessee), which is working to prepare a region that spans eight states for earthquakes that could occur in the New Madrid Seismic Zone, is building a network of licensed drone pilots who can assist in earthquake-response efforts. And the United Nations (New York, New York) International Children's Emergency Fund and the government of Malawi are developing an air corridor in Africa to test the use of drones for collecting imagery and transporting supplies during humanitarian crises. The project will also explore the possibility of using drones to extend Wi-Fi or cell-phone signals across challenging terrain.

Communications networks are critical to saving lives in emergency situations. Because first responders use commercial networks for mobile data and applications, these networks' quickly becoming congested after a disaster occurs can make communications and rescue efforts

challenging. In March 2017, the US Department of Commerce (Washington, DC) and the First Responder Network Authority (Reston, Virginia) tasked AT&T (Dallas, Texas) with developing and managing a nationwide high-speed broadband network that enables first responders to communicate in real time in the event of a crisis or natural disaster.

In the United States, more than 70% of 911 (the US emergency telephone number) calls come from cell phones; however, locating the people who make these calls is challenging because cellular devices do not make a direct connection with the 911 call center. When a person uses a cell phone to call 911, information transfers over a cellular network, and callers often need to give the 911 operator information about their location. The Federal Communications Commission (Washington, DC) estimates that inaccurate information about the location of emergency victims results in the loss of at least 10,000 lives annually in the United States. RapidSOS (New York, New York) has developed Haven—a smartphone app the company claims will dial 911 at the click of a button and send the user's location, medical information, and type of emergency to the nearest dispatch center. RapidSOS CEO Michael Martin highlights that smartphones have the ability to collect a variety of data, but 911 call centers do not receive access to those data when someone uses a smartphone to call 911. In December 2016, Google launched Trusted Contacts—a personal-safety app for the Android operating system. The app enables users to flag contacts as "trusted" and share their location information with those trusted contacts. Trusted contacts can request location information from the user, and if the user does not respond to the request within five minutes, the user's location—or last known location—goes to the trusted contact who made the request. This app could enable people to find one another in emergency situations that prevent a person from using his or her smartphone.

Enabling communication across multiple types of networks and means of communication can be difficult, but the failure to do so can lead to a disruption of information flow. To address this problem, the US Department of Commerce's (Washington, DC) National Institute of Standards and Technology (NIST; Gaithersburg, Maryland) developed a high-tech way to integrate the variety of means of communication—for example, walkie-talkies and cell phones—in use by first responders. NIST worked with industry partners to devise the Rapidly Deployable Public Safety Research Platform—a universal platform that enables multiple types of devices and protocols to work together. The platform enables "local users of broadband smart phones, Wi-Fi, data terminals and older walkie-talkie radios to all communicate with each other using voice, text, instant messages, video and data" ("NIST's rolling wireless net helps improve first-responder communications," Phys.org, 10 August 2016; online).

In the aftermath of a disaster, the accurate and timely delivery of humanitarian aid can be essential in saving lives. Windhorse Aerospace (Wells, England) is developing Pouncer—a disposable drone that can carry a 50-kilogram payload of food, water, and medical supplies 40 kilometers and land at its destination with an accuracy of about 10 meters (thanks to an onboard navigation system). Pouncer's preformed shell can provide shelter, and its wooden frame can serve as fuel for a fire that provides warmth and cooks food. Windhorse founder Nigel Gifford claims that Pouncer can deliver humanitarian aid more quickly, more cheaply, and more accurately than can the conventional aid-delivery methods currently in common use.

SoC942

Signals of Change related to the topic:
SoC913 — Making…Environments Smart
SoC909 — Augmented…X-Ray Vision
SoC853 — …Infrastructure Sensors

Patterns related to the topic:
P0933 — In Case of Emergency…
P0545 — …Tools for Crisis Management
P0453 — Managing Natural Disasters

STRATEGIC BUSINESS INSIGHTS

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May 2017

SoC944

Exploring Biobased Materials

By Ivona Petrache (Send us feedback.)

Around the world, consumer and government demand for renewables and sustainability concepts is increasing—especially in North America and Europe, where governments are introducing progressively stringent regulations. A growing number of companies in various industries are embracing the use of biobased materials in their products and even changing the types of biobased materials they use to address resource considerations. Tire manufacturer Continental (Hannover, Germany) is investigating replacing the natural rubber from *Hevea brasiliensis* (rubber tree) in its tires with a material from Russian dandelions. Modern vehicle tires still comprise 10% to 30% natural rubber from *Hevea brasiliensis*. Synthetic rubber is available, but natural rubber provides better wear characteristics. Problematically, rubber trees can grow in only certain climates close to the equator, which makes them vulnerable to both environmental and political changes. The latex from the roots of Russian dandelions provides wear characteristics comparable to those of natural rubber, and Russian dandelions reach their harvest phase much quicker than do rubber trees. Continental is collaborating with researchers from the Fraunhofer Institute for Molecular Biology and Applied Ecology (Fraunhofer Society for the Advancement of Applied Research; Munich, Germany), the Julius Kühn Institute (Quedlinburg, Germany), and Aeskulap (Steinach, Germany) to breed strains of Russian dandelion that yield the optimum amount of latex. Exploring alternative sources for various materials can improve the security of companies' supply chains and potentially even offer commercial advantages.

Materials scientists and manufacturers are striving to develop technologies and processes capable of minimizing the use of fossil fuels in the production of plastics and other materials.

Using established manufacturing processes, suppliers of materials such as additives and plastics are increasing the number of commercially available biobased materials. For example, in September 2016, Clariant (Muttenz, Switzerland) and Global Bioenergies (Évry, France) announced the industrial-scale production of biobased *isobutene*—a chemical compound in use for the production of derivatives such as the fuel additive isooctane. Clariant uses second-generation sugars from nonfood sources to produce hydrolysates. Global Bioenergies uses these hydrolysates and a bacterial fermentation to process biobased isobutene. Key application areas of biobased isobutene include the transportation, specialty-fuels, and engineering-polymers industries.

The variety of feedstock materials is increasing. For example, start-up Cine'al (Tel Aviv, Israel) developed *hydromash*—a biodegradable material that derives from the flesh of jellyfish and can absorb liquids in large quantities. To produce hydromash, Cine'al breaks down jellyfish flesh and incorporates antibacterial nanoparticles into it. This process removes the jellyfish sting and converts the jellyfish flesh into a strong and flexible biodegradable material. Cine'al is developing hydromash-based diapers and feminine-hygiene products and claims that these products biodegrade within 30 days.

Automotive manufacturers are expressing interest in making some automotive components out of biobased materials instead of petroleum-based materials. For example, Ford Motor Company (Dearborn, Michigan) is working with Tequila Cuervo La Rojeña (Tequila, Mexico)

to develop a process for converting agave-plant waste from the tequila-production process into a sustainable bioplastic. Initial tests indicate that the new bioplastic is durable and possesses desirable aesthetic traits. Ford believes the bioplastic could see use in wiring harnesses, storage bins, and other interior and exterior vehicle components; however, to see wide use in vehicles, the new bioplastic will have to meet the same regulatory standards that existing automotive materials must meet.

Researchers are attempting to use novel biobased materials to provide the fashion industry with convincing cruelty-free alternatives to traditional leather. In addition to having a large environmental impact, the production of leather contributes to animal cruelty and human-rights violations. Biotech start-up Modern Meadow (New York, New York) is using DNA-sequence editing to grow hide-like collagen sheets for tanning into a leather material. Members of the company's multidisciplinary team edit the DNA of animal cells to instruct the cells to produce collagen fibrils. These collagen nanofibers eventually bundle into larger fibers that members of the Modern Meadow team assemble into a sheet of hide-like material. This sheet then undergoes what the company claims is an environmentally responsible tanning process and becomes a leather material. Although biofabricated leather material is likely very expensive, its cruelty-free status will almost certainly make it appeal to the growing body of ethically and environmentally conscious consumers. Researchers from Newcastle University and Northumbria University (both Newcastle upon Tyne, England) are also using genetic engineering in their work, but their focus is on the use of biobased materials in architecture and construction. The researchers genetically modified *Escherichia coli* bacteria to produce *biocement*—a material consisting of calcium carbonate formed by bacteria in soil—in response to pressure. According to the researchers, once the genetically modified bacteria are in the soil, they will respond to pressure from a structure by producing biocement, thereby strengthening the soil to support the structure. However, concerns about introducing genetically modified bacteria into native soil may create barriers to the commercialization of the researchers' approach.

Materials scientists and manufacturers are striving to develop technologies and processes capable of minimizing the use of fossil fuels in the production of plastics and other materials. For example, BioBTX (Groningen, Netherlands) and the University of Groningen (Groningen, Netherlands) developed a technology that produces paraxylene (p-xylene) without the use of fossil-fuel-based sources. The technology uses a catalytic-pyrolysis process to convert glycerin (a by-product of biodiesel production) into biobased p-xylene and other bioaromatic compounds such as biobased benzene and toluene. P-xylene sees use in the manufacture of terephthalic acid, which finds use in the production of bis(2-hydroxyethyl) terephthalate—polyethylene terephthalate's (PET's) intermediate compound. The technology BioBTX and the University of Groningen developed played a crucial role in an effort by a consortium of Dutch institutions to develop a process for using biomass to produce PET that is 100% biobased. And researchers from Washington State University (Pullman, Washington) and the University of Science and Technology Beijing (Beijing, China) used soy protein and bacterial cellulose to develop a biobased air filter that performs better than do normal air filters, which typically rely on petroleum-based materials. Normal air filters trap small airborne particles but do not filter out toxic gaseous molecules. The researchers claim their biobased filter material can capture both particles and gaseous molecules from toxins such as carbon monoxide, sulfur dioxide, and formaldehyde.

SoC944

Signals of Change related to the topic:
SoC704 — Incredible Materials
SoC641 — Harnessing Nature
SoC446 — Harnessing Living Materials

Patterns related to the topic:
P1018 — Biological Processing in Cleantech
P0996 — Biological Material in Architecture
P0920 — Sustainable Thoughts

STRATEGIC BUSINESS INSIGHTS

EXPLORER

Viewpoints

April 2017

User Interfaces

By Sean R. Barulich (sbarulich@sbi-i.com)

Augmented Reality for the Enterprise

Why is this topic significant? Augmented- and mixed-reality devices can improve productivity and collaboration in the workplace.

Description

Although virtual-reality (VR) devices—including Google's Daydream, Samsung's Gear VR, and Oculus VR's Rift—focus primarily on entertainment and gaming, some augmented-reality (AR) products are reaching for the untapped enterprise market. Augmented- and mixed-reality products including Microsoft's HoloLens and Upskill's Skylight platform have added capabilities and applications that will make the products appealing to enterprises.

Microsoft has focused primarily on the enterprise with the current commercial version of HoloLens, and the product is a leader amongst augmented/mixed-reality (AR/MR) devices. The HoloLens runs on Windows 10 and supports a suite of enterprise-ready software including Autodesk, SketchUp, Trimble, Skype, and various Office apps. These apps and the operating system distinguish HoloLens from its competitors. HoloLens is a stand-alone device that uses mixed-reality (MR) technology to overlay environments with computer-generated graphics, widgets, and applications.

Another tool focused on industrial applications is Upskill's Skylight software platform, which runs on Google Glass. Skylight aims to provide informative and directional line-of-sight overlays to assist workers without impeding their vision.

In another example, Intel's Project Alloy uses Intel's RealSense technology to map entire rooms in 3D for a "merged" reality experience (Project Alloy is clearly capable of delivering AR, although Intel describes it as a VR device). Intel is collaborating with Microsoft to produce Windows-based content and also plans to deliver Project Alloy as an open hardware platform and provide APIs for the Alloy ecosystem. This open approach will allow developers to customize the device for enterprise applications.

Implications

AR has the potential to serve enterprise and industry as an interactive, collaborative, and flexible tool. Employees can use AR software to complete immersive training, to visualize complex parts for manufacturing, and to share and collaborate on designs.

AR headsets can increase productivity and help workers complete technical tasks rapidly and safely. An Upskill video shows a side-by-side comparison of a GE technician completing a task with and without Skylight support, and it claims that the AR system increased productivity by more than 30%. AR could also benefit the military by providing detailed and informative heads-up displays (HUDs) that give military personnel tactical information.

Impacts/Disruptions

The use of AR/MR in enterprise or industry does have some obstacles. AR/MR devices that are enterprise-ready are limited and are not affordable enough for small businesses or for mass distribution (as was reflected in low AR device shipments in 2016). If devices including HoloLens and Project Alloy can prove their value through early success stories that demonstrate capability, productivity, or safety benefits, then companies may increase their adoption of the tools.

Companies need compelling AR applications for regular use in the workplace. Today, many AR product producers are still exploring applications; third-party development is still young; and must-have enterprise-use cases have yet to develop. Although enterprise applications demonstrate some practical utility, gaming and entertainment applications of AR and VR will provide the best pathway to cost reduction and mass-market distribution.

Scale of Impact	Low	Medium	**High**	
Time of Impact	Now	5 Years	**10 Years**	15 Years

Opportunities in the following industry areas:
Enterprise, design, entertainment, consumer electronics, manufacturing, military

Relevant to the following Explorer Technology Areas:
• User Interfaces • Collaboration Tools • Pervasive Computing

STRATEGIC BUSINESS INSIGHTS

EXPLORER

Viewpoints

April 2017

User Interfaces

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EEG Headsets

Why is this topic significant? Brain–computer interfaces are providing new means of interacting with an increasingly digital environment. Using electrical input from the brain or muscles expands the methods for interacting with devices and applications.

Description

"Brain–Machine Interfaces: An Update" in the March 2017 Viewpoints mentions that commercial electroencephalography headsets, despite having a lot of unreliability in output, do have successful applications. New developments in electroencephalogram (EEG) interfaces are improving the capabilities and benefits of noninvasive brain–computer interfaces and allowing EEG headsets to interact with advanced prostheses, robotics, and games.

EEGs such as Emotiv's EPOC and NeuroSky's MindWave record electrical brain patterns and undertake signal processing, data classification, and training to serve as brain–machine interfaces for prostheses, exoskeletons, or other devices. Both Emotiv and NeuroSky have provided development kits and digital software libraries, enabling consumers to control various applications and games using their EEG headsets. In medical research, subjects have used EEGs to control prostheses and robotic arms without requiring invasive electrode implants.

EEGs also serve personal health and wellness applications. For example, the Muse headband claims to track brain activity relevant to practicing meditation and gives feedback on focus and performance.

Implications

EEGs can provide raw brain-activity data for medical applications and devices including helping diagnose mental-health conditions or concussion. Although less accurate than internal implants, EEGs can also provide a noninvasive means of controlling prostheses without the harmful scarring that results from implanting internal electrodes.

In nonmedical contexts, EEGs can interact with applications and software for education, communication, and gaming. EEGs also have applications in military contexts including integrating with hardware for remote control, providing live biometric data for soldiers, and for improving training. Marketing and analytics companies may also use headsets for testing the

effectiveness of ad campaigns and advertising media. As medical research drives improvements in EEG headsets, such consumer and enterprise applications may follow.

Impacts/Disruptions

EEGs have broad application as a noninvasive means to integrate brains and machines. Some disadvantages are inherent to the noninvasive benefits of EEG brain–machine interfaces, such as reduced accuracy and resolution of data compared with invasive methods. Optimal performance of EEGs also requires they be worn tightly, with sensors close to the skin. EEG headset performance is lacking when compared with embedded sensors, but given time, improved sensors and data analysis could make more defined control via headsets possible.

A concern from a cybersecurity standpoint is that raw data could be harvested from headsets by means of malware, with users unaware. Although EEG data may remain a small target for some time, the possibility reinforces awareness of the growing risks of connected devices, especially when dealing with sensitive data.

Scale of Impact	Low	**Medium**		High
Time of Impact	Now	**5 Years**	**10 Years**	15 Years

Opportunities in the following industry areas:
Consumer electronics, software development, gaming, medical research

Relevant to the following Explorer Technology Areas:
• User Interfaces • Biosensors • Pervasive Computing

CURRENTLY AVAILABLE TECHNOLOGY AREAS

3D Printing
Artificial Intelligence
Big Data
Biocatalysis
Biomaterials
Biopolymers
Biosensors
Collaboration Tools
Connected Cars
Connected Homes
Electronic Displays
Energy Storage
Engineering Polymers
Fuel Cells
Human Augmentation
Membrane Separation
MEMS/Micromachining
Mobile Communications
Nanobiotechnology
Nanoelectronics
Nanomaterials
Novel Ceramic/Metallic Materials
Organic Electronics
Pervasive Computing
Photovoltaics
Polymer-Matrix Composites
Portable Electronic Devices
Renewable Energy Technologies
RFID Technologies
Robotics
Smart Materials
Solid-State Microsensors
User Interfaces

STRATEGIC BUSINESS INSIGHTS

EXPLORER

Viewpoints

May 2017

User Interfaces

By Sean R. Barulich (sbarulich@sbi-i.com)

Projected AR

Why is this topic significant? Projection-based AR is a headset-free system to display information or entertainment content directly on surfaces. The technology could turn blank walls and other empty spaces into interactive light-based displays and environments.

Description

Improvements in lighting and artificial-intelligence (AI) technology are encouraging vendors to develop new projectors for headset-free augmented-reality (AR) applications. One example of this technology is the Lightform computer. Lightform says that when the computer is available, it will integrate with a projector to create overlays of digital content on surfaces or throughout entire rooms. The system will apparently create the display using 3D scanning and AI-generated effects, and users will be able to control the projection via an app. The Lightform team is partly composed of researchers from Microsoft's IllumiRoom project (a research effort to create projected AR for gaming). Recently, gaming-hardware manufacturer Razer announced that it was developing its own projector—Project Ariana—that, similar to Microsoft's IllumiRoom, will project extended active displays across a room.

Another AR projector is Sony's T, in development at Sony's Future Lab Program. The concept-stage projector is an all-in-one device that scans a flat surface and can recognize gestures and track objects' physical characteristics, including dimensions, angular orientation, and position.

Some developers are also working on portable light-based AR devices that can act as stand-alone platforms. Finnish start-up HoloLamp is developing a projection-AR system that generates simulated 3D objects with face-tracking sensors that orient and alter projections specifically for one viewer. The projector requires connection to a computer, and users must also use a controller—though the team wants to implement gesture control of generated objects.

Implications

Although many AR-projection systems are still in early development and testing, they do offer some promising future applications in enterprise, entertainment, and education. Sony's T and Lightform have the potential to provide informative and dynamic displays in enterprise or storefront settings. Displays could make use

of free space on desks or walls and potentially provide notifications or allow for collaborative meetings or presentations. Educational institutions and teachers may use the projectors to display information or educational exercises directly on student desks.

HoloLamp or Project Ariana, if successful, will likely find applications in gaming and entertainment. Ariana will most likely not go beyond providing background visuals for conventional screen-based gaming experiences (such as IllumiRoom). By contrast, HoloLamp may provide a new gaming medium. HoloLamp's integration with Unity will help make the platform accessible to game developers.

Impacts/Disruptions

The commercial success of projection-based AR systems will likely be heavily dependent on software capabilities to distinguish the technology from potentially competitive headset-based AR systems. Benefits of projector-based AR systems such as full field of view and ease of use will be important marketing messages. Plausibly, if costs for AR projectors are low, consumers may purchase projector-based systems as well as headset-based systems to serve different needs. For example, projector-based systems may enhance home gaming, and headset systems may provide AR on the move. Whatever the competitive position, AR projector designers and manufacturers will need to demonstrate compelling practical and recreational applications to achieve any market success.

Scale of Impact	Low	**Medium**	High	
Time of Impact	**Now**	**5 Years**	10 Years	15 Years

Opportunities in the following industry areas:
Projector manufacturers, consumer electronics, software development, entertainment, gaming

Relevant to the following Explorer Technology Areas:
• User Interfaces • Collaboration Tools • Connected Homes • Pervasive Computing

STRATEGIC BUSINESS INSIGHTS

EXPLORER

Viewpoints

May 2017

User Interfaces

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Chat-Bot Interfaces

Why is this topic significant? Chat bots are showing promising applications in providing service information to users, mediating between consumers and third-party services, and processing payments.

Description

Chat bots are becoming common as devices to mediate local and third-party applications and services for users. "Conversation as a Platform" in the May 2016 Viewpoints emphasizes the commercial significance of chat bots on messaging platforms for mediating between users and third-party services.

One example bot is Babylon's artificial-intelligence (AI) chat bot for iOS and Android, which acts as an intermediary between patients and doctors. The helpline-like chat bot asks users specific health questions corresponding to their particular concerns. The system gathers data from responses and cross-references the data with data from other patients and a large collection of medical information that derives from journals to determine a course of action (for example, booking a video appointment with a specialist).

Facebook is now enabling bots for group chats. The group chat bots play a passive role in conversation but provide information, including real-time news, e-commerce delivery updates, and updates on live sports games. Facebook has faced criticism for the performance and utility of its Messenger bots—but until now, the bots were the primary conversation partners. Now, the group model emphasizes bots as a service for finding relevant content and information.

Other chat platforms—including Telegram, Slack, Skype, and Twitter—also support bots, but many platforms have no native navigation for finding and adding bots. Although some platforms such as WeChat and Facebook have some bot-navigation capability, some third parties have created services such as Botlist that help users find bots for specific purposes across multiple platforms.

Implications

Although some chat bots are novelties, serious applications such as customer-service automation and payment processing are emerging. In fact, chat bots using AI and natural-language processing could serve as efficient user interfaces for many services and may end up faster and more effective than interactions with humans in certain cases.

In addition, chat bots may support a lot of preliminary low-skill offerings such as basic legal documentation, low-level tutoring, or even tax or financial advice for users. Developing AI technology will help to improve chat bots as companies explore both passive and active roles for bots in messaging services.

Impacts/Disruptions

Currently, chat bots serve companies best by connecting users to products and services—perhaps removing some of the need for customer-service employees and other staff. Further benefits will come from AI technology that enables targeted solicitations (for example, automated sales interventions) and low-friction payments. Such payment services may turn out to provide a strong use case for chat-bot interfaces—through banks or person-to-person transactions. In addition, chat bots may provide highly targeted marketing by recommending relevant services or products based on users' discussions.

Scale of Impact	Low	Medium	**High**	
Time of Impact	**Now**	**5 Years**	10 Years	15 Years

Opportunities in the following industry areas:
Consumer electronics, software development, software services, machine learning, retail, financial services, health care, entertainment

Relevant to the following Explorer Technology Areas:
• User Interfaces • Artificial Intelligence • Collaboration Tools • Pervasive Computing