How are new graphics processing units (GPUs) changing artificial intelligence? How fast are neural networks evolving? Assessing the development of such novel technological capabilities—i.e., “technological emergence”—is an important part of Management of Technology (MOT). Being able to identify emerging themes in a research domain can improve opportunity analysis for research, R&D prioritization, technological innovation management, and national science policy.

In their 2016 CIMS IMR article Alan Porter and Ying Huang introduced “tech emergence indicators” (TEI, for short) as a means of exploring “Big Data and Analytics” by spotting hot topics within that field and the players actively pursuing them (1). In his article below, Porter introduces a new TEI set that quantifies the extent to which a new technological capability is emerging in the transition from research to targeted development programs. It illustrates the sorts of technical intelligence these indicators can provide for the case of nanotechnology.

Porter is Professor Emeritus, Industrial & Systems Engineering and Public Policy, and Co-Director, Program in Science, Technology & Innovation Policy (STIP), Georgia Tech; and Director of R&D at Search Technology, Inc.

The process of measuring R&D emergence begins by searching and downloading R&D publication or patent abstract records, usually from publicly available, global databases. Then, terms are consolidated and processed to distinguish “high emergence terms” that meet four sets of criteria concerning: 1) novelty, 2) persistence, and 3) rapid growth in usage, plus establishment of a 4) viable research community. After that, further processing distinguishes the players (researchers, R&D organizations or countries) that lead the field in addressing these “hot topics.”

Our efforts to develop Tech Emergence Indicators (TEIs) derive from participating in the IARPA FUSE Program (Intelligence Advanced Research Projects Activity—Foresight and Understanding from Scientific Exposition)
Our aim has been to identify cutting-edge R&D with strong prospects for innovation; then use that information to add value to current MOT decision processes. The current examples draw on a series of TEI sessions at the Portland International Conference on Management of Engineering and Technology - PICMET (3,4).

Four Distinguishing Attributes

Drawing on FUSE attributes and an extensive review of efforts to measure technological emergence by Rotolo, Hicks and Martin (5), we seek four attributes to distinguish emergent topical terms—those drawing increasing recent attention—within a technical domain of interest:

- Novelty
- Persistence
- Growth
- Research community

We use ten years of data from the pertinent literature, with the first three years a base period and the last seven an active period. The analyst would search on a topic of interest in one or more global databases and download a set of R&D publications or patent abstract records. (S)he then decides which fields to use to identify topical terms; we usually combine title and abstract NLP (Natural Language Processing) phrases. Term cleaning and consolidation sharpens the resulting TEI.

We have set up a handy computational routine to generate “Emergence Scores” (EScores) for those terms (6). The routine (which a user can modify; see Figure 1 and Ref. 4) sets parameters for novelty (limited occurrence in a base period), persistence (appearance in at least so many records over so many years), and community (requiring multiple independent authors). The script then calculates an EScore that combines three measures of trend growth. The resulting terms reflect recent, accelerating R&D activity.

The procedure gives us two types of TEI. First, we distinguish topics attracting high and increasing attention lately. These can be used to analyze and track frontier R&D emphasis in a domain (e.g., “nanotechnology” or “nano” for short). The output is a set of high EScore terms: the TEI for the domain under study.

Second, we tally the use of those emergent topical terms for the dataset being analyzed (research publications or patents) to identify the leading frontier players—R&D organizations, countries or individuals—that use those high emergence terms heavily in their article (or patent) abstract records. Here we use a normalized scoring to generate players’ emergence score (4):

\[
\frac{\sum (\text{SQRT(EScore)} \times \text{# records for that EScore term})}{\text{SQRT (# of records of that player in the dataset})}
\]
This scoring of “player” engagement with cutting-edge R&D topics gives a tool for Competitive Technical Intelligence. Using these TEIs, we can now distinguish cutting-edge R&D activity and who is pursuing it.

Exploring Nano R&D

Let’s pose four sample questions concerning nano R&D to show what the TEIs add:

A. What are the hottest nano topics?
B. Which countries are leading the charge?
C. Which R&D organizations?
D. Who, within a target organization, is actively pursuing the frontier topics (in all or specific ones)?

Our nano search strategy (7, 8) was applied in 2016 on the Web of Science (WoS) database to retrieve abstract records. We split the records into various time periods; here we address an early period (184,077 records for 1991-2000) and a recent period (1,178,694 records for 2006-2015).

Addressing Question A, the high-emergence topics shifted notably. For the early period, the Top 10 included two variants of Atomic Force Microscopy and two of X-Ray Diffraction. For the recent period, graphene stood out (3 of the Top 10 terms were variants). For 2006-2015, 763 terms had EScores of 1.77 or higher (the threshold we use).

Questions to address beyond generally flagging “what’s hot” include:

- Which of those hot topics pertain to our organization’s interests?
- How does our research activity on pertinent emergent topics compare with that of key competitors?
- For our topical gaps, which are the highly active research organizations with whom we might want to partner?

The novel capability the TEIs provide is to distinguish the high-emergence R&D activity from the totality of research going on. For MOT, the TEIs provide a treasure trove for further investigation. (Here I illustrate using research publication; we have also examined patents.)

The second tier of TEIs focuses on the players—distinguishing them based on their contributions to high-emergence topics. Question B concerns countries, and the nano profile is startling (to me).

The Table on the next page compares the Top 5 countries for 2006-2015, based on EScores. Compare China and the United States starting with...
number of publications in 1991-2000; the U.S. dominated. Not shown here, second was Japan (20425); third, Germany (16651); fourth, France (10906); fifth, China. South Korea was ninth and India fifteenth; Iran was “nowhere.”

Publications have shifted markedly since 1991-2000, with China #1 and the U.S. now #2. Japan is 3rd (85132); Germany, 4th (80679); South Korea, 5th; India, 6th - followed by France, the UK, Italy, Taiwan, Russia, Spain, and at #13, Iran.

One rejoinder to such tabulations is that “sure, others are active, but our papers are cited more” (see Ref. 9). The EScores tell a different story. For 2006-2015, China dominates the Top 5 countries in publishing articles indexed by WoS that use the high-emergence terms. These findings pose challenging science policy questions (why does the U.S. no longer dominate the hot topics?) and national security interests (what to make of Iran’s tremendous strides in nano research?).

Moving on to Question C: Which organizations lead the research frontier? For the recent period, results also startle me. The Top 20 nano research organizations, based on EScores, consist of the Chinese Academy of Sciences and 17 Chinese universities, plus the National University of Singapore and Islamic Azad University in Iran (a private university system).

Of the Top 100, we spot only four U.S. organizations: University of Texas, Georgia Tech, MIT, and Rice University. For American MOT interests, this poses concerns about connecting with university research knowledge on hot nano topics. (Note that a “Top 20” based on nano publication quantity differs considerably, but China still dominates.)

For Competitive Technical Intelligence (CTI) interests, we probe further. To illustrate, we might separate R&D activity by companies. Not of prime interest here in that companies don’t emphasize publication as much and policies vary drastically, but we do note some active nano companies. Here are five highest publishers for 2006-2015 (although the data are not thoroughly cleaned):

- Samsung, 2599 publications
- IBM, 2177
- Intel, 1335
Turning to Question D, let’s explore high-emergence research activity within a target organization. Curious about Iranian nano research, we separate their publications in VantagePoint and explore. Figure 2 is a screenshot that breaks out information for one organization: the University of Tehran Medical School. It is one of the Top 10 Iranian research organizations based on its 1106 publications, but is notably high on EScore (at 116, second only to the Islamic Azad University system at 165).

Nano Research at U. of Tehran Medical School

Four detail windows help us gain perspective on that university’s nano research:

- Top Emergence Score topics are rich in nano-bio-medical: cytotoxicity, antibacterial activity, cancer cells, etc.
- List of top Authors (not restricted here to high EScore papers, but that could be done easily); we could go a step further to generate a network map to see how they conform into groups.
- Countries—of interest to see with whom these researchers collaborate internationally; we see the U.S. as the most prominent. We could dig further to identify those American co-authors and the topics of mutual interest.
- Times Cited—provides a measure of impact in the form of referencing of these papers. We note some highly cited work. Again, we could zoom in to check the papers rich in high-emergence terms.
**To Sum Up**

One can now tally activity levels for particular topics in an R&D domain of interest so as to distinguish cutting-edge work. That, in turn, enables us to measure which players (researchers, R&D organizations, countries) are most actively publishing (or patenting) on those hot topics.

We can use these indicators to compare research portfolios for a domain such as nanotechnology. We can also zoom in to investigate how we compare to others on particular cutting-edge topics. The TEIs thus add technological emergence measures to sharpen MOT. We would be happy to explore how the TEI could work for you.

**References and Notes**


6. Text processing done in VantagePoint desktop software (https://www.thevantagepoint.com/)


8. Arora, S.K., Youtie, J., Carley, S., Porter, A.L. and Shapira, P.
“Measuring the development of a common scientific lexicon in nanotechnology”; 

9. Citations to countries’ publications lend some credence to an American argument for continued prominence. Papers with one or more U.S. authors are more heavily cited (mean of 22, but beware that citations are extremely skewed, with some papers accruing huge numbers and most few or none. Citation rates for South Korean and Chinese authored papers average 13, with India at 10 and Iran at 8.

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**Beyond the Champion**

**BUILDING STRATEGIC INNOVATION CAPABILITY**

By Gina Colarelli O’Connor

*Prof. Gina Colarelli O’Connor and her research team at Rensselaer Polytechnic have been studying how companies manage radical, or breakthrough, innovation since 1995. Her previous CIMS IMR article (July/August 2015) reported that companies must recognize that innovation is distinct from other corporate functions, and that innovation beyond the incremental—strategic innovation—requires a hierarchy of roles associated with all of the necessary competencies.*

*Prof. O’Connor’s new book Beyond the Champion: Institutionalizing Innovation through People (Stanford Business Books, 2018) was written with Andrew C. Corbett and the late Lois S. Peters. It focuses on “the single biggest challenge that companies identified as they work to institutionalize a strategic innovation capability: that of developing and managing innovation-related talent.” Her article here is adapted from Beyond the Champion.*

In February 2016, Larry Fink, the CEO of BlackRock Inc., the world’s largest investment management company, sent a provocative letter to the chief executive officers of the S&P 500 and large European corporations. In that letter he urged them to figure out how to endow their companies’ future through investing in long-term, value-creating innovation, and to be transparent about it.

Investors and, indeed, economies, need something more than short-term stock price bumps, he claimed, in order to build a strong foundation for society. And, he claimed, if given the compelling vision of companies’ strategic intent, short-term financial deviations will be better tolerated by the investor markets.

The letter has generated many cynical comments and much debate, but to us it represents a clarion call. Somewhat surprisingly it comes from...
a leader in the finance community—a community that has often been considered the bane of innovation’s existence. Now it’s up to companies to respond, and to do so they must develop a capability for strategic innovation. It must become part of the fabric of large, established companies.

**How To Do It**

In our book we describe a way to do that: Develop a well-articulated strategic intent, and a process for updating it every five years or so. Build an innovation function and make it a permanent department alongside accounting, finance, marketing, manufacturing, R&D, and all the rest! Create the right governance system and a somewhat consistent and persistent resource plan. Develop discovery, incubation, and acceleration competencies. Adopt the Learning Plan® and Discovery Driven Planning® as tools for new business creation projects. Operate at the project, platform, and portfolio levels simultaneously. Design a complete, well-integrated management system for it that aligns with the objectives of strategic innovation. Don’t cherry-pick which elements of the management system (in illustration above) to focus on or set to the side. Make it cohesive.

**Develop the Right Talent**

And, at the root of it all, select and develop the right talent. There will be no sustainable system without recognizing and instituting the innovation roles required for a strategic innovation portfolio.

Company leaders must institute clearly defined innovation roles, and develop the selection and evaluation criteria to help individuals become innovation experts. They cannot expect expertise to develop if people are constantly rotated in and out of strategic innovation projects, or expected to work on their breakthroughs in the morning and their other projects in
The afternoon. It just does not work. The skills, attitudes, mind-sets, and time frames differ too much.

There needs to be clear recognition of the array of talent required and distinct activities to develop it. To continually seed and grow a company’s next platforms of business it needs to develop true innovation professionals, not part-time players.

**Intrapreneurs, Mavericks At Your Own Risk**

Similarly, companies cannot depend on intrapreneurs or mavericks—who operate on the margins of the system and are vulnerable to changes in sponsorship on a moment’s notice—to be the engines of the company’s future growth. And while the 15 percent free time rule sends a nice message about an organization’s cultural support for innovation, it’s an “at your own risk” approach.

Bootlegging resources and championing behavior are great examples of enthusiasm, but wouldn’t it be better if we could use the strengths of an organization to work with these folks, rather than surround them like antibodies trying to attack a virus?

That means that companies must design roles and responsibilities for innovation personnel, beyond those in R&D—roles that are viewed as legitimate across the company. Let them take the fruits of R&D and create wholly new business platforms. Provide them with stimulating career growth opportunities that leverage their innovation talent and interests.

Recognizing Discovery, Incubation and Acceleration competencies at the project, platform and portfolio levels provide a perfect framework for designing innovation roles. Together with the Chief Innovation Officer and Orchestrator roles that lead the Innovation Management system, an Innovation function with staying power is finally becoming a reality.

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Adapted from Gina Colarelli O’Connor, Andrew C. Corbett, and Lois S. Peters; BEYOND THE CHAMPION: INSTITUTIONALIZING INNOVATION THROUGH PEOPLE (c) 2018 by the Board of Trustees of the Leland Stanford Jr. University. All rights reserved. By permission of the publisher, Stanford University Press, sup.org. Published in hardcover and digital formats.
When Mildred S. Dresselhaus died at age 86 last February, MIT praised “a celebrated and beloved MIT professor whose research helped unlock the mysteries of carbon, the most fundamental of organic elements—earning her the nickname ‘queen of carbon science’.”

A winner of the 2014 Presidential Medal of Freedom, the National Medal of Science, in 1990, and numerous other awards and honors, Prof. Dresselhaus was the first female tenured professor in engineering at MIT. Throughout her 50 years on the MIT faculty she conveyed a message of persistence in scientific endeavor along with promoting the role of women in science. She published more than 1,700 scientific papers and co-wrote 8 books.

Dresselhaus made fundamental discoveries in the electronic structure of semi-metals. She researched graphite and published important work on fullerenes, also known as “buckyballs.” She was well known for her work on nanomaterials and other nanostructural systems based on layered materials, like graphene, and for much more.


Keegan: Your research covered electronic structures and various materials, intercalation, ion implantation, and then novel carbon forms, nanotubes, and now thermoelectricity. Is there a common thread through all these, an underlying interest?

Dresselhaus: We started out with these carbon systems in 1961, and that soon led to nano-things, because in the early 1970’s, when we started working on intercalation, that was a way to look at individual layers at the atomic layer. So I was into nano-stuff in the early 70’s. Everything that you mentioned has to do with nano.

Thermoelectricity was a new idea that came to me. For 30 years, from 1960 to 1990, there was essentially no advance. The Navy was interested in developing some kind of better thermoelectrics for submarine applications; that was their main interest. And they asked me if I had any ideas, so I said, well, we have all these new materials around now, nano-
“You can’t do everything.”

“When you have the smoking gun, then it’s all over.”

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things. That could be interesting. I looked into it, and it looked like it would be very interesting. So we had a new field. That was one field that I started and that I stayed with through its development, or much of its development. Now, there are so many people working in it, so it’s hard to find new things.

You can’t be in every field, fully. The carbon one, as that developed, went to nano structures, with fullerenes, and then nanotubes and graphenes. We have more things coming down the line, probably. So that’s a natural for me. I stayed with that one all the time. And thermoelectricity I work on also, but to a lesser degree. And then there were other fields that we started that other people have taken over. So that’s okay. You can’t do everything.

Keegan: What’s come of [Dresselhaus’s prediction that a nanotube could be “built out of making bigger and bigger fullerenes”]?

Dresselhaus: Well, lo and behold, about a half a year after we published our paper, making the prediction that these kinds of tubes would be especially interesting….Two groups at IBM and NEC figured out how to actually make these nanotubes. But it took six years between the time that they were discovered and the experiments were done to show that our predictions were correct. Part of the reason is, when you have a new kind of material, it’s hard to control and hard to make it reproducibly. The amounts of material available were so tiny that the appropriate experiments couldn’t be done right away. So it took a little while.

There was also a non-believing community out there. The research communities are always very conservative. They like to believe what has happened before is correct. And when you come up with something that’s revolutionary and new, they don’t like this. So until the day we published the paper, there was mostly unbelievers. Then of course, when you have the smoking gun, then it’s all over. And after that, there are no non-believers, but there is total conversion.

Michael F. Wolff, Editor, CIMS IMR, mwolff3877@aol.com

Blockchain Update

ON THE INTERNET OF VALUE

Blockchain ETFs Arrive

Two blockchain exchange traded funds have begun trading although without “blockchain” in their names as SEC regulators requested. The Amplify Transformational Data Sharing ETF and the Reality Shares Nasdaq NextGen Economy ETF are designed to expose investors to companies that could profit from blockchain technologies and such blockchain-based applications as may be developed.

“We believe blockchain is a foundational technology that is still in its early stages, much like the internet in the mid 1980s,” said Christian Magoon, CEO of Amplify ETFs, on Businesswire.com, 11/02/2017.

Wall Street Cheers

“The prospect of blockchain technology remaking financial services just moved a step closer to reality,” proclaimed “Blockchain Gets a Wall Street Win,” Bloomberg.com 11/30/2017. Matthew Leising reported that
a group of banks successfully completed a six-month trial using blockchain to track swaps contracts after their execution.

“Blockchain software has captivated Wall Street because it could vastly reduce the cost of back-office operations and speed up trade clearing and settlement times,” Leising wrote.

Managing Patient Records

A working prototype for storing patient records on blockchain could be up and running early in 2018, according to Chris Meitner, CEO/Founder of Healthbase Digital, Bonn Germany. “By storing patient records on Blockchain, we are ensuring their data is secure and immutable while also incentivising patients and care providers every time their records are accessed by medical researchers and companies,” Meitner told BlockchainNews 11/28/2017 (the-blockchain.com).

Prof. Dr. Philipp Sandner, head of the new Blockchain Center at the Frankfurt School of Finance & Management and an advisor to the Healthbase project, added, “The main point is that as a patient, you could sell your data to researchers—by means of a smart contract against money and with your consent. This could redefine the way pharmaceutical research works.”

Turkeys in the Blockchain

For the first time beginning Thanksgiving 2017, consumers were able to trace Cargill’s Honeysuckle White® brand turkeys from a family farm to their table. Using a pilot of “the first-to-market blockchain-based solution for turkey,” consumers in select markets could enter an on-package code at HoneysuckleWhite.com to access the farm’s location by state and county, view the family farm story, see photos from the farm, and read a message from the farmer.

“Blockchain models build a trusted, transparent food chain that integrates key stakeholders into the supply chain and create a distributed ledger with immutable records,” said Cargill. The agricultural conglomerate plans to use the pilot to learn more about the value of traceability in its turkey supply chain.

Making the World’s Food Chain Safer

In August 2017, IBM announced it was working with a group of leading retailers and food companies to explore how blockchain technology can be used to make the food supply chain safer. Dole, Nestle, Walmart and others are attracted by blockchain’s ability to provide secure, trusted information on the origin and path to market of individual foods, thereby speeding the identification of suspected food-borne-illnesses.

Brigid McDermott, IBM's blockchain BVP, elaborated on the project on Bloomberg Radio, 11/20/2017. “One of the things we’re working on right now is a food safety solution. If you look end to end at that system and there’s a problem with salmonella in papayas, how do you find it in seconds instead of weeks? The key to blockchain is not just to build a great technology but to bring the ecosystem together to see the value of sharing the information.”

With a trusted system of records, McDermott continued, “we’re looking at making this successful for everyone in industry. There needs to be a value proposition for everybody from a Fortune 20 retailer to a mom-and-pop grocery store, from a one-acre farmer to a 50,000-acre farmer, to contribute data and information to this system. When we’re trying to trace salmonella or e-coli we need the data from everybody. So the system needs to be built so there is a value proposition for everybody to participate.”

For more on the IBM project and food safety in general, see “IBM Forges Blockchain Collaboration With Nestlé & Walmart In Global Food Safety,” by Roger Aitken, forbes.com, 08/22.2017.

When Eric Ries’s The Startup Way arrived in bookstores on Oct. 16, 2017, the proud author blogged that he wanted people to use his book “as a way to start conversations about the critical roles of innovation and sustainable growth everywhere from startups to large corporations to public policy.... The success of the startup movement is about so much more than making cool new products; it’s about adapting our country for an uncertain future that holds as many opportunities as it does challenges,” www.startuplessonslearned.com.

Ries is a serial entrepreneur and consultant who has been an entrepreneur-in-residence at Harvard Business School, IDEO and Pivotal. His 2011 bestselling The Lean Startup detailed the practices of successful startups while maintaining that the principles of entrepreneurial management could be applied to companies of all sizes in all industries.

He describes his new book as combining “the rigor of general management with the highly iterative nature of startups” to create “a system that embraces and even thrives on speed and uncertainty.”

Drawing on his work with “dozens of amazing companies,” case studies of both “iconic multinationals” and “hypergrowth startups” and “the wisdom of an entire movement of likeminded leaders,” Reis presents “concrete guidance “for “a new, more sustainable system for creating long-term growth and flexibility.” He promises “a series of specific interventions that can help you invest in entrepreneurship as a core discipline, and walks you through how to change the mindset of senior leadership.”

Part 1 of this walk, “The Modern Company,” defines a startup as “a new atomic unit of work” and explains how to build a portfolio of startups within an organization.

Part 2, “A Road Map for Transformation,” explains how to move an organization to a more effective and entrepreneurial way of working, and answers three “fundamental questions”: What systems and structures must be implemented? How can managers and employees be convinced to try something different? When is a company ready to transform itself?

Part 3, “The Big Picture,” explores what happens after the transformation process has brought the organization to the ideal state of continuous transformation. More importantly, “What would a world filled with institutions working this way look like?”


This revised and updated 5th edition of Prof. Cooper’s seminal 1986
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book cites his most recent research and incorporates advances since the 2011 4th edition. Prof. Cooper, ISBM Distinguished Research Fellow at Pennsylvania State University and Professor Emeritus at Canada’s McMaster University, introduced the Stage-Gate® idea-to-launch process.

While earlier editions of Winning at New Products focused on what those winning companies do differently from the others, the 5th edition emphasizes, in Cooper’s words, “bold innovation, in record time, and speed—more specifically agility, flexibility, and acceleration and adaptability, which are all linked.”

Cooper credits the incorporation of Agile methods as a project management tool within Stage-Gate as being “the most significant change to my durable gating system since it was first developed thirty years ago!” He devotes Chapter 5, “Beyond Stage-Gate,” to “a new generation of idea-to-launch processes” that leading-edge companies are using to be more adaptive to changing circumstances.

Chapter 6, “The Agile-Stage-Gate® Hybrid Model,” explains the integration with Stage-Gate and how it has moved beyond IT or software-development applications to manufactured new products. The results have been “dramatic,” he writes. (Cooper’s two-part article “Meeting the Challenges of Agile-Stage-Gate” appeared in the Sept/Oct and Nov/Dec 2017 issues of CIMS Innovation Management Report.)

This new edition takes what Cooper calls a more holistic, systems approach to winning at product innovation, illustrated in the Innovation Diamond, “which includes strategy, resource and portfolio management, climate and culture, and process. These four “drivers of innovation success” are employed in a new, concluding chapter, “A Product-Innovation Strategy for Your Business.” The chapter delivers Cooper’s message that while tactics are important, “an innovation strategy is essential for product development and continued growth, especially in difficult times.”


In their Jan/Feb. 2018 CIMS IMR article, “Building Pathways To the Consumer,” Shawn Nason and Steve Junion presented a framework that supports Consumer Centered Innovation (CCI), which helps organizations build their own unique paths to their consumers. They explain how this framework is enabled and surrounded by three consumer values: Know Me, Surprise Me and Make It Easy.

The Power of YES promises readers they can not only learn to use these values, or consumer principles, to operate their day-to-day corporate worlds, but how they can apply them to their personal lives.

The book takes lessons from the writers’ eclectic consumer innovation experiences, including Walt Disney Imagineering and healthcare. It begins by exploring “what occurs when you say YES! to the power of innovation... what happens when you follow your passion and allow yourself to keep saying yes, and eventually harvest the rewards of focusing on consumer innovation.”

Section 2 explores leadership principles that have helped Nason and Junion develop organizations focused on consumer-innovation, while the
concluding Section 3 explains how the values of Know Me, Surprise Me and Make It Easy have been incorporated into the consumer-centered design work at several organizations.

“When you are able to connect with and live these values, your mindset will change, writes Junion in an accompanying note. “What you say yes to will have real and substantial impact on your customers.”

He and Nason promise to teach readers to:

- Leave “expert” labels at the door;
- Return the customer to the number-one priority;
- Understand how a philosophy of “Know Me, Surprise Me, and Make it Easy for Me” will reconstruct your customer’s experience;
- See lessons in the everyday, like how a toilet, a car and a mouse can teach us to better serve our consumers;
- Include the element of surprise in your efforts.


Authors from a variety of disciplines and work environments discuss how free and open source hardware (FOSS), in the words of issue Editor Joshua M. Pearce, “will drive the future of engineering.”

In the opening article, the founder and executive director of the Open Source Hardware Association explains why hardware is “the next step toward open source everything.” Subsequent articles deal with advances in desktop 3D printing, IP law in a 3D era, and 3d printing for small businesses; the reduced research and education costs and other positive impacts of open source hardware in science and engineering; how educators can use maker methods to introduce students to engineering. A Red Hat software engineer’s op-ed asserts that “open source and open innovation… empower society and make it possible to push the limits of what is possible. When the barriers to collaboration are lifted, people can accomplish incredible things.”

“As all of the article show, “ concludes Prof. Pearce’s Editor’s Note, “open source tools in the hands of this and future generations of engineers will be incredible indeed.”


“There will be a blockchain in your future whether you like it or not,” announces this Institute of Electrical and Electronics Engineers publication.

The report opens by explaining how blockchains work and “why they’ll change the world.” Subsequent articles reveal blockchain’s enormous electrical demands; help readers learn if the technology can solve their own problems; report that financial firms are planning “to move trillions in assets to blockchain in 2018”; define blockchain “lingo”; tour China’s bitcoin mines; explain what Dubai and the U.S. state of Illinois are learning about cutting government red tape with blockchain; and show how to
trade energy “for fun and profit.”


MIT Sloan School professors Brynjolfsson and Rock, and U. of Chicago economics professor Syverson give four “potential explanations” for why “measured productivity growth has declined by half over the past decade, and real income has stagnated since the late 1990s for a majority of Americans.” While suggesting this “clash of expectations and statistics” could be attributed to “false hopes, mismeasurement, redistribution, and implementation lags,” they argue that “lags have likely been the biggest contributor to the paradox.”

That’s because “the most impressive capabilities of AI, particularly those based on machine learning, have not yet diffused widely” and “their full effects won’t be realized until waves of complementary innovations are developed and implemented.”

“Realizing the benefits of AI is far from automatic,” they conclude. “It will require effort and entrepreneurship to develop the needed complements, and adaptability at the individual, organizational, and societal levels to undertake the associated restructuring.”


Children from American families with top 1% incomes are 10 times as likely to become inventors as children from families earning below the median. Moreover, there are similarly large gaps for minorities and women. That’s what economists from Harvard, MIT, London School of Economics, Stanford University, and the U.S. Treasury learned from studying the patent records of 1.2 million inventors and linking them to anonymous tax records.

Their paper presents empirical results on inventors’ characteristics at birth, childhood environments and career trajectories, and develops a model of inventors’ career choices that indicates childhood exposure to innovation is critical to becoming an inventor. Because the lack of such exposure “screens out not just marginal inventors but the ‘Einsteins’ who produce innovations that have the greatest impacts on society,” the investigators suggest policies for increasing innovation. These include developing and testing methods to increase such exposure among disadvantaged subgroups.

JOBS LOST, JOBS GAINED: WORKFORCE TRANSITIONS IN A TIME OF AUTOMATION; James Manyika et al; McKinsey Global Institute, Dec. 2017; mckinsey.com

New research from the McKinsey Global Institute estimates that between almost zero and 30% of the hours worked globally could be automated by 2030, depending on the speed of adoption.” Building on McKinsey’s earlier automation research, this 160-page report assesses the number and types
of jobs that might be created under different scenarios through 2030 and compares that to the jobs that could be lost to automation. Key findings include:

“While there may be enough work to maintain full employment to 2030 under most scenarios, the transitions will be very challenging—matching or even exceeding the scale of shifts out of agriculture and manufacturing we have seen in the past;

“60 percent of occupations have at least 30 percent of constituent work activities that could be automated;

“Even with automation, the demand for work and workers could increase as economies grow, partly fueled by productivity growth enabled by technological progress;

“By 2030, 75 million to 375 million workers (3 to 14 percent of the global workforce) will need to switch occupational categories. Moreover, all workers will need to adapt, as their occupations evolve alongside increasingly capable machines;

“Ensuring robust demand growth and economic dynamism is a priority: history shows that economies that are not expanding do not generate job growth.”

“Our Coming Wave of Digital Disruption”; Leslie H. Moeller, Nick Hodson, and Martina Sangin; strategy+business Nov. 30, 2017; strategy-business.com

These PwC consultants assert that a digital wave of technological advances in AI, cloud computing and more will give it “breadth and scale comparable to the introduction of commercial electric power.” As a result, they expect it will “shift a wide array of business practices, in nearly every sector, and in both business-to-business and business-to-consumer firms.”

Their article gives the experience of Netflix as an example of responding effectively to this type of disruption. “Netflix rode the wave of disruption, taking advantage of three factors that accelerated the change: significantly lower cost; a more effective approach to customer demand; better use of assets.”

Employ digital technology to bring these three drivers to bear and “you will be among the winners of the age of digital disruption,” they conclude.


This study by North Carolina State University post-doc Leonchuk and psychology professor Gray demonstrates “strong evidence for positive effects of Industry-University Cooperative Research Centers (IUCRCs) training on graduate S&E students’ outcomes.”

In a subsequent interview with NC State News, Leonchuk explained that “students who are trained as part of these collaborative centers report
feeling more prepared for their careers, more satisfied with their training, and having larger and stronger industry networks compared to traditional students.”

She attributes this to “a collaborative and open atmosphere where students are exposed to a variety of opportunities to work in a team environment and tackle real-world problems, even before they join the workforce.”

Superhuman Player

The AlphaZero algorithm from Google’s DeepMind AI lab beat the best human Go player last year. Since then it’s been generalized to achieve “tabula rasa, superhuman performance in many challenging domains.” That’s from the team’s December 5, 2017 paper claiming that, “starting from random play, and given no domain knowledge except the game rules, AlphaZero achieved within 24 hours a superhuman level of play in the games of chess and shogi (Japanese chess) as well as Go, and convincingly defeated a world-champion program in each case.”


Future-Shaping Technologies

Autonomy, mixed-reality, crypto currencies, and artificial intelligence offer the best tech opportunities of the next decade, according to Andreessen Horowitz analyst Benedict Evans. The VC firm’s analyst offered that vision at a firm meeting reported by Daniel Terdiman on fastcompany.com, Dec. 5, 2017.

Using the metaphor of a skyscraper being built, Evans called “autonomy ‘down in the muddy hold in the ground‘; mixed-reality’s just the building’s frame going up; crypto currencies have the frame up, but the facade is still being worked on; and AI is the finished tower looking for tenants.”

Best Run U.S. Companies

Amazon tops the 250 most effectively managed U.S. businesses as judged by the teachings of the late business thinker Peter Drucker. Compiled by the Drucker Institute at Claremont Graduate University, “Management Top 250” ranks the largest U.S. companies according to how well they perform in five areas that reflect Drucker’s core principles: customer satisfaction, employee engagement and development, innovation, social responsibility, and financial strength.
Following Amazon in the rankings are, in order: Apple, Alphabet, Johnson & Johnson, IBM, Microsoft, Procter & Gamble, 3M, Cisco Systems, and Nvidia.

Measuring Artificial Intelligence

The number of active AI startups has increased 14-fold since 2000 while venture capital investment has increased six times in the same period. This and related progress has been captured by an AI Index developed by a Stanford University-led group of AI thinkers called the AI100.

As reported in the Nov. 30, 2017 Stanford News, the AI Index “tracks and measures at least 18 independent vectors in academia, industry, open-source software and public interest, plus technical assessments of progress toward what the authors call ‘human-level performance’ in areas such as speech recognition, question-answering and computer vision—algorithms that can identify objects and activities in 2D images.”

In technical metrics, the Index finds image and speech recognition “approaching, if not surpassing, human-level performance. AI systems have excelled in such real-world applications as object detection, the ability to understand and answer questions and classification of photographic images of skin cancer cells.”

A project within the Stanford 100 Year Study on AI, the AI Index aims to be a comprehensive data and analysis resource. It’s goal, said Yoav Shoham, professor emeritus of computer science, who conceived of the index “is to provide a fact-based measuring stick against which we can chart progress and fuel a deeper conversation about the future of the field.”

New Innovation Research Center

Texas A&M University’s Mays Business School will open “a research-oriented academic center” to study “the nature of innovation.” According to the announcement, $5.6 million gifts from the Mays Family and Charles Koch foundations will support research “on how innovation advances human potential; the essential conditions necessary for innovation to flourish; how innovation spreads; and the social, economic and legal frameworks necessary to support innovation.”

“Our goal is to understand the true nature of innovation and investigate how innovation spreads through society, who benefits from innovation, the barriers to innovation, and corporate and government policies that can induce innovation,” said Eli Jones, the school’s dean.

NSF Funding Data Science Research

The National Science Foundation is funding 12 “Transdisciplinary Research in Principles of Data Science” (TRIPODS) projects with $17.7 million that will bring together the statistics, mathematics and theoretical computer science communities at 14 institutions in 11 states for long-term cross-disciplinary research and training activities in data science.