sabre labs

EMERGING TECHNOLOGY IN TRAVEL

2018 REPORT

Sabre®

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In Sabre Labs, we evaluate a wide variety of trends and technologies each year. Part of our practice is to chart out possible futures for each trend and technology to forecast how they will impact travel. Sometimes trends aren't fully apparent on the surface, but because we've traced the streams out to the future, we can anticipate their convergence and the resulting river and rapids.

This year, distilling down to discrete trends was challenging because so many of the dozens of technologies we follow have become inextricably intertwined. There are countless ways to segment the digital landscape, but we chose automation, authenticity and blockchain as three threads which, when woven together, give us a way to talk about a much broader array of technologies.

Automation was the trickiest trend to finalize. It was tempting to spotlight artificial intelligence instead, but we decided AI is more than a trend—it's become an essential part of the background of the digital environment. Framing the discussion around automation gives us a way to look at the effects of AI as part of the broader story of technological growth and development.

Authenticity is harder to quantify, and is the "softest" of the trends we've highlighted, but its ambiguity doesn't make it any less a factor in the travel ecosystem. When we started looking back through history—at things like the roots of automation—we found the current yearning for authenticity has historical patterns and is an expected response to a rapidly automating, globalizing world. In the midst of uncertainty, people crave the sense that something is real, authentic, concrete. Technological progress is a significant part of the impetus for authenticity as a need.

Blockchain. Oh, blockchain. It's so hyped, just mentioning it can suck all the other conversations out of a room. It's a juggernaut of a concept, audacious in ambition, revolutionary in theory and nascent in practice, surrounded by more confusion and misunderstanding than any other technology we can remember. So we take the luxury of addressing blockchain at length to help set the context to be both excited about its potential and cautious about its hype.

The intersection of tech and travel grows increasingly complex and at the same time, our attention spans are getting shorter and shorter. So we know few people will read this report cover to cover; no worries—we don't expect you to. Instead, we hope you'll dip in and out of topics of interest: be educated, be challenged, be inspired.

This report is an artifact of a lot of research and thinking, but it's also an inroad: please reach out to our Sabre Labs team to start a conversation. We don't have all the answers, but we do want to be part of authentic conversations about how we can use emerging technology to streamline and enhance the travel experience.

Thank you for reading. We look forward to talking with you soon.

Philip Likens, Sabre Labs Director
and the Sabre Labs team

MINDFUL AUTOMATION

Tech is transforming both mental and physical tasks

INTRODUCTION

Automation is an old idea, and a simple one—it's action happening without human assistance. The concept dates to the ancient Greeks, with automatic doors and self-moving wheeled machines in Homer's Illiad. In the intervening millennia, the leading edge of tech adoption has progressed to indoor plumbing, assembly lines, and Alexa. And the coming decades will see a continued acceleration of change.

For most of history, automation focused on physical tasks; today, new technologies (spurred by advances in artificial intelligence techniques) are automating mental tasks as well. For instance, the difficulty in automating a vehicle isn't the physical start/stop/turn (the first driverless cars were demonstrated in the 1920s); the difficulty in automating driving is the mental awareness of environment and the need to constantly adapt.[1]

Automation of mental tasks grounds Sabre Labs' spotlight on "automation" as a tech trend for 2018 and is why automation is poised to change the landscape of employment and the future of work in dramatic ways. We think it's essential for the travel industry to consider how emerging areas of automation provide new opportunities for what we do, how we staff our businesses, how we meet our customers' needs, and how we spend our time.

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[1] https://www.digitaltrends.com/cars/history-of-self-driving-cars-milestones/

GLOBAL PREDICTIONS

High profile reports on the near-term effects of automation forecast massive losses to present-day jobs over the next 10-20 years (focused primarily on developed nations). An in-depth report released in November by McKinsey Global Institute, identifies that ~50% of "current work activities are technically automatable by adapting currently demonstrated technologies." [2] (Essentially, if technology progress stopped now, we could use what already exists to automate half of all current work—not jobs but tasks.)

The McKinsey report also concludes that 60% of current occupations have at least 30% automation potential. Digging little deeper, there's an expectation that by 2030, as many as half of all displaced workers could be shifted into similar occupations based on their existing skills, but between 10% and 35% of all workers will need to be retrained for entirely new occupations.

A report from PwC Global expresses similar findings on job loss and work redistribution. It speculates automation will be responsible for a 14% global GDP increase by 2030.[3] This view supports the broader story of automation as a "double-edged sword," supplanting existing jobs while simultaneously growing the economy.

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[2]   https://www.mckinsey.com/global-themes/future-of-organizations-and-work/what-the-future-of-work-will-mean-for-jobs-skills-and-wages

[3]   https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html

The most pressing political and social challenges for automation today are 1) to find ways to continuously train workers in new skills to keep pace with changing demand, and 2) to find ways to ensure economic growth is distributed across all classes of society.

Travel is a global industry, employing people from every class and culture. Because of this tremendous breadth, travel will enjoy the upsides of automation all along the implementation curve, but will also have to work on many different fronts to address the challenges posed. Different stages and kinds of automation will impact different roles in different regions. But the breadth of travel means there will be amazing opportunities created in the shifting market.

As a paradigm shift, it may be helpful to stop thinking about business strictly in terms of jobs and roles, focusing instead on tasks and skills. Every job is made up of tasks; some of those tasks are going to be automated. Yet every worker has a set of skills, and those skills can be applied to a wide array of tasks. Valuing employees for their skillsets instead of simply filling particular roles is critical to maintaining and training—and retraining—a workforce.

EARLY TRAVEL AUTOMATION

Travel is all about people. Its primary role is to move people to a place, to help people experience a place, and to bring them back safely Everything else—comfort, entertainment, efficiency, etc.—is secondary,

Left:
Prior to Sabre, agents took airline reservations by hand, a process which took 90 minutes per ticket.
Image: Sabre

Below:
The SABRE automated system reduced the time required to process a new airline reservation to just a few seconds.
Image: IBM

no matter how important. As a people-centric industry, travel has a different relationship to automation than most other industries.

On the front end, travel requires a tremendous physical infrastructure—cars and planes, roads and runways, hotels and high-rises, restaurants and resorts, ports and parking lots—as well as the people to staff and maintain everything. On the back end, travel has a similarly complex infrastructure handling inventory, reservations, fulfillment, staffing, identity, security, compliance, transactions (in hundreds of currencies and point systems), translation (in hundreds of languages), and countless other details often invisible to travelers.

The back end of travel has seen an incredible amount of automation over the years. Automation of airline reservations pioneered online transactions and was a key driver of the networked digital era. The 1950s saw significant growth in demand for air reservations as flying started to become mainstream; at the time, every reservation was processed by hand. The need to streamline the reservation process led to a partnership between IBM and American Airlines which was the genesis of Sabre as a company.[4][5] By 1965, the SABRE (Semi- Automated Business Research Environment) automated system could process a new airline reservation in seconds compared to 90 minutes for the previous manual system.[6]

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[4]   http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/sabre/
[5]   https://www.sabre.com/files/Sabre-History.pdf
[6]   https://www.wired.com/2012/07/sabre/

Automation of reservation processing led to growth. Even with a several-hundred-fold increase in efficiency, automated reservation processing didn't lead to the end of reservationists. Instead it was an opportunity for reservationists to shift their daily tasks to meet growing demand to talk with customers, help find appropriate flights, etc.

More accurate and timely reservations lowered costs and increased choice for consumers, helped ensure accurate itineraries, increased plane occupancy, and increased revenue for airlines. As reservation automation became standard for hotels, trains, cruise ships and other aspects of travel, similar efficiencies followed. Each reservationist could handle far higher volume, offer more choice and provide better service. Any loss in demand for making manual reservations was more than offset by new opportunities and the need for new skillsets.

Productivity growth and increased bandwidth are common outcomes of automation, but aren't the only outcomes. Automation causes a shift in demand for particular skills—if workers don't or can't adapt their skillsets quickly enough to the changing market, they will end up losing their jobs. Historically, the increased efficiencies of automation produce enough overall growth to create new opportunities for adaptable workers. Adaptability is essential to thrive alongside automation.

The greatest concerns for automation are how new technologies will affect work: what jobs will be lost, what jobs will be transformed, what jobs will be created. And how businesses will prepare themselves and their employees to adapt in a changing world. None of these are new concerns—they came to prominence more than 200 years ago during the Industrial Revolution.

ADAPTABILITY IS ESSENTIAL TO THRIVE ALONGSIDE AUTOMATION.

LESSONS FROM THE INDUSTRIAL REVOLUTION

During the Industrial Revolution, hand production methods were replaced by machinery and factories. Physical tasks were relegated to machines in every industry and culture in which it was more economical to build and maintain machines than to pay wages.

Industrialization is credited as the most significant factor in modern history in terms of increasing wages and improving standards of living. It affected every aspect of society, transforming both work and leisure time. But the Industrial Revolution didn't happen overnight. Arguably, it wasn't a "revolution" at all, but a gradual shift over decades, with uneven distribution and inconsistent adoption. We live in a world with many examples of regions and industries where human physical labor is still cheaper than automation—industrial revolution is still under way.

The garment industry is a case study in how automation can shift demand for skills. In broad terms, making a garment requires: 1) design of the garment, 2) spinning thread for fabric, 3) weaving fabric, and 4) sewing the garment to match the design.

The Industrial Revolution saw the rapid automation of the middle steps in the garment process: the automation of spinning yarn put hand spinners out of work; but access to abundant, cheap yarn increased the need for hand loom weavers. Power looms then put the hand weavers out of work; but access to abundant, cheap cloth increased the need for sewers. Many attempts were made to automate sewing, but inventors quickly discovered sewing was highly resistant to automation. The dexterity and adaptability needed to sew two pieces of fabric together well is a relatively easy skill for a human to learn but is very, very difficult for a machine.

From a labor perspective, the initial shift from human spinners, weavers and sewers to almost all sewers took about 50 years. After the automation of tasks and skills stabilized, the distribution has remained similar for almost 200 years. The last few years have seen the first successful attempts to automate sewing, using high-speed cameras to feed computers enough information to make the micro-adjustments necessary to keep fabric aligned.[7] Essentially, the camera data makes the automated sewing machines far more adaptable, helping them come closer to parity with human sewers.

The adaptability needed to sew kept human sewing a necessary skill for centuries after other parts of clothing manufacture were automated. On the design side, the industry is also seeing the first attempts to use AI algorithms to automate garment design.[8] Right now, real world uses include Stitch Fix, a subscription clothing service, which uses AI to identify gaps in current fashion lineups and hires human designers to fill the AI-identified gaps.[9] But in the long-term, AI could be designing an increasing array of garments, or more-likely, working alongside human designers to spot opportunities, help rapidly prototype variations on an idea, and track garments all the way from design to sale to analyze the success of different trends over time and predict new trends.

While the advent of AI garment design and/or automated sewing may commoditize segments of the garment industry in the coming decades, the luxury end of fashion is expected to remain intact. Even today, with mass-market sweaters readily available for decades, there is a thriving industry and demand for hand-knitted products. "Designed by humans" and "sewn by hand" are likely to be signifiers of luxury, quality and authenticity, taking on aesthetic and cultural significance akin to hand-crafted furniture, fine art and gourmet meals.

[7]   http://www.textileworld.com/textile-world/knitting-apparel/2016/05/the-rise-of-robotic-automation-in-the-sewing-industry/

[8]   https://www.technologyreview.com/s/609469/this-ai-learns-your-fashion-sense-and-invents-your-next-outfit/
[9]   https://qz.com/1062257/amazons-new-ai-algorithm-designs-clothes-without-human-designers/

THE INDUSTRIAL REVOLUTION WAS ABOUT TECHNOLOGY AUGMENTING OUR MUSCLES; THE DIGITAL REVOLUTION IS ABOUT TECHNOLOGY AUGMENTING OUR MINDS.

In contrast, automation excels at repetitive tasks and static environments—and so far, this is as true for digital automation as it has been for industrial automation. The history of garment automation has an important lesson: the more "human" a task, the more resistant it is to automation. Among other strengths, humans have the capacity to excel at human interaction, creative problem solving, contextual awareness, and physical adaptability—and can utilize all these skills simultaneously.

THE FUTURE OF WORK

Humanoid robots, digital assistants and autonomous vehicles are all part of the current "digital revolution" (or "AI revolution" or "second machine age," among other terms). The Industrial Revolution was about technology augmenting our muscles; the digital revolution is about technology augmenting our minds.

This isn't to say automation today is only concerned with mental tasks (new technologies continue to automate an ever-broader array of physical tasks). But in many cases, the new physical tasks being automated are hybrid tasks—tasks that previously involved both mind and machine. And in many other cases—as with the digital concierge—automation is serving not to replace humans but to augment human functionality, helping make humans more efficient and more effective in their work.

McKinsey's speculation that at least 60% of jobs have room for at least 30% automation in the near future can be taken two ways—you can simply multiply the numbers (0.6 × 0.3 = 0.18) and assume at least 18% of jobs will disappear, or you can be more optimistic and see 30%+ automation as an opportunity for most of the workforce to have significantly increased bandwidth to begin to build and utilize new skills.[10]

[10] https://www.mckinsey.com/global-themes/future-of-organizations-and-work/what-the-future-of-work-will-mean-for-jobs-skills-and-wages

One of the important distinctions of the digital revolution is both white collar and blue collar workers are expected to see some of their tasks replaced by automation. Radiology is a powerful example; at its core, radiology is about medical diagnosis using image recognition and anomaly detection—ideal skills for a machine learning AI. To become a radiologist typically requires ~15 years of post-high school education, tremendous amounts of study and hard work, and often taking on significant debt.[11] The payoff though, is six-figure annual salaries, often close to $400,000 USD.[12] Historically, people with high education and wages have had little cause for concern with automation. In the case of radiologists though, the majority of their daily tasks are likely to be automated… so what role do they have in the future workplace?

In Labs, we see a tremendous opportunity for many jobs to move away from rote analytical tasks and toward human engagement and personal interaction. An algorithm may be much better than a human at analyzing X-rays and MRIs, but an algorithm doesn't have the context to translate the meaning of images into a specific course of patient treatment.

For a radiologist, a likely near-term future is partnership with an AI: algorithms automate image analysis and then hand-off to the human radiologist to make the analysis meaningful, to create a narrative. This means sitting down with a patient, looking at images, talking about the patient's life and priorities, discussing various treatment options, listening to their questions and fears, and working together to chart a customized course of treatment. The radiologist goes from their present role—often sitting in a dark room alone, looking at images—to a future role with ample time to act as a counselor, improving the treatment experience for both doctor and patient.

This idyllic story has its flaws: some radiologists may not have the bedside manner appropriate to become successful counselors; compensation structures may not allow doctors to spend adequate time with patients; demand for radiology consultations may drop, reducing the size of the profession. What remains constant is the need for adaptability. The hard-knowledge educational needs for many roles may remain similar post-automation, but "soft-skills" like human interaction are likely to increase in value as more and more jobs shift focus to center on human engagement and experience. In this scenario, the advent of the digital revolution has the potential to give us time to be more human.

Many travel roles have a similar potential shift from rote data-centered tasks to human-engagement skills. Travel agents in particular may spend far less time searching through rates and optimizing itineraries and can shift their time into building and utilizing the skills to engage customers in providing a higher level of customization and service. The rise of boutique travel agencies over the past few years is demonstrating the demand for better service and more nuanced trip planning (read

[11] [12] http://www.innerbody.com/careers-in-health/how-to-become-a-radiologist.html

a more in-depth discussion in the **Authenticity** trend).[13] In many cases, boutique agencies are embracing automation (through services like chatbots) to help with rote tasks and travel reminders, freeing agents to have more time to engage with travelers at any point in their journey.

Because agencies tend to have ebb and flow to demand, they're well positioned to encourage continuing education for their staff members. For the foreseeable future, anytime customer volume is lower than availability, extra agents could be assigned training to help them build their human engagement soft skills (or any other skills that the company expects to need in the near future). Variable bandwidth jobs are ideal for continuously teaching new skills.

VARIABLE BANDWIDTH JOBS ARE IDEAL FOR CONTINUOUSLY TEACHING NEW SKILLS.

[13] http://fortune.com/2016/07/27/travel-agents/

DEFINING ARTIFICIAL INTELLIGENCE

It's impossible to talk in-depth about digital automation without a somewhat nuanced understanding of artificial intelligence. In the past year, "AI" has dominated headlines, with tech moguls, top scientists, world leaders and countless others garnering media attention with superlative predictions about the future. In contrast to most of the visible hype, the global community of AI experts remained restrained in its forecasting, due, in large part, to an understanding of historical context and current limitations.

AI isn't a single technology—it's a broad concept with differing approaches to achieving "artificial intelligence." It's been a serious study since the 1950s, when the first computer systems made the possibility of an artificial brain seem possible.

Over the years, there have been countless attempts to define artificial intelligence; most definitions use humans as the benchmark for measuring "intelligence." With current AI, humans both define the problems to be solved and judge the success of solutions. "AI" is still a very human-driven endeavor.

In Labs, we've settled on: "the true benchmark of A.I. is the ability to acquire and apply knowledge with a human level of competence." Even that is a fuzzy definition—human competence varies greatly—but the ambiguity is intentional. Different kinds of problems require higher levels of AI competence than others. For instance, a customer support chatbot is viable for fielding simple requests to increase efficiency even if it's only

Robotic Process Automation (RPA)

Robotic Processing Automation (RPA) replicates the way employees make decisions and work across applications and systems via software bots. These bots perform highly repeatable, administrative, manual tasks. They operate at machine speed 24 hours a day across the globe and are reliable, flexible, scalable and relatively inexpensive. Workload distribution, to account for demand changes, is managed through a command center and additional bots can be activated and "trained up" within hours or minutes. Additionally, RPA reporting capabilities enable effective tracking, error detection resolution and incremental process improvements.

Since RPA solutions can be implemented quickly and their graphical user interfaces can help expedite fast rule deployment, an organization has the potential to see near-term returns from deploying RPA algorithms. The return on investment of RPA is enticing. At Sabre, the addition of a robotic software workforce is enabling our human workforce to spend more time creatively solving problems, improving products, generating new products and helping customers to be more efficient. And RPA deployment by customers is allowing their businesses to increase productivity and reduce expenses.

fractionally as competent as a human customer support agent; as long as it's working in partnership with humans capable of handling complex requests, the algorithm doesn't need to be exceptional. For a task like fully autonomous driving (Level 5), where the stakes are life or death and there isn't time for AI-to-human hand-offs, AI needs to target a level of competence safer than any human driver.

Understanding when and how to make use of different levels of AI intelligence for automation is a challenge that has already begun. Chatbots and robotic process automation (*RPA, see sidebar*) are two of the most immediate opportunities for low-intelligence automation. If a hotel can identify the most common guest requests for information (e.g. what time is check-out? what's the wi-fi password? how late is the pool open?) and implement and market a bot capable of answering just those questions, it may be able to save bandwidth for human staff at minimal ongoing cost. It doesn't even need to be particularly capable or adaptable—a small amount of highly searched in-formation available 24/7 and in the right context is a huge potential win with very low intelligence needed.

RPAs function as complex scripts, often without any AI-algorithm involved. But RPAs help bridge the automation gap between various kinds of computer software and sys-tems. Building an RPA today is akin to building an automatic loom or other mechanical system, but in the digital age.

In a streamlined world, every piece of software could share information with the same defined standards, but that's not realistic. Often, there is a need to enter data in a particular way for each system. Highly repeatable data-entry processes can be au-tomated by an RPA logging into remote systems and carrying out the same tasks a human would, but much faster, and without any need for intervention. RPAs aren't

particularly intelligent today although they will become more intelligent as they use more artificial intelligence, cognitive and machine learning. For now, they need human input to know how to execute repetitive tasks but once programmed to do so they execute over and over again without skipping or forgetting steps.

The caveat to low-intelligence systems is the lack of common sense. If an error exists or is created due to a change, the chatbot or RPA will continue to perpetuate this error very efficiently and at scale. In the simplest example, if a hotel changes its checkout time, unless it makes sure that new information is accessible in the right place in the right format, the chatbot will continue to give out the old checkout time, perpetuating misinformation. If the form an RPA is programmed to use changes in some small way (maybe a time field is changed from 12-hour to 24-hour format), the RPA will continue to try to process information in the old way and will do so very efficiently, 24/7, rapidly compounding an error.

Much higher relative-intelligence AI algorithms are under development, but delegation of automation exists on a sliding scale of trust. It's relatively easy for humans to trust algorithms with simple decisions and data entry—we understand what the algorithm has been asked to do and we understand why and how it will achieve the end result. More complex algorithms, such as those that make stock predictions or establish odds for sports games, or forecast the weather, we trust to be generally right, but we also frequently bet against, knowing the algorithms are good but incomplete.

The more complex an algorithm becomes, the more likely it is to be asked to operate with imperfect information. A calculator knows it has perfect information which leads to predictable, replicable correct results. In contrast, a weather algorithm is never exactly right; it can be approximate and useful, but perfection is impossible (it would require, at a minimum, modeling every atom in the system). The problem with more complex predictions and intelligence is that it's hard to know for sure which data is important to make the right prediction. And because we don't know which data to account for how to prioritize the data, we can't expect a perfect outcome.

Trusting AI with increasingly complex real-world tasks—increasingly human tasks—requires accepting imperfect outcomes. Adopting higher-intelligence AI algorithms will require humans to reevaluate acceptable levels of risk and continually reassess our tolerance for imperfections.

UNDERSTANDING MACHINE LEARNING

The current surge in interest around AI is grounded in a technique called "machine learning" in which a computer algorithm uses a data set (and/or a clear set of rules) to iteratively improve its performance at a set of tasks. There are some excellent resources available to better understand how machine learning, deep learning and neural networks function; but most of what is called "AI" today is machine learning.[14]

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[14] https://www.technologyreview.com/s/608911/is-ai-riding-a-one-trick-pony/

Machine learning is an incredibly powerful and versatile tool, but to be effective, it needs either labeled data to learn from (used for tasks like classifying images and language translation) or a clear set of rules and win conditions (used for tasks like playing chess and poker). And these requirements set the limits of machine learning's present utility.

Any data-based ML algorithm is only as good as the data, so if it's using bad data, it has no "common sense" to override the data it's given. One of the chief concerns around ML is its tendency towards bias and prejudice, because in most cases, an ML algorithm is learning from data based on human behavior.[15] A related concern is algorithmic acco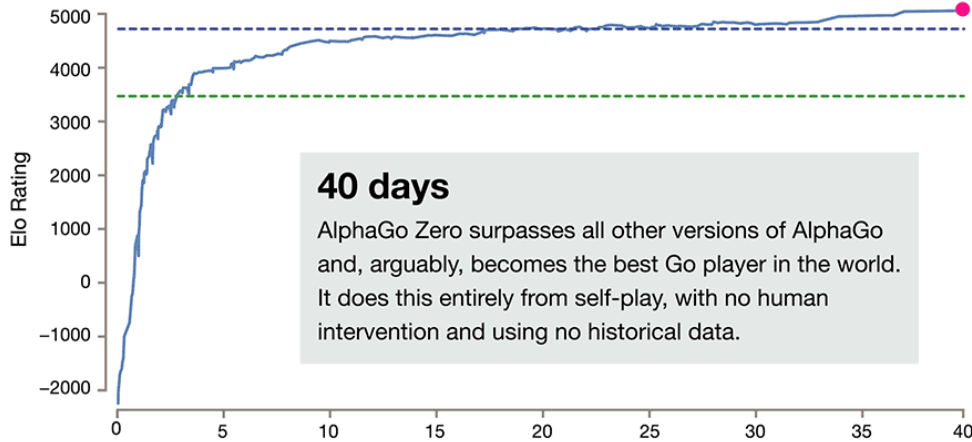untability when humans fail to understand the potential long-term consequences of the optimization goals provided to an AI; an algorithm is single-minded in achieving its programmed goals, and human goals aren't always aligned." [16]

Data-based ML algorithms also lack a sense of real-world context. An algorithm might "correctly" label a cat against a starry background as "cat in space," but it would never question whether cats can or do exist in space. The lack of thought also means algorithms can be fooled by what are called "adversarial examples." By making small changes to an object or a sound—changes that would be undetectable to a human—algorithms can be exploited to consistently come to the wrong answer. In one example, researchers used a 3-D printer to create a model of a turtle, but altered the pattern on its shell in such a way that an image recognition algorithm consistently identified the turtle as a gun.[17] In a similar project, scientists at UC Berkeley have developed a method for adding noise to any sound file to change what a voice recognition algorithm "hears," meaning a human and an algorithm would have very different opinions about the words in a recording, similar to the image recognition problem of thinking a turtle is a gun." [18]

AI algorithms can be tricked into incorrectly identifying objects that would never fool a human. This 3-D printed turtle is an example of an adversarial example; the pattern on its shell is designed to fool a neural network into classifying it as a rifle.

Image: LabSix

[15] https://www.theguardian.com/inequality/2017/aug/08/rise-of-the-racist-robots-how-ai-is-learning-all-our-worst-impulses

[16] https://qz.com/1211313/artificial-intelligences-paper-clip-maximizer-metaphor-can-explain-humanitys-imminent-doom/
[17] https://www.theverge.com/2017/11/2/16597276/google-ai-image-attacks-adversarial-turtle-rifle-3d-printed
[18] https://thenextweb.com/artificial-intelligence/2018/01/11/ai-learns-how-to-fool-text-to-speech-thats-bad-news-for-voice-assistants/

40 days

AlphaGo Zero surpasses all other versions of AlphaGo and, arguably, becomes the best Go player in the world. It does this entirely from self-play, with no human intervention and using no historical data.

Elo rating is a way of comparing relative skill levels for a game or sport. This chart shows how quickly AlphaGo Zero achieved the world's highest relative Elo score for the game of Go. The AlphaGo Zero algorithm improved based soley on self-play, using a reinforcement learning algorithm to improve its performance. The green dotted line represents the version of AlphaGo that famously defeated grandmaster Lee Se-dol in March 2016. The blue dotted line represents the online version of AlphaGo launched in January 2017 which won over 60 straight games against top Go players.

Chart: DeepMind

A rules-based "reinforcement learning" ML algorithm has a different, but similar set of limitations. When an ML algorithm is given a clean, rules-based environment and a means of scoring its success, it can improve incredibly rapidly, as in the case of Google's AlphaGo Zero.[19] In 2017, in 40 days of playing itself, AlphaGo Zero became the uncontested best Go player in history. It started without any notion of "good" or "bad" strategies and instead tried millions of approaches, strengthening connections for strategies tending to win and weakening connections for strategies tending to lose.

Reinforcement machine learning is unparalleled in its success within closed, rules-based environments. However, many of the areas in which people would like AI to be similarly successful are not closed environments. If driving had a clearly defined set of rules and a closed environment, autonomous cars would be viable today. But in the real world, the "rules" have constant exceptions: a policeman manually directing traffic, snow on the roads obscuring visibility, poorly marked road construction, etc. And beyond the environmental exceptions, at any moment, any human-driven vehicle (or pedestrian, or animal) might break any of the rules. Driving, like many real-world domains, has an incredible amount of potential disorder, challenging the limits of ML to successfully adapt.

[19] http://mashable.com/2017/10/19/google-alphago-zero/

This isn't to say autonomous driving isn't making tremendous progress—it is. But it is taking several different approaches to AI working together to make progress.

AUTOMATING PERSONALIZATION

One yet-to-be-realized promise of AI and automation is truly personal preferential filtering. This is a key opportunity for the travel industry to use AI: to work toward personalizing every aspect of the journey for the traveler, making every trip a bespoke experience. Automated personalization is most visible today in places like search results, online news feeds and Amazon shopping results. And while each of these areas has pros and cons, and an increasing concern with fake news, gamed search results, counterfeit products, and bias, there is a least underlying differentiation for each user.

In travel, there is tremendous potential to improve automation of traveler preferences, particularly for frequent and business travelers. We've seen some automation already able to simplify trips: if a traveler has status on an airline and any of that airlines' flights meet policy for a trip, those flights are the first results for tools like GetThere.[20] Same with hotels—if any of a traveler's preferred hotel group is in policy near a destination, this hotel group is the default search result.

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[20] https://www.getthere.com/

As ML algorithms continue to improve, it will be easier to monitor travel choices. At a granular level, since most business travelers have similar preferences from trip-to-trip, an ML algorithm could monitor traveler choices over time and start to offer up preferred, personalized results. In lieu of ML, even knowing aisle versus window or high floor versus low floor and carrying those defaults into every booking without a traveler needing to ask is the beginning of a more personalized experience.

Increased understanding of preferences not only makes things easier on a traveler, but it makes it easier to allow algorithms to assist in the planning process. If little is known about a traveler, it's very hard to predict an itinerary they will accept. If a lot is known about a traveler, it might be possible to guess an acceptable itinerary on a first try. When personalization is high and accurate, confidence in emerging technology such as chatbots, booking algorithms and shopping algorithms increases. Essentially, the more granular automation becomes, the more pleasant a trip could be."

AUTONOMOUS VEHICLE ADOPTION

Autonomous cars have tremendous symbolic and real-world significance as a technological milestone. For over a century, automobiles have symbolized freedom and arrested the imagination, running the design gamut from functional commodities to hyper-fetishized luxuries. No amount of similar advancement in other areas of transportation (automated trains, auto-pilot on airplanes, self-driving ferries, etc.) has

anywhere near the same degree of widespread public interest and emotional investment.

Autonomous vehicles are also symbolic as harbingers of a much more visible and pervasive autonomous future. The sensors and algorithms bringing autonomous vehicles closer to reality are improving daily. In Sabre Labs, we believe autonomous vehicles which are safe without any human intervention (level 4 and 5 automation) are not far off.[21] We're also confident that in the real world, adoption will be very uneven across the globe, at least for the next few decades.

The construction of an "autonomous-first" city, with urban design optimized to accom-modate current limitations of autonomous vehicles, is likely viable and safe today. Picture, a city with a total ban on all human-driven vehicles; a 35 kph urban speed limit; sepa-rate autonomous, bike and pedestrian lanes (possibly even on different physical levels); and clearly defined pedestrian crossings (with exorbitant penalties for jaywalking). No such plan has been publicized but it's well

within reason. The largest scale project that's been announced is a rollout of self-driving cars to a 125,000-person planned retirement community in Florida (for now, these cars will have humans in the driver seat just in case anything goes wrong).[22]

[22] https://www.theverge.com/2018/1/10/16874410/voyage-self-driving-cars-villages-florida-retirement-communities

Voyage is planning to roll out a "door-to-door self-driving taxi service" to the 750 miles of road and 125,000 residents of The Villages, Florida, a planned retirement community.

Image: Voyage

[21] https://en.wikipedia.org/wiki/Autonomous_car#Levels_of_driving_au-tomation

In another potential scenario, any country try could create "autonomous" interstate lanes (similar to current high-occupancy vehicle lanes); vehicles could be permitted to travel on interstates in geofenced areas without any human intervention. Such lanes would likely have on/off points or lots where either a human being has to take control for local driving or the lots would effectively be delivery or commuter transit stations, where the autonomous vehicles would refuel and turn back around, essentially serving in a similar role to trains. This kind of autonomous, limited point-to-point scenario is potentially viable today with level 3 autonomous vehicle technology, and might be especially appealing for countries without a broad transportation infrastructure. It could be possible for a single interstate lane (with occasional wide points for passing) to be enough to connect major cities, accelerating intra-city travel and commerce for many parts of the world.

Most likely, the longest tail of the adoption curve will be level 5 (fully autonomous, no steering wheel needed) vehicles gradually integrating with and replacing human drivers in Europe and the U.S.–physical infrastructure, legal concerns, personal entitlement and a narrative history of equating the "open road" with freedom will slow adoption, along with the question of "how safe is safe enough?" [23] Car accidents in the U.S. killed more than 37,000 people in 2016, and 94% of all car accidents are caused by human error.[24]

There's always been a sliding scale of efficiency vs. safety in every transportation equation. If the U.S. abolished speed limits, fatalities would be likely to increase significantly. Conversely, if cars were speed limited to 1 mile per hour, fatalities would drop to almost zero. The legal and cultural question for the U.S. and many other countries will be: how much better, statistically, do autonomous vehicles need to be, for them to be accepted? And that answer may vary widely from place to place, directly impacting the rate at which transportation jobs are replaced.

Autonomous cars—at any scale—will start to reshape fundamental transportation infrastructures. One of the near-term effects will likely be a shift away from regional air travel, freeing up planes and runways for more cross-country or intercontinental flights. These opportunities may have significant impacts on international tourism, but will also have effects on the ground too. Autonomous vehicles—not just for ground transport, also air and water—also open up options for an array of destinations that, up-to-now, have been inconvenient and/or haven't scaled well or been economical for traditional transport like buses, trains or cabs. Autonomous vehicles have the potential to transform the shape of the travel ecosystem, opening new opportunities and expanding the breadth of travel offerings.

ROLE OF THE DIGITAL CONCIERGE

In much of the travel industry, providing exceptional service is a key part of the experience—no job exemplifies this role more strongly than

[23] https://www.washingtonpost.com/local/trafficandcommuting/how-safe-is-safe-enough-to-put-driverless-cars-on-the-nations-roadways/2017/12/10/9a1aa348-d519-11e7-b62d-d9345ced896d_story.html
[24] https://www.usatoday.com/story/money/cars/2017/10/06/nhtsa-2016-deadly-crashes/739842001/

the concierge.[25] Press over the past few years has speculated on "digital concierge" services replacing traditional concierges.[26] Digital assistants like Siri, Alexa, Google, Cortana and Bixby are growing in integration and functionality, as are chatbots based on similar conversational technologies. These services are increasingly able to offer recommendations and provide answers similar to those provided by a human, but are still decades away (at least) from coming close to providing customer service comparable to an experienced concierge.

Part of the core value of a human concierge is in their network of human relationships with colleagues at restaurants, entertainment venues and local attractions—relationships and contexts that don't exist for bots. However, there is an important role for digital concierges to play in augmenting human concierges. A hotel chatbot or in-room digital assistant can serve as a frontline for guests, answering basic questions, making spa and dinner reservations and recommending local attractions, etc. The digital concierge can alert a human concierge of opportunities to improve a guest's stay. Similarly, a concierge bot should have the capacity to monitor social media channels to flag opportunities for a human concierge to both solve potential problems and affirm positive guest experiences. Augmentation of human capacity and human skills is a key role for future automation.

One underappreciated value of the human concierge (and similar service roles throughout travel) is the ability to act with discretion and without complete data support. All digital assistants are powered by data—the more specific data they have about a person, the better their algorithms can optimize recommendations and predict user needs and behavior. Digital assistants need data to be effective. However, data privacy laws prominently in place in Europe and emerging in other parts of the world, along with increased concerns over data breaches and cybersecurity, could complicate the efficacy of digital assistants. Many people are skeptical of how widely they share their personal data, and how widely their personal data may be used without their knowledge.
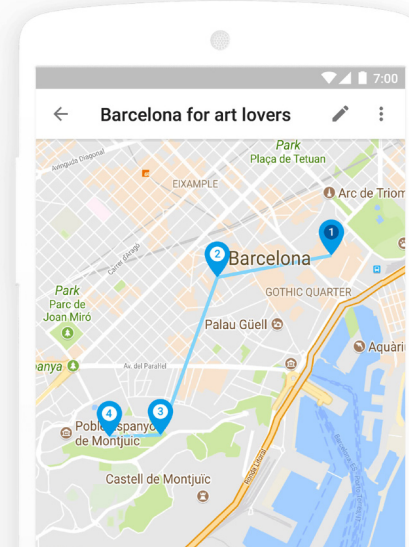
One of the algorithms built into Google Trips uses traveler location data and key points of interest to generate suggested half-day and full-day sightseeing schedules.

Image: Google

[25] http://www.ncakey.org/concierge-mentality-defining-role-hotel-concierge/
[26] https://venturebeat.com/2017/12/11/bots-are-poised-to-take-over-the-travel-industry/

These privacy concerns highlight the importance of humans' ability to assess situations and respond based solely on human interaction. In a few seconds, we can assess an amazing amount about another person from their tone, facial expressions, body language, etc. At the same time, we often adapt our own tone, facial expressions and body language to empathize with another person, helping to create a welcoming environment. Every person reading this sentence can likely remember specific positive interactions they've had over the years in travel—concierges, hotel clerks, stewards, travel agents, tour guides, etc., who created a powerful human connection and provided a level of empathy and service that transformed your travel experience for the better. It is hard to undervalue human connection as essential to the travel experience—and human connection appears virtually impossible to automate.

ROLES FOR ROBOTS

Despite the challenges, efforts continue to use robots to create emotional bonds mimicking human connection. Sophia is the most high-profile humanoid robot; it gave a speech to the United Nations last year and was recently granted citizenship in Saudi Arabia.[27] The Sophia robot has a human-like face and torso, and its software allows it to hold eye contact, recognize faces and use speech recognition to

[27] https://www.forbes.com/sites/zarastone/2017/11/07/everything-you-need-to-know-about-sophia-the-worlds-first-robot-citizen/

IT IS HARD TO UNDERVALUE HUMAN CONNECTION AS ESSENTIAL TO THE TRAVEL EXPERIENCE—AND HUMAN CONNECTION APPEARS VIRTUALLY IMPOSSIBLE TO AUTOMATE.

carry on conversations. However, its conversational capacity is limited and appears largely scripted for appearances at specific events. But its underlying physical structure allows for facial expressions to depict human-like emotions, which is a step towards achieving some sort of human-robot connection.

A much simpler attempt to emulate human connection is the Pepper robot, which identifies basic facial expressions, body language and vocal cues to attempt to provide situationally appropriate, emotionally

Above: HMSHost brought Pepper on a North American tour to encourage travelers to download their airport dining app.

Image: HMSHost

Right: Humanoid robot Sophia waits to greet guests at the Hanson Robotics booth at CES 2018.

Image: Hanson Robotics

appropriate responses.[28] More than 10,000 Pepper units are already in use by a growing number of businesses, including hotels, cruise ships and retail stores. Stores using Pepper often see an uptick in foot traffic and sales, but it's too early to know whether excitement around humanoid robots will last or whether it's merely good public relations inspired by novelty.[29][30]

Humanoid robots experience more challenges than their non-humanoid counterparts. The "uncanny valley" describes the eerie aesthetic effect of objects that look almost-but-not quite human.[31] And even if not disconcerting, many other ethical and cultural challenges exist around how to appropriately interact with humanoid devices. "Cute" simulacra like Pepper are likely to be as human as most robots get. Most robots introduced to culture are likely to be designed to avoid being too human, favoring function over form—like delivery robots, which are basically rolling boxes on wheels.

With few exceptions, the goal for much of robotic automation is to be ubiquitous but invisible: the Roomba that cleans the floor when no one is home. In travel, this will play out the same

[28] https://www.ald.softbankrobotics.com/en/robots/pepper
[29] https://www.recode.net/2017/1/4/14171436/softbank-robot-pepper-sales-brick-and-mortar-retail-ces
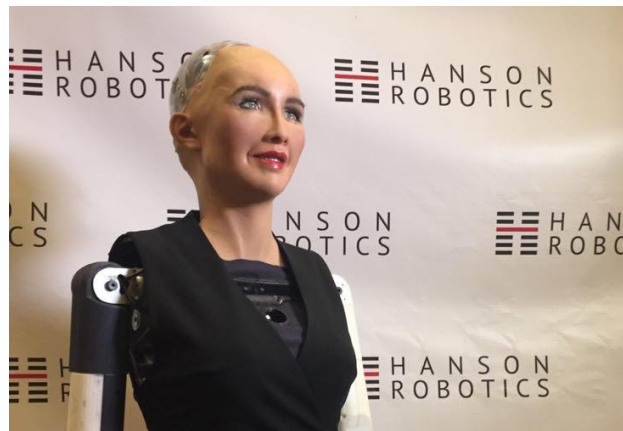[30] https://qz.com/676799/japans-personal-service-robots-are-novel-interesting-and-useless/
[31] https://en.wikipedia.org/wiki/Uncanny_valley

way, with robots moving baggage, delivering items and helping with cleaning, maintenance and inspection across the travel ecosystem. If, as Shakespeare says, "all the world's a stage," then digital automation—both software and hardware—will take on more and more of the behind-the-scenes roles and the bit-parts.[32] This increasingly leaves humans with few options except to be on-stage, in the spotlight, with our actions front-and-center.

AUTOMATION IS A MEANS TO AN END: ALL AUTOMATION IS AUGMENTATION OF THE BROADER HUMAN EXPERIENCE.

LOOKING FORWARD

Humans are uniquely narrative and symbolic creatures; no matter what is automated, humans will still need humans to provide stories to help make sense of the world. The broad arc of near-term automation is full of challenges, but also full of potential. There are incredible opportunities for the travel industry to turn the expected economic growth of digital automation into a more prosperous and human-first experience.

Success in the era of digital automation will depend largely on adaptability. Don't hire for jobs; hire for skills. Don't think of skills as static; continuously train and retrain to meet projected needs. And, at every level, value the human experience—both of your travelers and your employees. As it's always been, automation is a means to an end: all automation is augmentation of the broader human experience.

[32] https://en.wikipedia.org/wiki/All_the_world%27s_a_stage
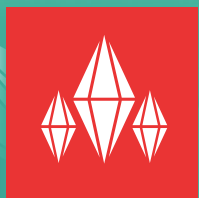
AUTHENTICITY IS FOR REAL

In a digital world, trust is scarce, but growing in value

INTRODUCTION

In Montreal, Fairmont Queen Elizabeth Hotel, room 1742, the future meets the past. For four nights in May 1969, the suite was home to newlyweds John Lennon (of The Beatles) and Yoko Ono. There, the couple staged their second "Bed-in-for-Peace" and recorded the enduring anthem "Give Peace a Chance." The suite has been renovated to memorialize the past and uses technology to immerse guests in a historic moment.

The hotel has taken a very different approach from the static "time capsule" nature of many historic attractions. Furniture and décor have been updated to reflect the tastes of the famous guests and many elements of the room have been customized to create a deeper sense of the events: from recorded phone messages from Lennon, to period videos on the TV, to photos of other celebrities who visited the couple during their stay. The immersive experience includes an in-room virtual reality headset with content to let visitors see through the eyes of Lennon and Ono: it recreates 1969, everything from the maids cleaning the room to the reporters mobbing the door.[33]

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[33] https://www.businesswire.com/news/home/20171005005029/en/UNLTD-Debuts-%E2%80%9CJohn-Lennon%E2%80%99s-Suite-1742-Virtual

A screenshot from the immersive VR experience, "Suite 1742: Bed-In for Peace," created by UNLTD, provides viewers the perspective of John Lennon and Yoko Ono--everything from the maids cleaning the room to the reporters mobbing the bed.

Image: UNLTD

Sure, you don't have to be in room 1742 to watch the VR video—you could watch the same footage on any VR headset and get part of the experience. But this is a bookable suite—there is no other room on the planet where you can sleep in the same spot as Lennon and Ono, see out the same windows and be surrounded by the same context. Thoughtful design and a robust technology layer are being used to help increase the immersion—and increase the authenticity—of the visitor experience.

"Authenticity" has emerged as a buzzword across culture and is being peddled as the cure-all for everything from politics to tacos.[34][35]

In the travel industry, leisure travelers are seeking destinations and brands able to provide authentic experiences—whether that means reliving a 1960s peace protest or providing whole-grain, organic, gluten-free, non-GMO foods for the morning breakfast buffet. Similarly, business travelers are seeking brands who are authentic in providing dependability and consistency in what they promise—whether that's a guaranteed seat on a flight or a mid-sized rental car ready and waiting for an on-time pickup.

Past any hype, what factors are driving the authenticity trend? How can we use emerging technologies to exceed traveler expectations and provide new kinds of authentic experiences throughout the travel journey?

[34] http://time.com/4859408/2018-election-democratic-candidates/
[35] https://www.wsj.com/articles/how-the-authentic-taco-made-a-gourmet-comeback-1428082953

DEFINING AUTHENTICITY

Authenticity swims amidst a sea of interwoven concepts: trust, transparency, reliability, fairness, novelty, scarcity, certainty, credibility, integrity, simplicity, justice, confidence, meaning, friendship, #nofilter. These are all part of a digital age paradox: limitless information has delivered amazing value, but it has also made it hard to filter what is real and know who to trust. And, simultaneously, it's become increasingly hard to stand out amidst the tumult of sources vying for attention.[36]

[36] https://www.wired.com/story/free-speech-issue-tech-turmoil-new-censorship/

AUTHENTICITY IS ABOUT BEING ABLE TO CREATE—OR RECREATE— AN EXPERIENCE OF SIMPLICITY, CERTAINTY AND TRUST.

Probably the closest semantic parallel for authentic is "real" or "genuine," and the context is often more emotional than literal. Authenticity is about feelings and intentions. It's about relationships—between friends, strangers, businesses, brands. It's about being heard. Authenticity is about being able to create—or recreate—an experience of simplicity, certainty and trust.

Authenticity is valued because it builds trust, but authenticity should never be conflated with truth. For example, a person can very sincerely provide poor directions, but no amount of authenticity can change the objective truth about a need to turn left instead of right. But because authenticity is inherently relational, misdirection doesn't always equate to a lack of trust.

In health care, medical malpractice suits are highly linked—not to medical error—but to breakdowns in communication and the resultant lack of trust.[37] Two-way, open communication—a.k.a. "rapport"—between doctor and patient results in high trust and very low incidence of lawsuits (even when errors occur). The centrality of communication in successful health care practice is a strong lesson for other relational industries like travel. Trust is less affected by whether or not a mistake is made than it is to whether or not a person feels listened to and empathized with when there are conflicting expectations.

[37] https://www.nytimes.com/2015/06/02/upshot/to-be-sued-less-doctors-should-talk-to-patients-more.html

Authenticity—and creating authentic experiences—is building a connection grounded in reality: between two people, between a person and a brand, between a person and an experience, between a person and a place.

REVALUING AUTHENTICITY

Authenticity is in the spotlight as a reaction to a global crisis of trust and the uncertainty of a rapidly changing world. Some would argue that trust is at an all-time low—trust in governments, media, businesses and even non-profit organizations.[38] Concerns over fake news, virtual worlds, cyber terrorism, losing jobs to artificial intelligence, and on and on are accompanied by a surge in craft movements, handmade goods, artisanal hobbies and social causes.

In a sense, the quest for authenticity is its own kind of retro movement; it echoes a 19th century trend, also in response to concerns over rapid, widespread social and industrial change.[39] A driving factor for this trend is called "The Law of Disruption"—technology changes exponentially, while humans change incrementally.[40] It is increasingly hard for humans to adapt to the pace, scale and complexity of the digital world.

To use digital terms, we lack the bandwidth to intake and make sense of the deluge of content around us, and filtering actionable priorities has countless variables. Even when we choose to act, it's hard to be sure we're making informed choices. Infinite content to choose from can have the effect of lasting discontent. This acceleration has no end in sight. As tech writer Graeme Wood phrased it—"Change has never happened this fast before, and it will never be this slow again." [41]

Within this rapidly changing cultural and technological landscape, the travel industry is both a significant contributor to and a beneficiary of the change. Travel is providing a tremendous source of opportunity and realized escape to new places, new experiences, in the form of tourism. Travel and tourism represent more than 10% of global GDP as well as almost 300 million jobs (1 in 10 jobs worldwide, with an expectation to grow to 380 million jobs in the next decade).[42] Airlines connect the world at staggering scale; travelers flew more than 4 billion times in 2017, with that number expected to roughly double over the next 20 years, driven in part by skyrocketing demand in the Asia-Pacific region.[43] Travel and tourism at all levels are key drivers of economic growth, particularly in emerging economies.[44] Travel has a long history

[38] https://www.edelman.com/news/2017-edelman-trust-barometer-reveals-global-implosion/
[39] https://www.washingtonpost.com/news/made-by-history/wp/2017/08/04/how-capitalism-cornered-the-market-on-authenticity/
[40] https://www.washingtonpost.com/news/innovations/wp/2017/10/30/will-modern-luddites-smash-techs-future/

[41] http://graewood.blogspot.com/2009/09/ipasocial-principle-9-change-will-never.html
[42] https://www.wttc.org/research/economic-research/economic-impact-analysis/
[43] http://www.iata.org/pressroom/pr/Pages/2017-10-24-01.aspx
[44] http://www2.unwto.org/content/why-tourism

of technological adoption—the act of connecting the world is made possible by connected infrastructure.

Digital technologies are a double-edged sword for issues of authenticity and trust. Curated news feeds can mean the stories surfaced often reinforce existing beliefs and omit opposing views; on the flip side, AI algorithms can be used to help combat the spread of fake news and fake

University of Washington researchers used machine learning algorithms to generate this highly realistic fake video of former President Obama based on audio clips and weekly video addresses.

Image: University of Washington

product and service reviews.[45] Increasingly sophisticated photo, video and audio tools are getting better and better at altering reality, going way beyond filters and Photoshop. Research demonstrating the ability to create a fake Barack Obama video is a powerful example, but is only one of a host of other similar efforts under way.[46] [47] AI algorithms seem to be the only hope of spotting fabricated content at any kind of scale—the sheer volume of generated media is far too vast for humans to monitor and vet.

There's uncertainty about which side of the digital truth arms race will stay ahead. *Gartner's Top Strategic Predictions for 2018 and Beyond* report projects "by 2020, AI-driven creation of 'counterfeit reality' or fake content, will outpace AI's ability to detect it, fomenting digital distrust."[48] Looking a little further, Gartner also predicts "by 2022, the majority of individuals in mature economies will consume more false information than true information."

Of course, consuming false information isn't the same as believing it. Personal filters must be more rigorous, more discerning than ever. This can be exhausting and accelerates the need for trusted brands—safe spaces where we can let down our guard and trust we're getting true information.

[45] https://www.technologyreview.com/s/609717/can-ai-win-the-war-against-fake-news/
[46] https://spectrum.ieee.org/tech-talk/robotics/artificial-intelligence/ai-creates-fake-obama
[47] https://www.technologyreview.com/s/604270/real-or-fake-ai-is-making-it-very-hard-to-know/
[48] https://www.gartner.com/technology/research/predicts/

Travel has always been at the forefront of connecting the world, and the digital revolution is providing new tools to power human experience. This is a great opportunity for the travel industry to pair digital tools with human strengths to lead the way in being authentic, in sowing and cultivating trust.

TRAVEL IS PRESENCE

At its core, travel has a tremendous authenticity advantage over most industries: it's innately about physical presence. No matter how much of life is "on demand," there is no shortcut to "being there." Travel is an inherently human industry, an inherently relational industry, and exists to enable people to experience new parts of the physical world.

Travel has an outsized presence in individual consciousness, both in contextualizing the past and in anticipating the future. The act of planning and anticipating a trip increases happiness (often as much or more than the trip itself).[49] The mandate of full participation also means travel is one of the key domains in life fueling anticipation. For most people, recent trips are top of mind, and when you ask what someone is looking forward to, upcoming travel often tops their list. Sharing travel stories—our modern adventures—is part of human connection, part of establishing authentic connections with others.

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[49] https://well.blogs.nytimes.com/2010/02/18/how-vacations-affect-your-happiness/

Even for something as simple as a single plane ride, you and everyone else on board have several elements in common: you're all travelers who— at least for that segment—have a shared origin, a shared destination, a shared experience of the flight, and you bring into it the lived history of all your previous travel.

Each traveler is an amalgam of goals and expectations, which makes the experience of authenticity relative to each traveler, each trip, each segment, and each moment in time. Expectations, spoken or unspoken, realistic or not, may include things like:

> » _Because the weather is clear in both my outbound and arrival cities, I expect my flight to be on time, or slightly early in arrival._
>
> » _Because I am leaving my house 1.5 hours before my flight is scheduled to depart, I'll be able to board my flight on time._
>
> » _When I get to the hotel 45 minutes before "official" check-in time, I will be allowed to get a room early so I can shower and unwind._

Each traveler, in each scenario, has a set of tiered goals they are trying to accomplish. At a base level, a sales executive could be trying to win a new account through an in-person meeting. As part of the process, a sub goal could be getting from point A to point B on time.

Another goal could be trying to find the precise dinner spot to host the potential client—a location that is not too loud, not too casual, but not too romantic or stuffy, has a variety of options on the menu including

four vegan entrees, and has a great wine list. A trip can be seen as an attempt by the traveler to maximize the payoffs for each of those goals and subgoals.

As everyone who has worked in travel knows, travel is rarely simple, seldom seamless, and never perfect. Forces inside and outside each travel provider's control affect the traveler's experience of their trip. For instance, weather delays, or an inconvenient company policy may prevent a service representative from being able to meet a customer's expectations.

These goals and desires also partially dictate a traveler's readiness to accept the experience provided. For instance, if your goal and intent upon arriving at a hotel is to unpack as quickly as possible, take a hot shower after a long day of travel, and slip into bed with Food Network reruns in the background, you may not be ready to have an "authentic local experience" during check-in. A prolonged check-in, no matter how personalized and professionally executed, may oppose the traveler's goals for that moment.

The growth of digital keys and check-in is one important way technology is giving travelers more power to choose their level of engagement with staff. Digital keys allow travelers to use their smartphones to unlock their room. When combined with mobile check-in and room selection, travelers to some properties now have the option to skip personal interaction altogether. Early adopters included Marriott and the Starwood Preferred Guest program, who enabled smartwatch-based digital keys. Of the major hotel chains, Hilton has put the most resources into making digital keys commonplace, particularly across their North American properties, and has plans to have digital keys in use across half it's 5,000 global properties in place by the end of this year.[50] Yet despite significant growth, on a global scale digital keys are still in very early adoption, in use at less than 1 percent of all properties across the industry.

As with everything, mobile check-in and room keys have trade-offs. Using mobile check-in to select a room means a traveler is limited by all the things they may not know about the location, such as which rooms are the quietest or have the best views. Going to the front desk and establishing
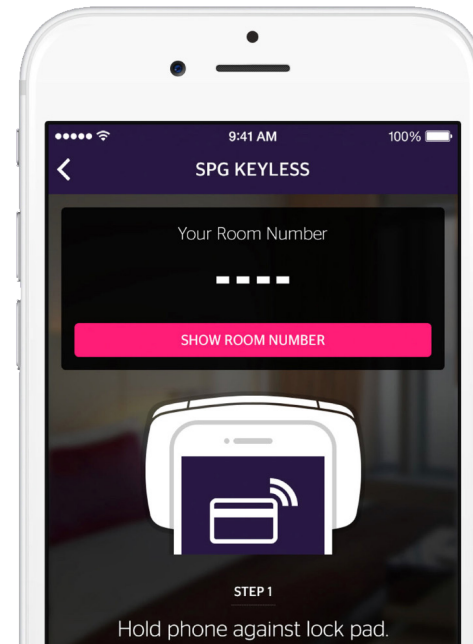
Starwood Hotels is one of several hotel groups beginning to offer digital keys, allowing travelers to bypass the front desk and use their smartphone as a room key.

Image: SPG

[50] https://www.ft.com/content/28455880-6232-11e7-8814-0ac7eb84e5f1

rapport with the staff can mean getting the benefit of their knowledge and service—and sometimes even an occasional room upgrade or bottle of champagne that never would have been offered in-app.

And for most travelers, their preferences will vary based on the specifics of the trip. A business traveler arriving late and checking out early may just want the most seamless possible experience. But that same traveler with a weeklong stay may want the value of a potentially better room and the relationship with the front desk in case of any needs. Regardless, the consistent objective is to give travelers options in how they want to engage on each trip as a way of building trust that a travel provider is prioritizing the traveler's best interests.

ESTABLISHING AUTHENTICITY

Authenticity in travel is playing out across the entire technological spectrum: from tech-heavy examples like the Fairmont's room 1742 media immersion to conspicuously tech-free examples of "digital detox" vacations promising to help people reconnect with themselves. There's no proscribed formula; no fixed level of technological engagement to create optimal authenticity. Instead each opportunity needs to be evaluated to see how digital tools can be used to create a stronger connection with customers, employees, news media, regulators, and partner organizations, and to do so in a brand-appropriate way. What's natural and authentic for one company can feel very forced and false for another.

Each stage of a trip is a chance deliver nuanced experiences to enable

or encourage the traveler to have a more authentic experience. And authentic doesn't always mean "real," in some cases it means exceeding or escaping reality. A turbulent airplane ride in back-row, middle-seat economy might be the reality of a flight, but no flier wants to immerse themselves in that experience. For an airline, trust can be gained through distracting the flier from the experience by providing a wealth of digital entertainment options, streaming wi-fi, and, perhaps most importantly, using new technologies to reduce the biological stress of flying.

The newer Boeing 787 Dreamliner and Airbus A350 use carbon-reinforced plastic composites to create stronger cabins that can operate at higher internal air-pressure, simulating the air at lower elevations.[51] The new planes keep the cabins at a pressure roughly equivalent to 6,000 feet above sea level, and retain more humidity. Both factors lead to less passenger discomfort and combat the symptoms of jet lag. Qantas is partnering to research the way different tones of light, variable cabin temperature, and careful diet can all be used to help create in-plane environments optimized to minimize jet lag on long-haul flights.[52]

Carbon-reinforced plastic composites and color-shifting lights may not be as glamorous as headrest flat-screens and the latest Hollywood movies on-demand, but environmental technologies have a significant

[51] https://www.usatoday.com/story/travel/columnist/hobica/2017/01/18/jet-lag-altitude-sickness-dehydration/96677564/
[52] https://www.bloomberg.com/news/features/2018-02-05/can-science-beat-jet-lag-airlines-seek-help-for-19-hour-flights

potential to improve the in-flight experience for everyone, including the back-row of economy class. And every effort an airline can put into place to reduce discomfort—to distract from the "normal" flying experience—can build trust and loyalty with travelers.

In-flight authenticity has certain challenges and strengths, but traveler priorities are different on the ground and at sea. For hotels and cruises, lodging is often an anticipated part of the experience. People want to enjoy and engage with what's being offered. Minimizing impediments and offering appropriate distractions is still important, but creating authenticity becomes more active with more tangible options to navigate.

The on-the-ground experience can be improved through a variety of different resources, centered on providing a memorable personality for a place. And every employee in the travel provider space has a role to play in creating that personality, bringing their unique knowledge and resources to bear. No matter how much personalized data is shared by a traveler, they don't share everything, and they may be open to experiences outside of their profile. Finding ways to broaden their experience is a powerful way to create an authentic impression of a place. Each provider must ask: In your location, what is unique and convenient? Is there an unusual sculpture, an artisanal coffee roaster or microbrewery, a local memorial or other point of interest?

Within those tailored recommendations, it's essential to understand the scale of a traveler's availability and offer opportunities appropriate to that scale—even if it's only a few minutes. Suggesting a route with an ex-tra block to/from a destination to see a historic street may be enough to change their experience and foster a sense of authentic connection with a place. The same sense of scale is important when a cruise ship pulls into port: understand a traveler's preferences and limitations and offer options optimized to their level of adventure and comfort.

Hotels are beginning to offer tailored digital escapes—meditation, digital detox rooms (no TVs, only one outlet, etc.), as ways to give travelers a respite they would be unlikely (or unable) to create at home. That might be an unplugged experience for a day, night, or entire stay. On the flip-side, some hotels are going full-digital, and using technologies like virtual reality to give travelers a different kind of experience that might not be available at home. Hotels around the world are offering in-room VR to connect visitors to local offerings and sometimes offer a behind-the-scenes look at on-property amenities like spas and restaurants.

The more unusual, the more local, the more memorable an experience is, the more it feeds into a deepening desire across travel for novelty. What does it mean for a traveler to go somewhere none of their friends, family or colleagues have been? What does it mean to "discover" the exceptional value of a food truck or pop-up bistro before it has online reviews or a robust social media following?

NOVELTY VS. AUTHENTICITY

We are in a world where it has become virtually impossible to under-value novelty. Last November, a likely Leonardo da Vinci painting sold

for a record-breaking $450m (USD)… $150m more than other painting in history.[53] The auction took place after a global marketing push, a world tour and celebrity hype. The buyer was eventually revealed to be acting on behalf of the Abu Dhabi Department of Culture & Tourism, which has placed the painting on display as a centerpiece of the Louvre Abu Dhabi museum.[54] The sales record was achieved despite skepticism

[53] https://www.nytimes.com/2017/11/15/arts/design/leonardo-da-vinci-salvator-mundi-christies-auction.html
[54] https://www.louvreabudhabi.ae/

Scenic Cruises uses a boat with an ice-rated hull to include Arctic and Antarctic destinations among its many experiences tailored to taking travelers to undeveloped corners of the world.

Image: Scenic Cruises

over the authenticity of the painting.[55] So what was actually sold: a painting, a story, or something else?

Regardless of the price or the story, the painting is undeniably novel—one of less than 20 known paintings by one of the most famous artists and inventors of all time. In that sense, it's priceless. And novelty is related to authenticity—the two ideas lean against each other, the tension reinforcing one another. Scarcity and novelty are increasing in value, not just in travel, but in culture at large. Both business and leisure consumption are being driven by these forces.

The claim "experiences matter more than products" plays out throughout the travel ecosystem—particularly for Millennials and Gen Z travelers. And increasingly, we are seeing examples where the lines blur and the experience is the product, and the digital artifacts (like Instagram and Kuaishou) are an intrinsic part of the sought experience.[56] Travel is seeing this in the continued growth of exclusive experiences, made more desirable by their scarcity.

Cruise is at the forefront of offering ultra-premium, highly tailored luxury experiences in ways no other segment of the industry can provide. Scenic Cruises, based out of Australia, has announced an expedition-style vessel with its own helicopter and submarine, Zodiac boats for landing in

[55] https://www.wmagazine.com/story/salvator-mundi-leonardo-da-vinci-reviews-memes
[56] https://www.bloomberg.com/news/articles/2018-01-16/tencent-backed-video-site-is-said-to-seek-17-billion-valuation

remote locales, and an ice-rated hull for Arctic and Antarctic voyages.[57] It's part of a small, but growing segment of cruise focused on exploring every corner of the world—especially remote locations that have rarely or never before been available for travel. The entire ultra-luxury element is framed around creating authentic, once-in-a-lifetime experiences of undeveloped places, essentially promising tour without the tourism.

For airlines, the trend towards luxury suites the past few years is a nod to the demand for novel experiences, perhaps none more decadent than Etihad Airways' A380 three-room "The Residence." [58] On the accommodations side, premium hotel brands are expanding their experiential offerings through partnerships, like Four Seasons partnership with Noma, one of the world's most acclaimed restaurants, for a three-week private-jet global food tour.[59] Or for $1 million a night can rent your own private island.[60]

Exclusive travel providers, like those in the Virtuoso network, offer a range of tailored experiences to meet different kinds of traveler preferences. The *2018 Virtuoso Luxe Report* released in November identifies "what travelers will seek in 2018: pristine, unfrequented and unique destinations" [61] and cites specific examples of the kinds of human connection travelers are

seeking, including: "reaching the edge of space in a MiG-29 flight in Russia, to herding cattle in Australia…[to] sleeping under the stars in the desert— no tent required." High-end, experiential travel is seeking increasingly diverse and deeply engaged offerings and is embracing a broader shift away from being "tourists" and towards being travelers and adventurers. In the last year, the Virtuoso nework has also seen rapid growth of its Wellness and Adventure travel communities, seeking to provide additional personalization for particular traveler motivations.[62]

[62] https://www.travelpulse.com/news/host-agency-and-consortia/virtuoso-experiences-record-growth.html

Etihad's "The Residence," a bookable three-room suite aboard one of the airlines' A380 planes. Image: etihad.com

[57] https://www.usatoday.com/story/travel/cruises/2018/02/05/scenic-cruises-build-second-ship-its-own-helicopter-submarine/306260002/
[58] http://www.scmp.com/magazines/style/travel-food/article/2107649/history-first-class-reveals-luxury-air-travel-tug-war
[59] http://www.townandcountrymag.com/leisure/travel-guide/a7051/four-seasons-culinary-discoveries/
[60] http://velaaprivateisland.com/
[61] https://www.virtuoso.com/getmedia/a66cafd3-866f-4661-b6c3-02f8bfc9a83f/2018-Virtuoso-Luxe-Report-Release_FINAL.aspx

To a large degree, luxury experiences have always existed, even if they are getting more exotic. What's new in the novelty space is the emergence of boutique, high-tech travel agencies specializing in providing "surprise" vacations.[63] Pack Up + Go, The Vacation Hunt, Whisked Away, are among the evergrowing list of providers.[64][65][66] Travel magazine AFAR headlined "surprise is the new luxury."[67]

HAVING AN AUTHENTIC EXPERIENCE IS AIDED BY BEING IN A TRUSTING FRAME OF MIND.

Part of the luxury of a surprise trip comes from the freedom of not having to do the planning—or even decide on a destination. To help ensure surprise trips are in line with travelers' preferences and abilities, most surprise trips start with questionnaires, helping the agency discern what might be of interest.

The audience, degree of surprise, granularity of planning, and price points vary, but what all surprise trips have in common is providing people travel plans without advance details. In most cases, travelers will know when to head to the airport and roughly what weather to pack for, but everything else will be a mystery.

Surprise trips offer a very high degree of personalization and often intentional connection into local culture, whether that be tours from residents, meals in hole-in-the-wall restaurants or locals' homes, or even hands-on experiences ranging from helping out on a farm, to community service, to shadowing artisans or tradesmen for the day.

The reviews of surprise vacations tend to be enthusiastic—these are perceived in many ways as more authentic experiences, likely because the details are outside of the traveler's control, but also because the experience hasn't been overthought in advance. Minimizing the required planning cost—even the investment of narrowing down a destination—tends to be freeing, making travelers more receptive and open to engage the experience. Having an authentic experience is aided by being in a trusting frame of mind.

[63] https://www.washingtonpost.com/lifestyle/travel/want-to-travel-but-dont-care-where-surprise-vacations-have-you-covered/2017/09/28/5792bad8-9a54-11e7-82e4-f1076f6d6152_story.html?utm_term=.a875924ae3a1
[64] https://www.packupgo.com/
[65] https://www.thevacationhunt.com/
[66] https://www.explorewhiskedaway.com/
[67] http://www.harpersbazaar.com/culture/travel-dining/a11297/surprise-travel-trend/

VALUING THE VIRTUAL

The ease of digital manipulation inspired the *#nofilter* hashtag on images, which people use to indicate the accompanying image (or video) is authentic. *#Nofilter* means the creator hasn't applied any filters or editing to the image file as it was rendered by the camera software. People are using the hashtag to convey the idea something is so inherently worth sharing that it doesn't need help from filters or Photoshop—that the thing they are sharing is real.

Oculus Go, a soon-to-be-released standalone virtual reality device—no smartphone or computer required.

Image: Oculus

The growth in the creation and distribution of virtual reality content is adding a new twist to the #nofilter equation. Immersive VR film and 360-degree photographs are increasingly common, and—filters or not—they come with a higher inherent degree of authenticity than 2-D images. When you're capturing in 360-degrees, there's a lot of context, and the ability of a viewer to choose where they look—and how long they focus on what—creates a degree of trust for the viewer. Bringing the viewer into the scene and giving them autonomy to control the scene helps create an inherent connection.

For travel brands, creating VR content may be an important way to ramp up the perception of authenticity in the future. See the exact room or seat or meal you'll be experiencing. Have your full imagination primed to engage in the specifics of a trip, not the generalities. The recent announcement of several untethered VR-only headsets—notably the Oculus Go and the Lenovo Mirage Solo—are expected to help reinforce this trend, ramping up user engagement with VR content and reducing the barrier to entry of previous systems, as well as making it easier to consume VR content on-the-go (e.g. in airplanes, trains, hotel rooms).[68][69]

VR livestream is also contributing to an evolving notion of "being there." Watching a sport on TV is objectively better than going to a live game for knowing what's happening: fancy graphics and stats, slow-motion

[68] https://www.theverge.com/2018/1/8/16866318/oculus-go-xiaomi-mi-vr-snapdragon-821-ces-2018
[69] https://techcrunch.com/2018/01/09/googles-first-worldsense-vr-headset-the-lenovo-mirage-solo-ships-in-q2-for-under-400/

replays, live commentary, etc., and often the ability to rewind, pause, and grab a snack without missing any of the action. But livestream VR can provide all the stats as well as the ability to sit courtside and be closer to the action than ever before, in a more immersive way, for a fraction of the cost of the physical tickets.

Yet, sitting virtual courtside for free vs. the expense and costs of going to a game is not a simple value equation; the two experiences are so different they are hard to compare. There is also something unique in going to the game, talking with the people on the sidelines, cheering on your favorite team in a way they can hear you, gorging yourself on nacho-cheese and soda-pop, all while experiencing those things with a best friend, significant other, or family member. VR won't replace being courtside, but it might spur a rise in virtual Super Bowl parties so friends from around the world can be on the sidelines together.

In that sense, VR has a role to play in democratizing otherwise rare and exclusive experiences—whether it's front row seats to a sporting or cultural event or a trip to the ends of the earth. Very few people may physically be able to travel to Antarctica or take a helicopter trip inside an active volcano, but through VR, the cost drops to nearly zero for people to have some version of the experience. And while it makes rare experiences available to everyone, it may also serve to inspire potential travelers to seek out "the real thing," after experiencing the digital version.

The deluge of all kinds of digital content is making the idea of "what you see is what you get" both easier and harder. Easier in the sense that

VR HAS A ROLE TO PLAY IN DEMOCRATIZING OTHERWISE RARE AND EXCLUSIVE EXPERIENCES.

you can see 1,000 pictures of something before you book a ticket or make dinner reservations; harder in the sense that you have no context— no filter—for who created which images and how their perceptions might align with your own.

There's a role for machine learning algorithms to advance in their sophistication of applying virtual personalities to immediate problems of preference. We see this in recommendation engines on commerce and media platforms: on Amazon, "customers who bought this also bought…" and on Netflix, "Recommended for you…" both are based on what othe shoppers/viewers similar to you might have picked out.[70][71] But overall, these recommendation algorithms have plenty of room to continue to improve their recommendations.

[70] https://www.wired.com/2016/05/amazons-giving-away-ai-behind-product-recommendations/
[71] http://www.wired.co.uk/article/how-do-netflixs-algorithms-work-machine-learning-helps-to-predict-what-viewers-will-like

Ideally, there's a "virtual me" algorithm that can be applied to take one person's preferences and context into reducing the digital overload. If you are searching for and value long, romantic dinners with your spouse, you might want your algorithm to filter out the five-star restaurant review for "awesome nachos". Curation via virtual profiles prioritizing individual user preferences for a particular event or moment in time is an area for growth and opportunity, and will help create more engaged consumers, pre-biased in favor of the kinds of experiences they'll be primed to have, adding to the authenticity of their experiences.

VERIFIED EXPERIENCES

Authenticity is about agreement, and it benefits all parties to be honest, and to often strive to provide novelty. The evolving on-demand, sharing economy is a key way this is playing out in travel. Platforms like EatWith, Vayable, Triple and Airbnb Experiences are exploring ways to connect travelers to locals who are passionate experts in niche areas.[72][73][74][75] At their core, these platforms connect to exactly the kind of authentic local experiences often sought out in travel.

A quick scan: experience a Vietnamese vegan feast at a woman's home in Tel Aviv, Israel; meet contemporary artists and tour private studios in Buenos Aires; play traditional Swedish lawn games and picnic with locals in Stockholm; "touch, photograph and even howl with the wolves," at a wildlife refuge outside of Seattle.[76][77][78][79]

Using technology platforms to connect travelers to local resources is critical to the future of authentic travel. Similar to how the Internet allowed niche interest groups to flourish because of global connection, local platforms will allow people with niche expertise to monetize and share their knowledge, skills and expertise.

We expect this to give rise to ever-more curated travel experiences, catered to niches like the rise of various lifestyle diets (e.g. plant based, vegan, whole foods, local, organic, gluten-free, dye-free etc.), cultural movements, hobbyists, and on and on.

For travel, there are incredible ways to use these platforms as resources—both to help connect travelers to local experiences, but also to learn what is out there, and what is hyperlocal that may fit client profiles. Going beyond traditional experiences and venues is a great way to establish expertise and build trust.

Along with these new kinds of experiences will be an expectation for new standards in vetting and validation. People tend to trust other people more than brands and more than marketing, which is part of why

[72] https://www.eatwith.com
[73] https://www.vayable.com/
[74] https://triple.co/
[75] https://www.airbnb.com/s/experiences

[76] https://www.eatwith.com/events/26947
[77] https://www.vayable.com/experiences/14991-art-city-tour
[78] https://triple.co/stockholm/outdoor-activities/play-swedish-park-games-with-local-friends-109/
[79] https://www.airbnb.com/experiences/47240

PERSONAL EXPERIENCE—AND SHARING YOUR EXPERIENCE—HAS BECOME THE HIGHEST COMMONDITY IN TRAVEL.

reviews on sites like TripAdvisor can carry so much weight. However, there are always concerns of false reviews or of sites curating reviews out of public sight. Companies like Revain leverage technology, in this case blockchain, to put authenticity and trust back in the review sector.[80] Revain proposes to have every review verified then added to the block-chain; in theory, there will be no way to delete or hide a review once it's been verified. The platform uses the IBM Watson Tone Analyzer and natural language recognition to help with filtering and authenticating reviewers. Revain is launching with a focus on reviews related to block-chain offerings, but plans to expand to other industries, including travel.

REAL NEXT STEPS

Putting reviews on the blockchain has the same pros and cons as other blockchain solutions (see more in the **Blockchain** section of the report),

but as a concept, it speaks to an attempt to meet consumer need for authenticity: we want human reviewers to be verified, but we want their opinions to be unfiltered, particularly if they're helpful to us. Inherently, in an age of digitalization, we still want and value human connections and human trust.

Personal experience—and sharing your experience—has become the highest commodity in travel. No amount of loyalty points, status, perks or discounts can replace the customer experience. Travelers are going to share their real impressions of every step of the travel journey, and travel providers are tasked with increased vigilance to make sure those experiences—hiccups and all—are positive.

Within the travel ecosystem, emerging technologies should be seen as tools, not as mandates. Just because the Fairmont Queen Elizabeth Hotel has a created a novel, historic VR experience doesn't mean all hotels should rush to create VR experiences. Just because Alexa and Google Assistant are becoming more common in hotel rooms doesn't

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[80] https://www.coinspeaker.com/2017/10/06/blockchain-technology-will-change-reviews-industry/

mean they should be ubiquitous.[81] Nor does the rise in silent retreats for digital detox mean all hotels should ban cell phones.[82] Just because long haul flights are implementing new airplane technologies doesn't mean every regional carrier needs to buy new planes. Just because there's a rise in surprise trips doesn't mean all leisure travel should be a mystery. Instead, travel providers should remain focused—and refocused—on the experience they want to provide and carefully consider what technology strategies can help them create a deeper connection with current and future travelers.

Travelers have no shortage of options, but they do have a shortage of time and of attention. Focusing on ways to build trust with travelers helps alleviate their need to consider every option, instead allowing them to focus on curated options and experiences. In a world of infinite choices, reliably simplifying decision making is one of the greatest services a brand can provide. Every brand that can provide smart choices and help create authentic experiences along the way will create loyalty deeper than any trend.

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[81] https://www.hospitalitynet.org/news/4086445.html
[82] https://www.cntraveler.com/story/silent-retreats-are-the-latest-in-digital-detox-vacations

BLOCKCHAIN BEYOND BITCOIN

Scarcity & permanence create new models for trust

INTRODUCTION

Blockchain has been the biggest tech rollercoaster of the year. Crazy headlines and absurd promises have stretched dreams to exhilarating heights, largely focused on the explosion in cryptocurrency values. Bitcoin has received the lion's share of the press, but it's far from the wildest story: a $3,000 purchase of Bitcoin at the beginning of 2017 peaked at a value of ~$50,000 towards the end of the year. The same $3,000 purchase in Ripple cryptocurrency was worth more than $1 million at the end of 2017, though as we write this a few weeks later, its value has plunged 75% from its highest point.

At this stage in the evolution of cryptocurrencies, there's no telling what Bitcoin, Ripple, Ether or any other cryptocurrency will be worth when you read this. Any investment could be worth millions or pennies. So if you're reading this as an investment primer: *DON'T*. Cryptocurrencies are just one of countless possible uses for blockchain, but getting to other uses and the broader blockchain landscape requires pushing through the noise.

RAMPING UP REGULATION

2017 was the year blockchain exploded into public consciousness, led by the crypto-millionaires and billionaires riding an early wave of cryptocurrency investment; the conversation was around how to get a piece of the market and how high it might go. Prediction: in 2018, the hype will still be dominated by cryptocurrencies but the discussion will shift to focus on regulation and its role in long-term growth and adoption. Beyond cryptocurrencies, we'll see a lot of real world implementations of blockchain across virtually every industry as companies and individuals experiment with how this new technology can add security and efficiency to real world problems.

In the opening weeks of the year, we've already seen headlines from around the globe of governments and NGOs trying to get a handle on how to regulate cryptocurrencies to make them less volatile, less disruptive and easier to integrate into existing structures.[83] (Hopefully by 2019 or 2020, we'll start to see the dominant conversation move beyond cryptocurrencies to address other aspects of blockchain potential.)

In North America, the U.S. is taxing cryptocurrency gains, and the Securities Exchange Commission has begun to crack down on initial coin offerings (ICOs). Canada is more lenient with cryptocurrencies, still allowing their purchase with credit cards, and one prominent Canadian bank has announced an effort to create a blockchain vault for safely holding customers' cryptocurrency assets.[84] [85]

In Europe, it looks like cryptocurrencies will be regulated, with anonymous trading forbidden, in hopes to reduce the possibility of money laundering through digital exchanges.[86] France and Germany are leading an effort to have the G20 international forum cooperate on broader regulatory policies to help combat investor fraud and possible funding of illegal activities.[87] Switzerland (not a part of the European Union) is leading the way as a blockchain and cryptocurrency progressive nation, treating these as just another class of assets, and is attracting global talent around blockchain development and investment.[88] The Eastern European nation of Belarus is openly embracing blockchain development, including offering tax incentives and fully legalizing cryptocurrency transactions in an apparent effort to spur tech-forward development and foreign investment.[89]

In Asia, individual countries have been sending mixed-messages on acceptance of cryptocurrencies. China appears to be moving towards

[83] https://bitcoinmagazine.com/articles/cryptocurrency-regulation-2018-where-world-stands-right-now/

[84] https://globalnews.ca/news/4025648/banks-ban-buying-bitcoin-credit-cards/
[85] https://www.express.co.uk/finance/city/918661/bitcoin-news-cryptocurrency-hacking-vault-canada-invest
[86] https://www.theguardian.com/technology/2017/dec/04/bitcoin-uk-eu-plan-cryptocurrency-price-traders-anonymity
[87] https://www.reuters.com/article/us-germany-france-g20-crypto/france-germany-call-for-joint-g20-action-on-cryptocurrencies-idUSKBN1FT176
[88] https://www.lexology.com/library/detail.aspx?g=58180c95-90ff-45e4-aa5f-44260efc2055
[89] https://www.washingtonpost.com/news/monkey-cage/wp/2018/01/25/why-would-authoritarian-belarus-liberalize-cryptocurrencies/

a potential ban on ICOs and cryptocurrency exchanges.[90] South Korea was rumored to be considering a full ban on trading cryptocurrencies, but came out instead with a ban on anonymous trading.[91] India has declared cryptocurrencies illegal as tender and buyers and sellers must register on exchanges and total funds and transactions will be available to the government on a central repository.[92] Japan recently experienced the largest cryptocurrency heist in history with a value of over $500 million USD, which has prompted industry groups there to move towards self-regulation.[93] Thailand has banned banks from dealing with cryptocurrencies until regulations can be established.[94] Vietnam has banned all cryptocurrency payments, though mining cryptocurrencies is still allowed.[95]

Australia and New Zealand are allowing cryptocurrency payments and still allowing credit cards to be used to purchase cryptocurrency assets.[96]

The most notable cryptocurrency story in South America is the Venezuelan government's plan to launch "petro," its own oil-backed cryptocurrency, as an attempt to create a newly legitimate currency in the face of hyperinflation and devaluation of Venezuela's fiat currency.[97]

In Africa, various local cryptocurrencies are emerging, each claiming to be a game-changer in unifying across national and cultural boundaries. Unstable fiat currencies add to the appeal of cryptocurrencies that can maintain value across borders.

This quick overview is by no means a complete picture of the global cryptocurrency landscape. These are highlights; presumably every government is wrestling with how to handle blockchain-based value tokens. Broadly speaking, the near-term trends we expect to become pervasive around cryptocurrency regulation:

» *Most—but not all—countries will require registration to use cryptocurrencies (no anonymity allowed).*

» *Cryptocurrency exchanges will become increasingly regulated and will likely require insurance and backing of funds held by investors, becoming more similar to traditional banks.*

» *Most countries will forbid using credit cards to purchase cryptocurrencies as a way of protecting consumers who might go into severe debt if cryptocurrencies crashed in value.*

» *Most countries will tax cryptocurrency gains in ways similar to other investments.*

» *Virtually all countries will allow participation in blockchain networks and the resultant cryptocurrency mining assets that may accrue (even if those assets can't be spent for now).*

[90] https://www.forbes.com/sites/sarahsu/2018/02/07/china-serious-about-ending-icos-cryptocurrency-exchanges/
[91] https://www.coindesk.com/korean-government-firm-on-crypto-kyc-mandate-in-petition-response/
[92] https://cryptoslate.com/indian-bitcoin-exchanges-scramble-adjust-regulation/
[93] https://www.cnbc.com/2018/02/15/cryptocurrency-japan-industry-to-launch-self-regulating-body-sources-say.html
[94] https://cointelegraph.com/news/thailand-central-bank-asks-all-banks-to-avoid-crypto-pending-regulations
[95] http://www.zdnet.com/article/vietnam-bans-payments-in-bitcoin-cryptocurrencies/
[96] https://www.financemagnates.com/cryptocurrency/news/major-australian-banks-will-not-ban-cryptocurrency-related-transactions/
[97] https://www.bloomberg.com/news/articles/2017-12-29/get-set-for-petro-venezuela-s-cryptocurrency-answer-to-bitcoin

Expanding the toolbox

At its core, a blockchain is a concept for a particular kind of database. Going back a step further, a database is just a means for storing a collection of digital information, usually in a way it can be easily be updated and searched. Information within a database can be any kind of value—birthdates, property records, biometric information, taxes, healthcare records, etc.—anything.

There are many different ways to set up a database, each optimized for different use cases. Some databases are set up for search efficiency, some for extreme data privacy, some for redundancy, and on and on. Functionally, a database is a kind of tool, and not every tool is right for every job.

A blockchain is a new kind of database—effectively a whole new kind of tool to put in the toolbox of information storage solutions. In a world that previously held just hammers and screwdrivers, a blockchain is a wrench. It has functionality that no other database tool can offer, making new kinds of jobs possible.

Just because blockchain is a new and buzzworthy technology doesn't mean its utility is universal. For certain kinds of information storage, blockchain may be superior to traditional databases, but in many cases, blockchain may not be the best tool for the job.

Permission to use cryptocurrencies as payments for goods and services is widely split for now; further regulation and stabilization of the value of cryptocurrencies is likely to increase acceptance of their use as payments.

Fortunately for our discussion, there's far more to blockchain than just cryptocurrencies. And it's the broader use cases for blockchain as a technology that have the greatest disruptive potential. So instead of discussing cryptocurrency viability at greater length, we're going to walk through the technological innovations at the core of blockchain to see how it's unique and what its practical use cases might be, particularly for how it may affect the travel industry.

BLOCKCHAIN DEFINED

In Labs' 2017 Radar Report, we defined blockchain as "a framework optimized for immutable, distributed public ledgers." [98] Those properties "allow the direct transfer of value between parties without requiring those parties to trust each other."

We still stand by that definition as true; however, since the *Radar Report*, we've come to realize the limitations of our definition. It's good in a dictionary sense: it's concise and accurate. But in a practical sense, it often fails to help explain to a broad audience why blockchains matter. Many of the terms in our original definition require their own definitions and examples, setting off a recursive spiral of defining and redefining, where the point of the definition risks getting lost in the process.

This challenge isn't unique to Labs—many "simple" blockchain definitions suffer similar jargon density. So for the Emerging Technology Report, we're skipping most of the jargon

[98] https://www.sabre.com/labs/radarreport/

THE MOST EXCITING FEATURE OF BLOCKCHAIN IS THE TRUE SCARCITY IT BRINGS TO THE DIGITAL WORLD.

and taking a different tack: looking at the high level distinctions driving excitement around blockchain, in hopes this approach will make the hype more accessible. There are three features we think are essential to understand about what a public blockchain provides: scarcity, shared oversight and permanence.

ESSENTIAL 1: SCARCITY

Over the last several decades, we've increasingly come to think of digital information as cheap and infinitely replicable. Once something is digitized into 1s and 0s the cost to copy it has come close to zero: documents, songs, images. It costs a user nothing to send an email or to CC: an email to a hundred people. If a million people want a copy of the same song or image, the asset never runs out. This replicability places digital objects in contrast to physical objects, as each physical object takes up space and has a cost.

The most exciting feature of blockchain is the true scarcity it brings to the digital world. Values stored on a blockchain cannot be copied, they can only be transferred from one owner to another. A value on the blockchain can be any asset that can be represented digitally: a monetary unit, a deed, a vote, an image, an airline ticket, a hotel room, a biometric identity, etc.

It's easiest to conceptualize how a public blockchain works by using physical examples: think of an Olympics medal ceremony. When the presenter hands the gold medal for women's Giant Slalom to the winner, the medal changes hands. There is no way to "copy" the gold medal; in that moment, a transfer of ownership takes place. You can't copy the medal, but you can copy and share the witness of the transfer taking place. Thousands of people watch medal award ceremonies in person and a host of cameras broadcast each ceremony to millions of viewers. There is only one "gold medalist in women's Giant Slalom" award each Winter Olympics, but there are countless witnesses verifying the transaction took place.

Each of the hundreds of medals awarded at each Olympics is unique and is scarce. A value on a blockchain is like an Olympic medal: it can

be transferred from owner to owner, but it can't be copied. With Bitcoin, every Bitcoin is unique and has a defined owner. You can't counterfeit a Bitcoin because there is no way to insert a forged block into the "chain" of records; it would be like trying to create a new Olympic medal for "best air guitar solo on skis;" even if you were able to create a realistic looking award, it would be meaningless unless you were able to convince or trick all the countless witnesses to verify the medal as real—an impossible task.

ESSENTIAL 2: SHARED OVERSIGHT

In many prominent current examples (like Bitcoin, Ethereum, etc.),- blockchains are completely public, operating on a voluntary peer-to-peer network of nodes (computers) all around the world; anyone who wants to can become part of the network and helps maintain a copy of the record of all recorded transactions. If a blockchain is public, we can access the entire transaction record and see what values were transferred and to which accounts. For instance, Bitcoin, the first successful blockchain, has a record of every block and transaction since it was created in 2009.

This is the Olympic medal example equivalent of every audience member, camera and remote viewer watching an event. The shared record is one element of what makes it virtually impossible to forge a record on a blockchain: every node (participant in the network) is a witness to the truth.

Sharing is also part of what allows public trust in a blockchain. The fact that anyone can see the full record of transactions helps provide oversight and transparency around data use. Even in private applications of blockchain, where participation is limited, the fact that a group of peers have full access to the data means fraud is reduced.

The shared oversight provided by blockchain is usually referred to as a distributed ledger or distributed database. Regardless of the term, it means many different parties in difference places have copies of the entire blockchain record.

ESSENTIAL 3: PERMANENCE

The other critical element of a blockchain is the permanence of its transactions. Anytime a value is transferred, there is a permanent record made of the transaction. It is very difficult to undo a transaction. Instead, a new transaction has to be made. For instance, if you overpay with a cryptocurrency, you can't cancel the transaction, instead the other party must actively transfer the difference back to you.

In tech parlance, the permanence of blockchain is referred to as "immutability." Immutability simply means that a transaction cannot be reversed, an edit cannot happen unless it is recorded officially in the blockchain. Blockchain achieves this immutability by using previous blocks as the mathematical basis for creating each successive block—a process called hashing.

You can imagine the creation of new, secure blocks like creating nested photographs. Take a Polaroid photograph—that's your first block of data. When you want to add new data to the record, place the first

Polaroid at the edge of the frame and take a new picture—the 2nd Polaroid is your next block—it contains your new data as well as a photo of the original Polaroid. For block three, put the 2nd photo in the corner of the frame and take a new picture. That 3rd block contains new data, plus a photo of the 2nd Polaroid which contains a photo of the 1st Polaroid. And on and on and on. Every new block contains a unique signifier (a hash) of the previous block pointing all the way back to the first block.

You can also imagine creating blockchain records as stringing beads on an unbreakable chain. Every piece of data is permanently locked into place by the beads around it. The chain is unbreakable, so you can't go back and change an earlier bead without removing every single successive bead. Similarly, changing a record in a blockchain would require destroying every record (every bead) back to the point of the change. While technically possible, it's practically impossible, and there would be no way to recreate the lost data.

TRUST & BIOMETRICS

Scarcity + shared oversight + permanence = trust, at least that's the usual promise of why blockchain is so revolutionary. These elements are central to its utility. Many of the proposed or experimental use cases for blockchain exist because having a record which is publicly accepted as immutable and unforgeable creates an environment of trust.

Biometric identity is one of the most powerful proposed use cases for blockchain. Using a blockchain to store encrypted records of a person's various biometric identifiers—their voice, fingerprints, hand geometry, iris pattern, facial model, gait, etc. Having an unforgeable, permanent source for matching biometric data would be incredibly powerful. It could eliminate the need for passports, driver's licenses and other forms of identification, finally giving rise to true trusted presence—that someone is who they say they are and can prove it.

However, a comprehensive biometric record would need to be completely secure—completely trusted—to gain broad adoption. The liability issues around protecting that much personal data are significant, and gaining consumer trust to opt-in to a central source for biometric data could be challenging because of fears over privacy.

One way a blockchain could help create trust is by being set up to verify biometric identifiers by comparing the living person against the encrypted blockchain record. In this case, if your fingerprints are scanned, the scan is compared against the blockchain record without any new value being stored—like holding up a photo next to a real person to see if they match. In this case, each person has a real biometric data set on a blockchain as a point of comparison, but the biometric data is never stored except on the blockchain—each point of verification would gain only yes/no approval when compared to the blockchain record. This could keep personal data private but still allow for seamless

transactions and ubiquitous trusted presence. Another possibility being explored for identity is to use a blockchain as an index, pointing to secure biometric information held outside the blockchain. The extra complexity of this system would create more security risks in some ways, but would also allow for more flexibility and a way to delete information if required in order to meet privacy laws. There are also some security upsides to not having all information stored in a single place.

Another way blockchain could be used to garner public trust is to ensure a complete record is kept each time a person's biometric data is accessed: when and by who. This way, individuals could monitor their own biometric profile to see how it is being used and who is using it. A system that guarantees a perfect record of access to personal data could be a way of winning over and creating a high degree of transparency and trust for users. It would also allow bad actors to be seen, reported and booted out of the system.

USING SMART CONTRACTS

A fundamental feature of many blockchains is the ability to set up and execute "smart contracts." Essentially these are if/then statements triggering transfers of value when certain pre-agreed conditions are met. All parties in a smart contract are bound to the terms of the smart contract and it will monitor the internal blockchain and external data to determine when the terms are met.

For example, as workers we have a contract of sorts with our employer. That implied (or explicit) contract states that if we work certain hours, or complete certain projects, we get paid for our time and effort. In this example it's up to the employer and worker to monitor whether the requirements for pay have been met, then to issue payment. But if compensation were built as a smart contract there would be some metrics set up that can be monitored by the blockchain, the proposed payment could be reserved, and the payment would be issued automatically by the blockchain once conditions are met. Because both parties agreed on the conditions, they can allow the blockchain to be the neutral 3rd party.

In travel, an easy way to see this in use would be around travel insurance. Assume a traveler buys travel insurance providing payment for any costs associated with weather delays. For instance, if a blizzard ensues in Kraków, Poland and a traveler misses her flight because of the weather, the travel insurance blockchain is monitoring the flight data and can see the flight was cancelled. The insurance would automatically activate to reimburse the traveler, provide a stipend for a hotel, or whatever other provisions were covered by the insurance.

It's not easy for a traveler—particularly in the midst of travel disruption—to try to self-educate and self-advocate for compensation or meet insurance requirements; automating insurance with a smart contract could guarantee prompt resolution without the need for either party to act.

Blockchain experimentation

If you want to experiment with creating a blockchain, Ethereum and Hyperledger are the most promising platforms for testing and development. Ethereum is a public blockchain made for building decentralized applications with smart contracts. Hyperledger is made for building enterprise grade, permissioned blockchains. In Sabre Labs, we have experimented with both.

In 2017, Sabre Labs built a proof-of-concept on the Ethereum blockchain to track check-in and check-out of all our gear—VR rigs, Hololens headsets, voice assistants, smartwatches, EEG headbands, 3D printers—the usual paraphernalia of an innovation lab. Experimenting hands-on helped us understand how early in standardization blockchain technology really is.

Ethereum is a relatively mature platform in the blockchain space, and for all the things that look good on the surface (or in news stories), the platform is less polished behind the scenes. Since it's an emerging platform, community support is not as robust as it is in more traditional areas of programming. The developer support, content libraries, FAQs, etc.,

are still limited. They are coming, but for now, it's a lot of work to build something functional.

We think platforms like Hyperledger are more promising in the near term. With the ability to scope permissions and stabilize compute, it's more immediately applicable to the problems Sabre and our customers are eyeing.

Sabre Labs is one of many groups at Sabre experimenting with and considering the broader impacts blockchain may have on every aspect of the travel ecosystem. Today's keyword is "experiment." The functionality supported by platforms like Sabre's Global Distribution System (GDS) is essential to global travel; its efficacy, reliability and security are the result of decades of work and development. Looking at ways to augment GDS content with blockchain solutions is an area of current exploration.

Blockchain has the potential to change existing business models, but it's too early to say how much maturity and exploration is necessary in the blockchain ecosystem to assure an effective, reliable and—most importantly—secure system for sensitive information.

On the insurer side, this would potentially reduce the customer service load while increasing customer satisfaction and making travelers more likely to purchase insurance. For travelers, it would mean being able to travel anywhere in the world and not have to worry about fair compensation for inconvenience—the terms would be built in from the time of booking. The same approach could be applied across other parts of the travel ecosystem: rail, cruises, hotels, etc.

Smart contracts can go way beyond travel insurance. They can effectively help complete transactions across all kinds of various parties. And since the agreement is immutable and will act automatically as soon as conditions are met, it allows the users to have more inherent trust in one another.

It's all well and good to look at the benefits of smart contracts, and they have the potential to work well in clearly defined domains, but smart contracts don't handle ambiguity. For instance, there are many reasons for an airline delay, including weather, staffing, security issues, mechanical issues, etc. Some of these might be clear-cut cases where insurance kicks in, but other cases may not

be clear, or may be the result of multiple contributing factors, which makes it much harder to feed a smart contract concrete data. Most real-world contracts have room somewhere for ambiguity, for the unexpected, for "acts of god."[99] And when gray area exists, a "smart" contract isn't smart enough to handle uncertainty—it's out of scope of the program, and another solution needs to be found.

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[99] https://www.seal-software.com/blog/blockchain-why-we-need-intelligent-contracts-aka-smart-contracts-30

America Online (AOL) launched in 1989 and represented the state-of-the-art for Internet at the time, but would be unrecognizable today. HTML wasn't adopted as a standard until late 1995.

Image: washington.edu

CRAWLING OR TODDLING?

Depending on which expert you hear, blockchain either resembles Arpanet circa 1969 (the first message on what grew to be the Internet), the Internet circa 1989 (before HTML or browsers existed), or some other more recent date—all of which are still very early from a broader tech development timeline. It's widely agreed blockchain is in its infancy, but whether that means it's crawling or toddling yet is a matter of opinion.

Regardless of where blockchain is in its development, it's still unclear which protocols will have lasting viability. Because public blockchains are distributed across countless different computers owned and operated by countless different parties, their existence is subject to popularity—as long as it makes economic sense for people to devote their computer and processing power and electricity to Bitcoin, it will have a presence. If the rewards of contributing to the Bitcoin network become less than the material costs of maintaining its existence, individual users will retask their hardware to support a different network.

Obviously, people with a large stake in Bitcoin have an incentive for the blockchain to continue to exist. But every public blockchain has a set of economic incentives to stay alive. And when those incentives become misaligned, any blockchain—even Bitcoin—could theoretically disappear into the graveyard of outmoded blockchains.

In December, Ethereum founder Vitalik Buterin, one of the most influential figures in the blockchain space, chastised the hype and questioned the actual value being created. In a series of tweets, he asked: "So total

cryptocoin market cap just hit $0.5T* today.[100] But have we *earned* it?" Some of his specific questions related to the social and economic relevance of the blockchain movement:

> *"How many unbanked people have we banked?"*

> *"How much censorship-resistant commerce for common people have we enabled?"*

> *"How much value is stored in smart contracts that actually do anything interesting?"*

> *"How many Venezuelans have actually been protected by us from hyperinflation?"*

> *He ends: "The answer to all of these questions is definitely not zero, and in some cases, it's quite significant. But not enough to say it's $0.5T levels of significant. Not enough."*

Buterin's questions capture a particular ethos intrinsic to many of the important figures in the current blockchain ecosystem: the belief that blockchain is uniquely capable of creating a "better" world: fairer, more equitable, more trusting, more transparent, less siloed, less censored. Blockchain can't only be considered in economic terms—much of the

driving force behind its growth and escalation is inextricably intertwined with issues of social justice. As blockchain matures as a technology, how it is used to address social issues will be a benchmark of whether or not it is living up to its hype.

THE HUMAN ELEMENT

Blockchains are coded by humans in response to perceived human needs or to solve human problems. And—even moreso than most technologies—blockchains are only as strong as their weakest link. So some of the positive features of blockchain risk becoming liabilities when not kept in context. The immutability and high-degree of trust in a blockchain can simply mean blockchain keeps an immutable record of human mistakes and crystalizes differing opinions:

> *Using blockchain as a parallel record for physical goods is only as good as the input it receives; e.g. inventory must correctly scanned at every step of the way, transactions entered correctly, names not misspelled, etc.*

> *Using blockchain to transfer value is dependent on the underlying code being bug-free. And while bugs have been relatively rare in blockchains thus far, the results of coding errors can be catastrophic because the distributed infrastructure and consensus validation of transactions makes it virtually impossible to fix errors once they exist.*

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[100] https://twitter.com/vitalikbuterin/status/940744724431982594?lang=en
  * $0.5 trillion USD, or 400 billion Euros

» *Even if a blockchain is secure, the software and services around a blockchain are not necessarily secure. Most cryptocurrency thefts have not directly targeted a blockchain, instead they've targeted the intermediaries (exchanges) which make it easier for people to access and use blockchain tokens. While it is possible to transfer value on the blockchain without an intermediary, doing so requires more technical expertise than most users are likely to develop. So in the current environment, the security of intermediaries are the easiest targets for theft and fraud.*

» *The more people who are involved in something, the more likely there are to be different opinions. With blockchains, anytime opinions diverge (about how the blockchain should operate), it poses the risk of a split (called a "fork"). With a blockchain fork, both competing versions of the truth persist, each supported by a different set of code and a different set of nodes validating transactions. Both Bitcoin and Ethereum have seen highly visible public forks (creating alternative currencies Bitcoin Cash and Ethereum Classic), and more forks are likely in the future. Diverging realities are an inherent risk (or feature?) of public blockchains.*

As a social issue, the ability of blockchains to fork based on diverging ideas is often talked about as a feature. For instance, if a network like Facebook or Twitter were held on a public blockchain, the entire record of content (every message, every image, every preference) would be publicly held. If a group of users disagreed about an aspect of the system (such as a privacy setting or an advertising policy or a compensation model), they could fork the blockchain, creating a parallel network retaining all the content up to the moment of the fork.

Content generated after the fork would be unique to each branch of the fork, but if one branch offered a substantially better user experience (more privacy controls, less ads, less costs… whatever), then it would be possible for that branch to eventually become the dominant branch, with the less-successful branch eventually withering away as it ceased to have community support. Of course, if multiple branches sustained support, they would represent a permanent and irreparable fragmenting, since there would be no way to ever combine the forked branches. The relative ease of forking a blockchain is a powerful differentiator, providing both pros and cons depending on the scenario.

SHIFTING TRUST

One of the oft-touted claims of blockchains is they eliminate the need for participants to trust one another, and while that is true in some ways, talk of "eliminating the need for trust" is a bit of a smokescreen.[101] Blockchains don't eliminate the need for trust. Instead, they shift where trust is placed and how it's distributed. As with any other piece of software, you have to trust the blockchain you're using is accurately coded and

[101] https://medium.com/@preethikasireddy/eli5-what-do-we-mean-by-blockchains-are-trustless-aa420635d5f6

intrinsically secure. As a new technology with a young ecosystem, this is not necessarily easy to do. IBM, Microsoft and many other companies are working to provide enterprise-grade blockchain solutions.[102][103][104] Having a trusted partner involved in building the blockchain helps not only speed up time to launch but also lets a business know in whom they are placing their trust that the underlying structure is secure.

BLOCKCHAINS DON'T ELIMINATE THE NEED FOR TRUST. INSTEAD, THEY SHIFT WHERE THE TRUST IS PLACED AND HOW IT'S DISTRIBUTED.

[102]   https://www.ibm.com/blockchain/
[103]   https://azure.microsoft.com/en-us/blog/accelerating-the-adoption-of-enterprise-blockchain/
[104]   https://gomedici.com/companies-providing-enterprise-grade-blockchain-solutions/

And while working with a trusted partner helps in building (and even maintaining) a blockchain, by itself, it doesn't solve all trust issues. Even if the original blockchain code was created bug free, there will inevitably be the need for updates to add new features or meet regulatory changes. Updates require consensus, which may be hard to reach—especially if a bug disproportionately benefits one set of parties over another.

Imagine a blockchain for global hotel room distribution needs an update to meet a new EU privacy standard, but meeting the standard will increase costs of operating the network. Hotel chains based solely in the EU would be all for the effort, whereas hotel chains without an EU presence would want to be compensated for the additional expense. Hotels with EU presence as part of a broader global portfolio would want offset compensation for the difference. Balancing the new incentives and bringing every party to the table to reach consensus is not a trivial task.

Another challenge is that since transactions are permanent, there is no recourse—no higher authority—to appeal to when something goes wrong. If money is erroneously transferred to the wrong account (through fraud or error), there is no way to get it back—the same would be true for values like airline reservations or voting records. These challenges reinforce why centralized intermediaries exist today: if they are trusted, they add peace of mind for all parties in a system and can reduce the element of risk for all concerned.

Even if blockchains do away with the need for centralized intermediaries to facilitate transfer of value, every blockchain uses some form

of governance. By "governance" we mean the system and processes stakeholders use to make decisions concerning the way a blockchain operates.[105] Stakeholders include the developers who write the underlying code, the owners of the various nodes helping process transactions and the users of the blockchain.[106] The last few years have shown that blockchains demand innovation of governance models just as much as they provide innovation in operational systems.[107]

Blockchain governance issues are important as governments around the world start to work towards regulation of blockchains. Regulatory concerns, particularly around liability and accountability for all kinds of blockchain use cases will be tremendous issues going forward, especially for values held on public blockchains when it's unclear where responsibility may rest. Experimenting with different kinds of governance models may be a way for blockchains to adapt to find a balance for appropriate oversight of different kinds of value.

CryptoKitties, a blockchain allowing people to buy, sell and breed virtual cartoon cats, briefly became so popular it slowed down all Ethereum-based blockchains by as much as 10%.

Image: CryptoKitties.co

[105]   https://www.coindesk.com/making-sense-blockchain-governance-applications/
[106]   https://vitalik.ca/general/2017/12/17/voting.html
[107]   https://medium.com/@FEhrsam/blockchain-governance-programming-our-future-c3bfe30f2d74

SCALABILITY AND INCENTIVES

Most businesses depend on some combination of dedicated local or cloud servers to fuel their software infrastructure. Server issues (even as simple as a server being accidentally unplugged) can be responsible for costly outages across the tech sector. One of the touted promises of blockchain is the ability to eliminate downtime by distributing demand across a much broader global, ad-hoc infrastructure of connected nodes, each contributing to the total compute needed.

The Ethereum blockchain made headlines recently with the advent of CryptoKitties, a blockchain allowing people to buy, sell and breed virtual
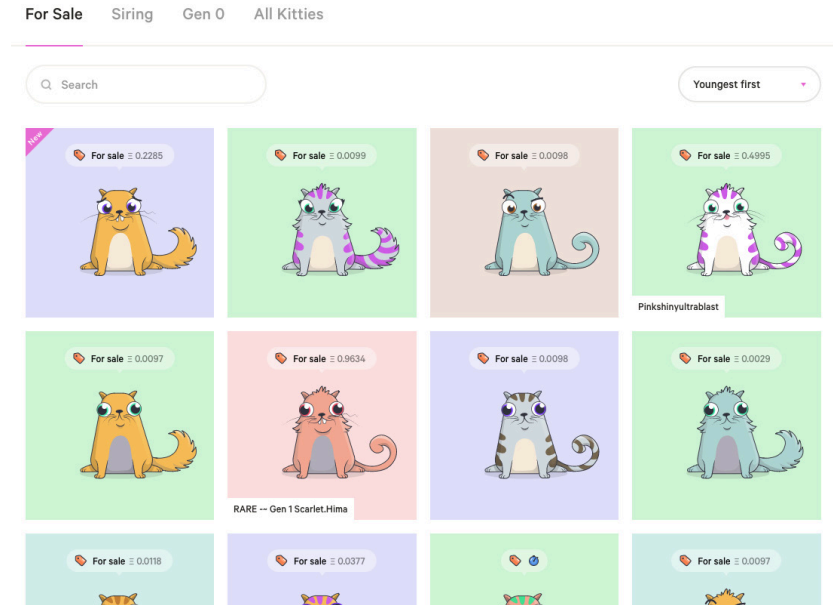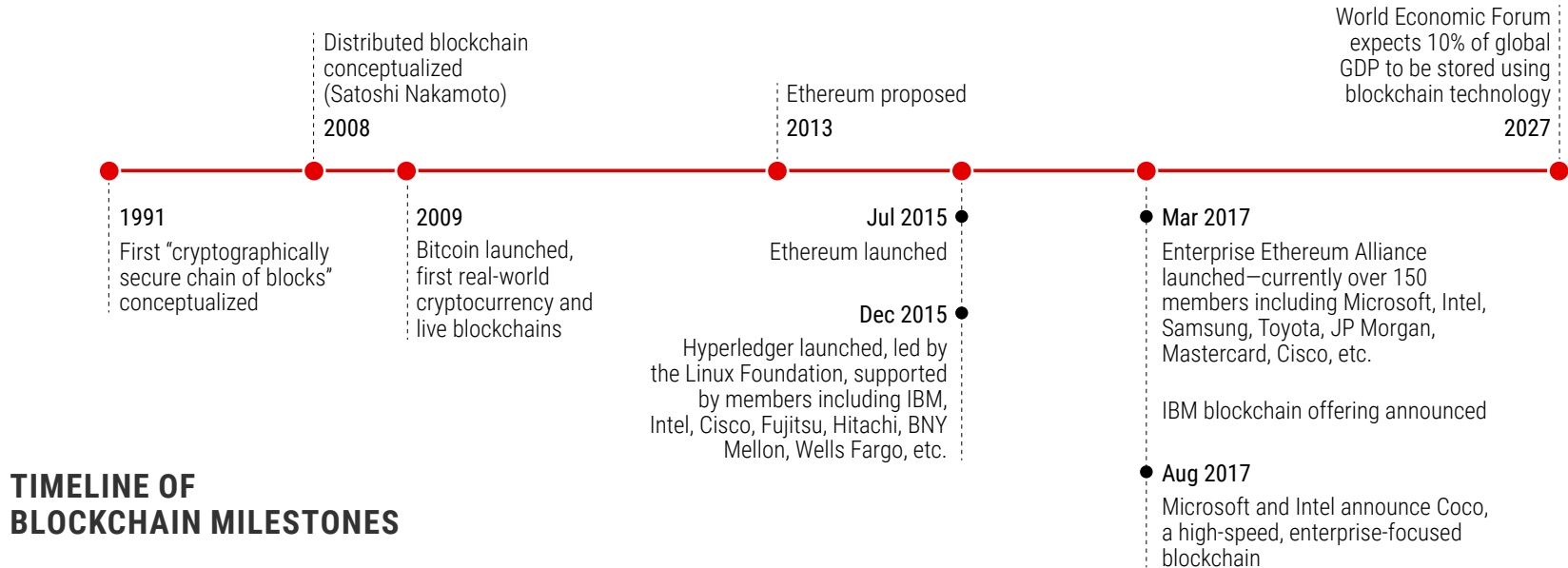
cartoon cats. The viral and rapid growth of interest in CryptoKitties created user demand which temporarily slowed down the underlying Ethereum blockchain by an estimated 10%.[108] This highlights the very real challenge of scalability in the current ecosystem. On Ethereum and
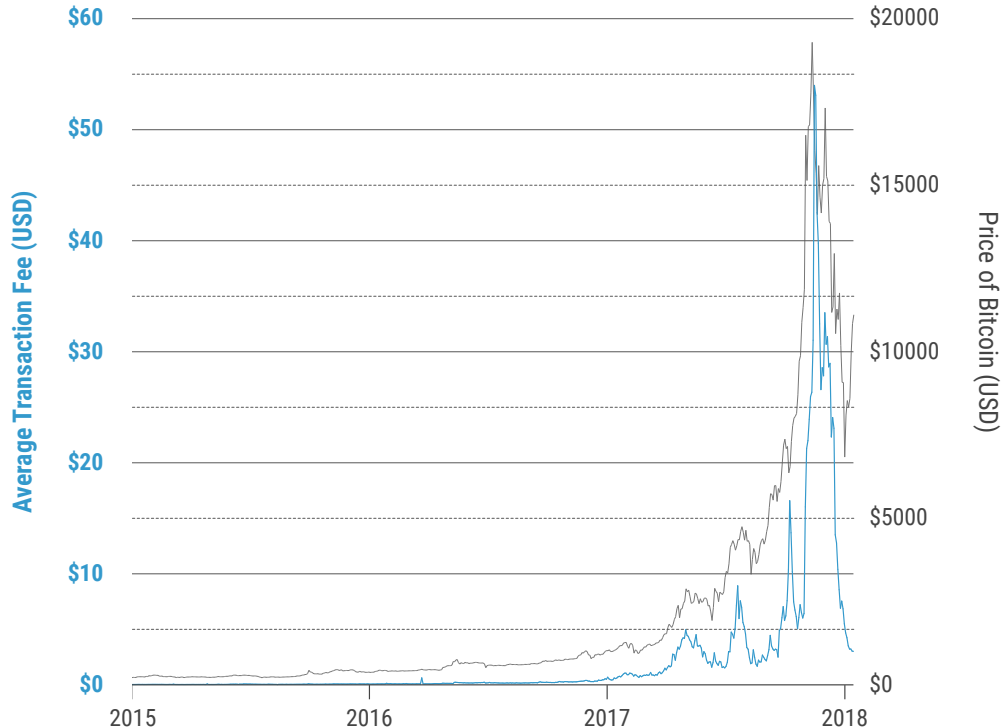
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[108] http://www.bbc.com/news/technology-42237162

many other public blockchains, enterprise software can run alongside all the other software in the network.

A related topic is incentive costs. To conduct transactions on a public blockchain, participants must be paid with something—processing requires hardware and electricity and networks aren't voluntarily maintained for free.

Distributed blockchain conceptualized (Satoshi Nakamoto)
2008

Ethereum proposed
2013

World Economic Forum expects 10% of global GDP to be stored using blockchain technology
2027

1991
First "cryptographically secure chain of blocks" conceptualized

2009
Bitcoin launched, first real-world cryptocurrency and live blockchains

Jul 2015
Ethereum launched

Dec 2015
Hyperledger launched, led by the Linux Foundation, supported by members including IBM, Intel, Cisco, Fujitsu, Hitachi, BNY Mellon, Wells Fargo, etc.

Mar 2017
Enterprise Ethereum Alliance launched—currently over 150 members including Microsoft, Intel, Samsung, Toyota, JP Morgan, Mastercard, Cisco, etc.

IBM blockchain offering announced

Aug 2017
Microsoft and Intel announce Coco, a high-speed, enterprise-focused blockchain

**TIMELINE OF
BLOCKCHAIN MILESTONES**

BITCOIN TRANSACTION FEE
& PRICE VOLATILITY OVER TIME

Average Transaction Fee = total transaction fee paid / # of confirmed transactions
Source: blockchain.info

When Sabre Labs built a proof-of-concept blockchain on Ethereum, our prototype blockchain required us to have a balance of Ether tokens and to pay tiny amounts of Ether to validate new transactions as they added to our chain. But over the past year, we witnessed most token values dip and spike in a way that would make it virtually impossible to predict or budget for transaction costs. As Ether, Bitcoin, and other currency values skyrocket, so do the real-world costs of blockchain transactions. As currency values crash, so do the real-world costs of transactions along with the value of the incentives to process transactions.

As a point of comparison, imagine if airlines had a parallel problem with jet fuel, never knowing whether it would rise or fall by 10x or 100x or 1000x in a year. Even if they were able to lock in transaction rates for a period of time (as they do now with fuel costs), it would still be impossible to budget long term. If jet fuel prices in 2017 were up 1,300% on the year like Bitcoin, very few of us could afford to fly. (*See chart: Bitcoin Transaction Fee & Price Volatility Over Time*)

Similarly, if using cryptocurrencies for payments, what happens if a hotel is booked in January for a July stay at a cost of 0.3 Ether per night (~$270 at time of

writing), when does payment take place? In six months, the real-world value of that Ether might be $27 or $2,700 or any other number. How does a hotel budget if it has no idea what amount will be paid for a room? How does a corporate traveler manager budget if they have no idea what they might eventually pay?

This isn't to say there aren't affordable ways to operate on a blockchain. Our Ethereum prototype experience demonstrated that we had some degree of choice—between speed and cost. If we wanted our transactions processed quickly, we had to pay a premium to incentivize the network to prioritize our transactions. If we were willing to wait in line, we could pay dramatically less. Which is fine for a prototype—and might be OK for cartoon kitties. But generally, is not fine for enterprise grade solutions. When you are part of a global distributed blockchain network, you're beholden to the limitations of the network, placing scalability and incentive costs largely outside of your control.

PUBLIC, PERMISSIONED & PRIVATE

There are ways to mitigate the challenges of scalability, incentive costs and forking risks depending on how a blockchain is structured and who is allowed to access what features of the system. The three broad structural categories are public, permissioned and private.

Most of the news right now around blockchain focuses on public blockchain solutions, with shared infrastructure open to all participants: anyone who wants to can run a node (hosting a copy of the blockchain and validating transactions), anyone can use the blockchain, and anyone can read values from it. But there are real-world challenges to using public blockchains for enterprise solutions, which underscores the need to understand the merits of permissioned or private blockchain solutions.

Permissioned blockchains usually have multiple participating partner entities; the protocols for the permissioned blockchain limit who can run a node (which also limits who holds a copy of the blockchain), who can write new transactions to the blockchain, and who can read data from the blockchain. In contrast, private blockchains are fully controlled by a single entity.

Permissioned and private blockchains can be built on a variety of platforms. Both categories resolve many of the scalability and accountability issues inherent in public systems while still offering the core values of scarcity and permanence. One of the most visible examples is the Quorum blockchain built as a secure global blockchain for financial transactions by a partnership led by J.P. Morgan.[109] As a permissioned network, with existing trust among participating entities, it can be much faster and less costly to operate than a public blockchain because it doesn't have to constantly validate the integrity of the participants. A higher degree of internal trust reduces processing overhead which creates significant enterprise advantages.

Concerns over enterprise blockchains largely center around security and

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[109] https://blockchainatberkeley.blog/introduction-to-quorum-blockchain-for-the-financial-sector-58813f84e88c

the issue of data permanence. In a blockchain, if a small group or a single entity controls the entire blockchain, they can update the blockchain at any time with full internal consensus. Which has huge advantages, but there are concerns over whether or not this invalidates the claims of scarcity and permanence. With complete control over the underlying code, couldn't an organization falsify records and copy values?

In theory, yes. If you build and implement your own blockchain, it would allow many more forms of control, though editing is still seldom practical. Back to the example of stringing beads on an unbreakable chain, even a private blockchain can only change values by unstringing the blockchain back to the point of edit, effectively destroying all transaction records after the point of edit, which will seldom be feasible. For this reason, even private blockchains operated by a single company may prove useful for applications like internal audits or inventory tracking.

In a permissioned blockchain, the distributed ledger will be shared across multiple parties, so with each stakeholder having copies of all the transaction records, it makes it virtually impossible for any one entity to make alterations to advantage itself over its peers. Scarcity and permanence exist, and all parties are incentivized by mutual scrutiny to act with integrity.

Permissioned models have tremendous potential for many enterprise and government use cases. If the European Union wanted to go all-in on blockchain currency and replace the Euro with a new cryptoEuro, it could

PERMISSIONED MODELS HELP SOLVE MANY OF THE ISSUES OF BOTH PUBLIC AND PRIVATE BLOCKCHAINS AND HAVE MORE FLEXIBILITY TO ADAPT OVER TIME.

(at least in theory). One conceptual model for such a network would be for each country in the E.U. to be permissioned as a governing stakeholder, contributing nodes to the network and holding copies of the entire blockchain transaction record.

In this scenario, only E.U. governments could contribute processing power, using their nodes working together to verify transactions. And because the E.U. is made up of 28 countries, each with its own motivations and priorities, competing but mutually benefitting entities act as watchdogs of the network, ensuring accountability. And the block-chain would permission authenticated individuals to use values on the blockchain—the cryptoEuro token—as a widespread currency.

With careful execution, permissioned models help solve many of the issues of both public and private blockchains, and, when demand

increases and transactions slow down, act as a finite network that can be scaled by its members, ensuring the flexibility to adapt to the necessary demand and transaction costs over time.

Permissioned blockchains comprised of publicly competing and invested entities are fertile ground for many kinds of experiments and future use cases, assuming issues of governance, incentives and control can be resolved at the foundation of the networks. Of course, there is no perfect solution for all situations—public, permissioned and private blockchains each have far more nuance than we have space to address here. This year, Labs will continue exploring the different blockchain structures and operating models to add detail and firsthand experience to our ongoing recommendations.

BLOCKCHAIN FUTURE

The long-arc of blockchain is likely to prove the near-term problems of the technology will largely be solvable with more experimentation and continued maturity in the blockchain space. For now, it's important to remember blockchain is incredibly new as a technology, and as such still has many rough edges to smooth out, complicating its immediate usefulness.

Despite its youth, it appears blockchain is poised to grow up to achieve great things, changing the global perception of digital value. The biggest challenge is that blockchain is a new kind of creature, and so no one can accurately predict how quickly it will mature in the current environment. Regardless, all appearances are that blockchain is a powerful tool only beginning to see its potential.

THANK
YOU

We hope you enjoyed reading Sabre Labs'
2018 Emerging Technology in Travel Report.

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process and projects, visit sabrelabs.com.

For questions, media inquiries and speaking requests,
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