ENVIRONMENTAL BUSINESS JOURNAL®
Strategic Information for a Changing Industry

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LOCUS TECHNOLOGIES ENVISIONS AN AI AND BLOCKCHAIN FUTURE FOR BIG DATA MANAGEMENT ON SINGLE REPORTING SYSTEM

Locus Technologies is a provider of enterprise cloud software for environmental, health, safety, and sustainability (EHS+S) compliance, and water quality management. Locus Platform is a horizontal platform for building EHS apps. EIM is a vertical platform focused on analytical chemistry and emissions management, which complement each other by addressing complex workflows and integrations in large enterprises. Locus offers the only true multi-tenant SaaS solution for EHS+S compliance, allowing for rapid, low-cost implementation and ongoing collection, management, analysis, visualization, and reporting of EHS+S data.

***Neno Duplan is founder and CEO of Locus Technologies**, a Silicon Valley-based environmental software company founded in 1997. Locus evolved from his work as a research associate at Carnegie Mellon in the 1980s, where he developed the first prototype system for environmental information management. This early work led to the development of numerous databases at some of the nation's largest environmental sites, and ultimately, to the formation of Locus in 1997.*

EBJ: Congratulations on your success with Locus Technologies and all the years of experience accumulated in the environmental information business! Can we get your perspective on the how the industrial client has used and applied environmental information systems over the last two decades, and how this has impacted the way you sell software?

Duplan: At Locus Technologies, we have spent the last 23 years combining an understanding of environmental science with a vision of how to gather, aggregate, organize and analyze environmental health and safety (EHS) and water quality information to help organizations better manage their environmental footprints. During that period, we had the privilege to observe a changing industry.

Let me take you back in time to 1999, when Locus deployed the world's first commercial Software-as-a-Service (SaaS) EH&S and water quality management system. Early on, customers were skeptical about using cloud-based technologies to manage their environmental data and associated compliance activities. Particularly after the internet bubble burst in 2000, things got rough for us. Half of our long sales process involved explaining the difference between the cloud and desktop software deployment model. In the second decade of our existence, the initial fear of cloud-based software disappeared, but we then found ourselves spending much of our time explaining the difference between a single-tenant and a multi-tenant cloud deployment and the benefits of the latter.

Multi-tenancy is a principle, not a software version or an upgrade. It is not an evolutionary step; instead, it is a revolution in the software delivery model.

Today, most customers want only SaaS. It is almost a given that a customer is going to select a cloud-based system over competing on-premises systems or single-tenant clouds. I do want to emphasize that multi-tenancy, a prerequisite for a cloud business to succeed, is still something that many customers and research analysts who are supposed to help customers select the right software, don't understand. Those who don't, ultimately pay a very high price. Many are back in the marketplace again when the first upgrade of single-tenant software is forced upon them. One of the greatest contributions of SaaS is to free the enterprise from the tyranny of a software upgrade model that involves revision numbers and painful upgrades. This model dominated the software industry for many years.

Multi-tenancy is a significant shift in computing and requires an all-new approach from the ground up to software architecture and the delivery model. It is transformational, and customers who intend to buy the next generation of EHS software should spend the time to understand the differences. More importantly, multi-tenancy is a principle, not a software version or an upgrade. It is not an evolutionary step; instead, it is a revolution in the software delivery model, and it matters in the long run for the customer.

The operational burden, enterprise-wide distraction, and associated costs to roll out enterprise software and then the subsequent hesitation to repeat this experience when a new release of that software becomes available is a deployment model that is not sustainable nor affordable for many companies. When customers install enterprise software that has a version or release number (on-premises, data center, or commercial cloud provider) and pay an annual maintenance fee for that software, they don't realize at the time of implementation that they are committing themselves to a process that is prone to errors, especially when integrated with other third-party software as part of the upgrade process. They are also delaying their ability to take advantage of any new features and functionality being developed by their

software provider. That is because upgrades or new releases of such software typically are deployed on an annual or even less frequent basis. In contrast, with the onset of multi-tenancy and its associated flexibility, rolling upgrades allow customers to experience improvements in their systems on an ongoing basis. Versioned number software is a terrible business model for the vendor and for the customer. If you doubt me, you need not think of an in-house enterprise system. Consider your own experience with Windows.

Another thing that has changed over the last 20 or so years is that, early on, we were primarily replacing no systems at all or at best homegrown desktop spreadsheets and databases. Over the last five years, more requests for proposals (RFPs) are being issued to replace already implemented, competing vendor systems. This is an important observation as many software implementations in the last decade failed to meet customer expectations as vendors became victims of their own success (many for reasons explained above), over-promising and under-delivering, primarily due to the software architecture that they ported from some earlier desktop or client-server system.

In years past, we witnessed the colossal failure of many IHS acquisitions, and we are seeing it again now in the second wave of attempted market consolidations by private equity firms. It is a mission impossible to consolidate several competing EHS software companies unless the acquiring company commits to a single software consolidation platform. Most of them don't for three simple reasons: 1) fear of losing existing customers stuck in yesterday's technology, 2) the effort is too expensive, and 3) the work is likely to drag on for years.

The work we do at Locus has evolved over time to encompass more and more aspects of a business's strategic planning. While a key incentive to using Locus SaaS is a single end-user configurable platform made up of multiple integrated apps for regulatory compliance, my team and I have taken a wider view of the mandate to improve environmental stewardship by creating systems to improve EHS+S performance across our clients' organizational silos; manage facilities, assets, emission sources, and regulatory programs; integrate EHS, environmental, social and governance (ESG), and GRC and risk modules; and interface with other technology platforms and mobile devices.

In short, we solve our customer's complex information management challenges for environmental, sustainability, water, and energy data using cloud technologies, a single platform and a single system of record. We turn environmental big data into actionable, real-time information. Most importantly, we help our clients lower their operating costs and reduce risk.

EBJ: What about the evolution of mobile technology and the arrival of the mobile phone as a communication, tracking, data collection and other applications device? Has this changed how the user accesses and applies actionable environmental information? How are your engineers and software developers challenged to create programs and applications and manage cross-platform links between the desktop environment and the mobile environment?

Duplan: Internet of Things (IoT) is one of the fastest-growing trends in tech. When applied to the environmental monitoring industry, there is an overwhelming influx of information that has to be dealt with. Many companies we deal with are concerned that the sheer volume of data that they collect will render the information useless. For that reason, Locus has invested in smart software and intelligent databases to deal with this new trend, long before IoT had a common name.

Mobile phones are just beginning to have a significant impact on how EHS information is collected, verified, reported and viewed. Of particular importance is connectivity to the web, GPS mapping technology, and cameras built-into mobile phones to record everything. Now customers that use mobile devices have a complete audit trail of who collected information in the field; when (timestamp), where (location stamp), and from what source (picture of location) was information collected; and the details of the transmission (how and when data from the mobile phone entered the cloud database). Before the onset of mobile phones, all of this data collection was performed by technicians in pickup trucks using paper forms or, at best, laptop computers that lacked many of the features of today's mobile phones.

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To take full advantage of mobile phone technology, phones must be fully integrated with the cloud-based, mothership software and communicate and synchronize both ways with the platform system. Also, mobile phones must have the ability to continue collecting data when the connection to the web is not present and to upload collected data once a connection is established. We prefer mobile applications developed on the phone's native operating system like Apple iOS.

But mobile phones are only part of the broader array of IoT devices that automate various aspects of EHS software improvements. Locus' automation technologies have evolved over the years to encompass the vast array of Internet-connected devices, sensors, programmable logic controllers, and other instruments to gather and organize large amounts of streaming data. The future of emissions monitoring is in streaming data and continuous monitoring rather than monitoring on some prescribed interval.

Locus IoT services and mobile phone technologies offer connectivity beyond machine-to-machine communications and cover a variety of protocols, domains, and applications. Our IoT offerings interconnect our SaaS platform with monitoring devices, testing equipment, and various sensors and programmable logic controllers (PLCs) within the existing Internet infrastructure. Anything that has an IP address and is connected to the Internet becomes integratable into our SaaS platform with minimum effort.

EBJ: How has the progress of environmental information management impacted environmental quality?

Duplan: Advances in environmental information management have had a significant impact on the quality of data collected and reported. In particular, laboratory data validation has benefited significantly from being moved to the web. Automated data validation and verification checks improve data quality and reduce the costs of external reviewers. Here at Locus, we have imported thousands of historical lab data sets, then put them through our automated data checks. We have yet to encounter a clean historical database. Data that comes from user-entered spreadsheets are particularly notorious and are generally riddled with duplicates and alternate spellings of the same entity. Other common problems are missed holding time exceedances for samples with VOCs and incorrect unit conversions. Some of these issues are not trivial as the data has formed the basis for multimillion-dollar cleanup decisions.

Clean and verifiable data and a proper data verification and validation engine can work to everyone's benefit. Data can be uploaded and processed faster and cheaper, and data validators can spend more of their time on tasks ill-suited for automation. Most importantly, greater opportunities exist for negotiating reduced sampling and analysis frequencies with regulators.

Over the years new customers have come to us with some incredible horror stories such as data being "held hostage" by third parties; data being lost over time as a result of multiple contractor changes; data being stored in email or file cabinets; and data lying in scattered piles of PDF documents or hard copies (very typical for boring logs). These examples are just a sample of the data issues that have been reported to us. We are constantly surprised at the variety of ways that organizations have unwittingly put their critical data at risk, particularly given the effort and the cost it took to generate such data.

The key to effective data stewardship is to know where it is, to adopt processes that ensure its high quality, and to have uninterrupted access to it. This is something that Excel can't offer, and it's also something that a hodgepodge of spreadsheets, emailed PDF files, stacks of hard copy boring logs in multiple offices, and custom-built databases simply can't do.

Workers' safety has also benefited significantly from process digitization. Organizations that implement corporate incident management software can start addressing incident patterns in a much more comprehensive manner than those that do not have enterprise software. Web and mobile incident management apps, for example, empower employees to immediately and intuitively report any injury, illness, property damage, safety observation, or near miss. Such software not only enables workers to document safety incidents in a central repository, but it also typically has the capability to notify managers to review and accept incident reports and track the progress on dealing with the aftermath of the incident.

Similarly, waste management apps have helped automate the tracking of waste containers, improve container management, and ensure that incompatible waste streams are not mixed. Radio-frequency identification (RFID), barcoding and QR code technology have also helped automate the management of waste containers and their tracking from inception to disposal.

On a larger scale, digital transformation (popular two words these days) is already having a significant impact on environmental data quality and management. The decarbonization of the economy will benefit from improvements achieved by obtaining higher-quality environmental information and more of it. And for those who are still skeptical that man's activities are contributing to climate change, we need a larger set of defendable and aggregated data. Most of the data today sits in and is controlled by the corporate world, where it exists in various silo systems making it impossible to aggregate to view the whole picture and make any correlations.

EBJ: How has the gradual onset of climate change policy, particularly in your home market of California, impacted how you integrate data? What about the compliance paradigm into the traditional environmental categories that may apply on a national level?

Duplan: Most of today's debate about the causes of climate change centers are on either GHG emissions or energy management. Newspapers are full of articles describing industry-by-industry contributions to global warming. Almost every month there is a "monthly special" on one contributing industry. Rarely do we see discussions on a more holistic approach to dealing with climate change.

These articles try to apportion blame for a small percent of GHG that each trade or industry contributes to overall emissions: oil and gas, energy in general, agriculture, cement, even cows, or combinations of some. There are countless studies on what every industry should do to lower their emissions and switch to sustainable resources management. We are going in circles and never seem to look at the interaction of all-natural and human-made forces that have shaped the current state of our planet.

Many environmental regulatory programs like the Clean Air Act or the Clean Water Act have been around since the early seventies and have served us well. Rarely do we see discussions linking existing environmental regulations with the broader actions needed to tackle climate change. Many of the existing programs, with gradual adjustments, could fulfill an important gap to fight climate change. But for some reason that discussion is not taking place. Everyone is talking about the need for some massive regulatory action like cap and trade or taxing emissions to start addressing climate change in a more aggressive manner. To date, where has that led us? More progress could be accomplished with gradual adjustments of current regulations than waiting for the political will to enact new climate change laws.

The software developed to help quantify the causes and impacts of climate change has followed a similar siloed approach: There are apps for energy management that do not interact with ones for water quality management, air emissions or soil contamination. Companies must stop thinking about climate change based on their internal organizational structure, an approach that leads to the implementation of different siloed software apps to manage sustainability metrics associated with a particular department. Instead, they need an integrated, platform-based approach to view their entire organization's impact on both the environment and climate change.

It is almost ironic that more than 2000 years ago, Greeks and others looked at the interaction of natural forces in a more holistic approach, not in the context of climate change and emissions management but in the context of survival on planet Earth, which in today's context, is almost a synonym.

Fire, earth, air, and water. To the ancient Greeks, these were the keys to understanding the world around them. To modern-day climate negotiators and regulators? Not so much. Carbon dioxide and greenhouse gases are what dominates the discussion about climate change in today's world. But carbon dioxide is only a product of some of man's activities associated with one of four elements. In fact, you can replace the word fire with the word energy, which for our purposes can be treated as a synonym for emissions. Without our uses of fire (combustion engine, power plants, etc.), there is no fossil fuel energy production and no climate crisis looming in our future. Today's science understandably dismisses the four elements theory associated with the ancient Greeks. But these four elements account for much of what we gather information on to assess environmental degradation and climate change. Since we already have regulations in place to deal with the earth, air, water, and to certain degree energy, we should focus on extending and integrating those into a single reporting system for big data. That would enable us to address climate change and emissions management issues faster than any completely new regulations.

EBJ: Do you still believe California is a pioneer and leader that others seek to follow in terms of environmental and climate change policy?

Duplan: Yes. With an increased focus on the role that GHG emissions play in climate change, ensuring that companies' emissions are reported accurately is more important than ever. California's Global Warming Solutions Act of 2006, better known as Assembly Bill 32 or AB32, outlines the state's initiative to reduce climate change or GHG emissions. AB32, which was signed into law in 2006, aims to cut GHG emissions to 1990 levels by 2020 and below 1990 levels by 2050. We are still awaiting the results of how we did by 2020. To ensure compliance with AB32, companies need a calculation engine that can handle complex equations using appropriate emission factors, conversion factors, and calculation methodologies for each reporting program. The right calculation engine can reduce the stress, time, and potential inaccuracies found in homegrown accounting methods.

To address this issue, and as informed by the verification of over 500 inventories, Locus developed a highly scalable and configurable calculation engine as a part of its multi-tenant SaaS Locus Platform. For GHG calculations to pass audits and meet California cap and trade requirements, calculation transparency is required.

We are very fortunate that we got involved early on with verification services for AB32. This work contributed to our domain expertise across all sectors and allowed us to build software applications to help companies manage their GHG emissions. Locus continues to expand its carbon practice at a rapid pace. Coupled with our carbon software services and domain expertise in all three key AB 32 reporting sectors including cement, refineries, and electrical transactions, Locus is becoming a partner of choice for all companies wishing to be credible in their carbon reporting needs. But more importantly, we do not build any software application as a silo but rather as part of an integrated solution across domains for EHS compliance, sustainability management, and GHG emissions management.

EBJ: How has the rise of the technology giant impacted our industry or your ability to do business? We note your partnership with Amazon Web Services as an example; what other significant developments do you see?

Duplan: We are a big believer in commercial clouds that are infinitely scalable and much more secure. For that reason, we have moved all our multi-tenant SaaS to AWS.

Locus moved Locus Platform (LP) to AWS in 2018 and has been testing the system extensively since then. EIM generates big data, and with over 500 million analytical records representing over 1,500 sites worldwide, is one of the largest centralized, cloud-based water quality management systems in the world. With anticipated growth in double digits stemming from the addition of streaming data from sensors and many IoT monitoring devices, Locus needed to have a highly scalable system. AWS's unmatched performance and scalability powers Locus' on-demand water quality, EHS compliance, sustainability platform apps, and GIS. We also believe that our environmental beliefs and goals are aligned with those of Amazon.

Running on AWS's fault-tolerant, highly performant infrastructure helps support Locus's everyday business and scales easily for peak periods, where reporting demand such as our GHG calculation engine or significant emissions incidents like spills can skyrocket demand.

Locus intends to leverage AWS IoT by building a new native integration to help businesses generate value from the billions of events generated by connected devices such as real-time environmental monitoring sensors and environmental treatment systems controls.

AWS IoT is a set of cloud services that let connected devices easily and securely interact with cloud applications like EIM and Locus Platform as well as various devices. Locus IoT Cloud will connect with AWS IoT to combine device data with customer data in Locus Platform, allowing businesses to create meaningful customer experiences based on real-time activity and emissions monitoring across all their connected sensors and devices.

For example, a water utility company that maintains tens of thousands or more of IoT-enabled sensors for water flow, pressure, pH, or other water quality measuring devices across their dispersed facilities can use AWS IoT combined with EIM or Locus Platform as a whole solution to ingest and manage the data generated by those sensors and devices and then interpret it in real-time. By combining water sensor data from AWS IoT with Locus IoT customer data, water utility companies will be able to automatically create an emergency shutdown if chemical or other exceedances or device faults are detected and will be better prepared to serve their customers. And that is a real-time water monitoring.

By combining the powerful, actionable intelligence in EIM and rapid responsiveness through Locus Platform with the scalability and fast-query performance of AWS, customers can seamlessly analyze large datasets on arrival in real time. This allows Locus' customers to explore information instantly, find insights, and take actions from a greater variety and volume of data—all without investing the significant time and resources required to administer a self-managed, on-premises data warehouse.

EBJ: How we capture, collect, disseminate and use environmental information and data has evolved dramatically over the last 20 years, driving changes in how our industry does business. What changes do you anticipate over the next 20 years?

Duplan: Although it may not happen in 20 years, I envision movement toward a single system of record for the whole planet with centralized management of decentralized information based on blockchain technology or something similar that has not even yet been invented. Every piece of information (e.g., emissions) will be input only once, then used everywhere else as needed. With time we may come much closer to answering the question: "Can a Butterfly in Brazil Really Cause a Tornado in Texas?" as everything will be connected, measured and observed via software real-time modeling of the near future.

If Facebook can organize social interaction of over a billion people and Google can serve the world with a search engine that touches on all aspects of our interest and existence, why is it that a similar technology or technologies could not be deployed to organize, for example, all the world's emissions in real-time? The technology certainly exists but a will to deploy it (or monetize it?) is not there yet. Would it be less expensive to deploy software technology to handle trillions of emissions data in real time or organize man's transfer to another planet and start everything from scratch? I am envisioning the worst of the worst outcomes which may seem farfetched to many. My point is that we do not know what fate awaits us if we do not tackle the climate crisis that is already unfolding. Too much of our discussion centers on the cost of taking actions that will minimize climate change. Too little deals with the cost of not acting.

In the short term, AI has penetrated many aspects of our everyday lives, and it is about to disrupt how we deal and manage EHS compliance and sustainability, and how we approach safety in organizations. We are heading towards a future in which AI is omnipresent.

To date, many companies have not reached the point of being able to make use of their data for more effective compliance. Nearly every company is looking at ways to increase the use of data in their business operations. A popular trend in 2020 is digital transformation, which is the adoption and integration of digital technology into all areas of a company's business. It is the move from physical to digital. This transformation will take some time. Unwilling or poorly trained personnel or an intransigent corporate culture can undermine an organization's attempt to negotiate its way

through a digital transformation. Furthermore, less than 10 percent of companies have advanced technology systems (e.g., multi-tenant SaaS) to pull in the massive amounts of streaming and "unstructured" data or data that are not well organized. And only about a quarter are doing something meaningful with their legacy data. Over half of companies still call spreadsheets their "system of record." So, we have a long way to go.

People, rather than technology, are always the biggest impediment to progress. Addressing just why some companies' bids to digitally transform their EHS compliance departments ultimately proved disastrous, there is a broad consensus that it is nearly always down to problems with corporate culture and key personnel rather than technical failures. Another issue that is important and that we encounter frequently concerns the optimum length of the incubation stage of the transformation process. Time and again we see companies taking years to make a decision that should have taken no longer than weeks. Why? Managers hire armies of consultants, research analysts, or another type of middlemen to cover for their poor knowledge of technology and their fear of making any decision without having somebody on their side to blame when things go wrong.

In summary, the selection process becomes more important than the outcome. And, as is usually the case, the more people get involved and the more "grading" spreadsheets are built, the worse the outcome. Unnecessarily lengthy incubation periods ultimately derail the implementation phase of the transformation process. I am of the opinion that prompt action is essential to maintaining momentum when initiating such a comprehensive, company-wide change. Unlike on-premise traditional software decisions when a customer needs to commit large expenditures to buy and implement software and wait years until the outcome is known, SaaS can be implemented and tested fast and little cost with no fear of failure.

I have two takeaways for companies ready to undergo the digital transformation of their EHS department: Firstly, it is always better to change what people actually do, rather than to try to change how they think; and secondly, it's usually far cheaper to simply stop doing something than to develop a means of automating it. Throughout the process, it is imperative that common sense is applied.

Companies certainly are talking more about "digital transformation," even AI and blockchain. But all of these fall in secondary and perhaps tertiary categories. What is the point of such expansive talk when fundamental primary issues are not yet tackled? And by primary I mean: 1) a multi-tenant SaaS with fully integrated apps across customers' organizational structure, 2) single system of records and 3) the ability to seamlessly share and consume data to enhance collaboration across the organization, eventually solving many of the toughest problems in real-time.

Many companies are trying to get their arms around all the data available to them to apply predictive analysis, something that was not possible only several years ago. Since the big data surge took hold in the past decade, most companies have come to realize that they need to take advantage of accumulated legacy data for their compliance function and across business operations, if for no other reason than to reduce operational costs. Emissions data and information from the IOT are at the forefront of those data sets. Those companies that can tap into their new streams of data and combine them with legacy data and ever-changing regulatory content in the real-time stand to see a windfall for improving their daily operations in addition to staying in compliance.

By automating the process of pulling together all the necessary data, companies can improve transparency and maintain better oversight of who is working with the data. So, when they are looking at a result that might end up in a regulatory report or financial statement, they have complete traceability back to the source system of record, instead of everybody having their stuff in spreadsheets.

EBJ: What is your take on how advances in satellite and drone imagery and scanning create challenges for you and your business? What about challenges confronting the broader consulting and project solution community?

Duplan: Advanced imagery and scanning adds just another layer of information and a very powerful one. They will augment existing GIS systems and make them eventually go live. Today's GIS systems have a variety of built-in mapping technologies, but they are all dated the moment they are published. I see a future where real-time mapping will provide accurate information about the location and interactions of many connected data streams such as weather, emissions, virus spread and much more. ¤

ENVIRONMENTAL BUSINESS JOURNAL®

Strategic Information for a Changing Industry

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TECHNOLOGY TO PLAY A BIGGER ROLE IN THE 2020s

The environmental industry grapples with the pros & cons and risks & costs in overcoming obstacles to innovation

Modern technology in the information age is generally regarded as beneficent. Like the technologies that formed the industrial age, the initial benefits of information technology were obvious and measurable in economic terms. But perhaps, like industrial technology before it, information technology will also turn out to be a double-edged sword of benefits balanced by risks that become more apparent over time. *The Economist* welcomed the decade of the 2020s with a leader about 'techno-pessimism', commenting that the technologies expecting to dominate the new decade also cast a 'dark shadow' that are already feeling the effects of a 'techlash'. Social media is eviscerating our privacy, allowing mass distribution of disinformation and undermining democracy. E-commerce apps are undermining labor and exacerbating inequality. And parents and teachers worry that smartphones have created a whole new generation of screenagers, a syndrome not just limited to the teen years, and likely connected to the rise of obesity and diabetes as well as a disturbing disconnection with nature.

Yet in spite of its litany of negatives, *The Economist* almost begrudgingly pivots its message of pessimism into a positive promise of progress. And while perhaps not optimistic, it does assert that the pathway to the solution of most of the world's problems is likely paved with technology. And while economists are generally viewed as a somewhat cynically analytical and pessimistic lot, engineers on the other hand are usually regarded as optimistic and possessing a can-do attitude. Just so the

Current Deployment of Technologies in Environmental Projects

Technology	Percentage of Projects
Information Systems & Software	52.2%
Analytical or Monitoring Technology	44.0%
Mapping, Modeling & Project Visualization	41.1%
Treatment or Control Technology	31.0%
Remote Sensors & Monitors	22.5%
Satellite Technology	19.4%
IoT (Internet of Things)	14.4%
Energy Efficiency Systems or Equipment	14.2%
Power Generation Equipment	11.9%
Drones	9.6%
Artificial Intelligence & Machine Learning	8.8%
Power Storage Equipment	7.5%
Augmented & Virtual Reality	5.6%
Robotics	4.2%
3D Printing	3.5%
Block Chain	3.0%

Source: 2020 Survey of Disruptive Technologies in the Environmental Industry, EBI, Inc. Question was: Indicate the percentage of projects in which you are using the following technologies. 95 total respondents.

Inside EBJ: Disruptive Technology for the 2020s

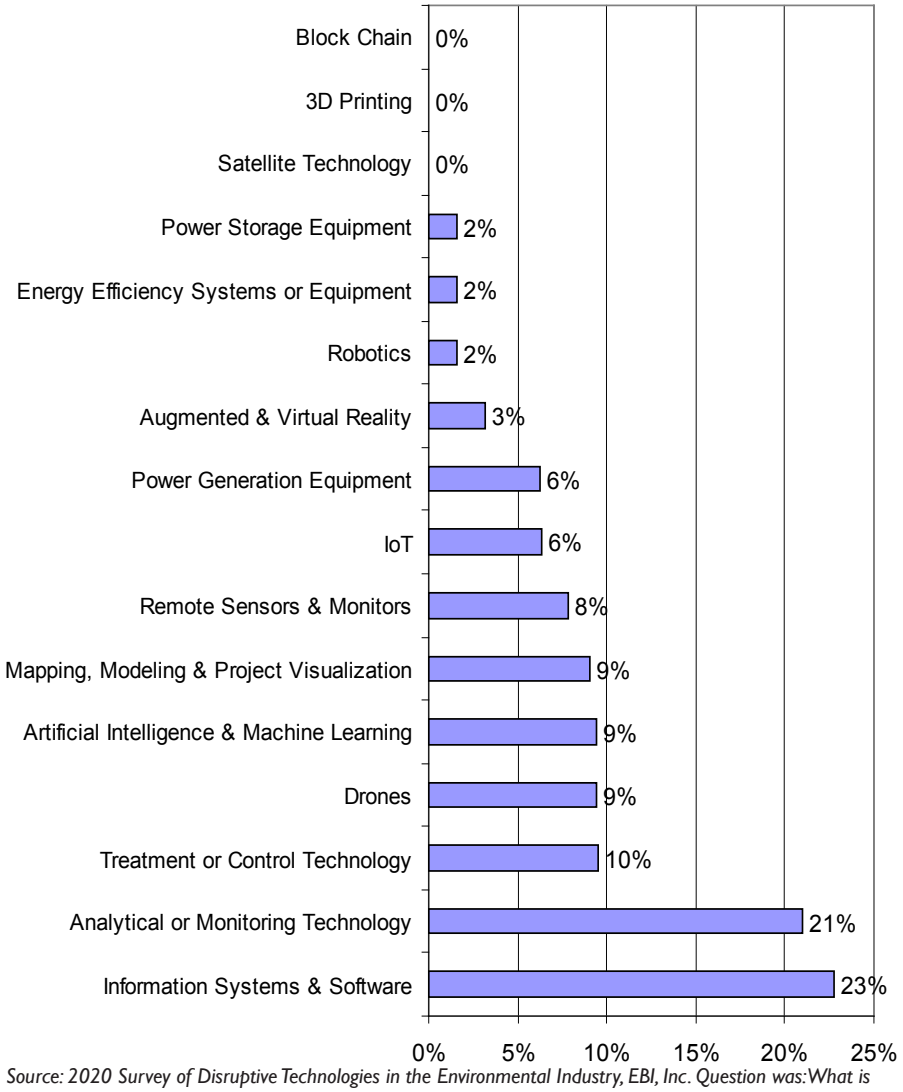
intrepid environmental industry also tilts optimistic in its outlook for the 2020s, and the potential that still emerging technologies have to enable them to more rapidly usher in the transition to a sustainable economy. And along with the beneficence of technology comes the benevolence of the environmental industry that displays a strong sense of community in sharing best practices on their current deployment of technology in these pages of *Environmental Business Journal*, as well as a consensus on the most likely trajectory of emerging and potentially disruptive technologies in this new decade.

Best practices in deploying innovative or disruptive technology in the environmental industry however, is somewhat of a moving target akin to building a sand castle with the tide coming in where each subsequent wave either destabilizes the foundation or topples the most recent addition, and setting the IT department or CTO scrambling to redesign and rebuild before the onset of the next wave.

Despite pioneering generations of innovative solutions never before conceived of prior to the environmental industry's founding, the industry itself is mostly viewed as fairly slow to adopt new technologies compared to peers in science & engineering and in services & manufacturing sectors. Even today's most rapidly emerging technologies have been proven mostly in other industries prior to adoption by the environmental industry. Virtual & augmented reality from the gaming industry, robotics from the automotive industry, satellite imagery and data from the weather forecasting industry, and drones, scanners and sensors from the military are all examples of technologies that mostly made the move to mainstream adoption in those industries prior to the environmental industry.

So where have we distinguished ourselves? Where have environmental companies had to lead or to push the envelope of innovation? Most environmental executives would agree with one or their peers who said that, outside of treatment technologies, "It's all about the data." And not necessarily crunching data, which has been the purview of the information tech-

Percent of Environmental Companies Making a 'Very Significant Investment' in the Following Technologies



Source: 2020 Survey of Disruptive Technologies in the Environmental Industry, EBI, Inc. Question was:What is the level of investment that your company is putting into the following technologies. Complete table on p.4.

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Impact of Disruptive Technologies on Various Business Areas of the Environmental Industry

	Most Significant Positive Impact	Very Significant Positive Impact	Significant Positive Impact	Moderately Positive Impact	Not much Impact	Slightly Negative Impact	Significant Negative Impact
Differentiation: Quality of Service	15%	28%	25%	21%	12%	0%	0%
Enhanced Productivity of People / Teams	11%	21%	30%	19%	16%	3%	0%
Cost Efficiency: Reduced Need for Labor	10%	11%	28%	20%	25%	6%	0%
Corporate Culture: Employee Retention	3%	22%	13%	30%	30%	1%	0%
GHGs or Carbon Footprint	10%	7%	10%	13%	55%	3%	0%
Obsolescence of Existing Technology	4%	16%	9%	10%	36%	23%	3%
Demands on Staff: Time for Training	1%	10%	21%	10%	29%	24%	4%
Costs of Technology: Time on Evaluation	1%	10%	13%	9%	34%	28%	3%
Screen Time or Desk-bound Time	1%	10%	6%	15%	42%	22%	3%

Source: 2020 Survey of Disruptive Technologies in the Environmental Industry, EBI, Inc. Question was:What kind of impact are disruptive or innovation technologies having on the following areas of your business. n=95

nology industry over past decades. For the environmental industry 'the data' has been about: 1) collecting it in a more efficient, timely and convenient manner; 2) managing, moving and accessing it across a variety of platforms; 3) editing, manipulating and displaying it into usable or actionable visuals and narratives; and 4) monitoring and reporting data on a real-time basis for compliance, risk mitigation, security, resource productivity and other applications—all the while remaining sensitive to 'data overload' for clients and employees.

EBJ SURVEY RESULTS

EBJ's 2020 Survey of Disruptive Technologies in the Environmental Industry, conducted in March 2020 aspired to determine the current state of technology across the industry, as well as key areas of growth and investment for the 2020s. Part of assessing the state of technology in the environmental industry involved a survey question regarding current deployment of technologies on environmental projects. The table on page 1 shows somewhat surprising results in the relatively low level of deployment in the variety of technologies queried.

While it is hardly surprising that over half of projects involve the deployment of some sort of sophisticated information management system, and 40-45% of projects involve analytical or monitoring technology, and some form of mapping, modeling or project visualization, most of the innovative technologies that the industry is evaluating and curious about are deployed in less than 10% of projects. Whereas some form of treatment or control technology is deployed in about 1 in 3 projects, only 1 in 5 projects involve the use of remote sensors or satellite technology. Drones and artificial intelligence or machine learning systems are only used in less than 1 in 10 projects, and augmented or virtual reality only in about 1 in 20 projects, and 3-D printing and robotics in only about 1 in 30 projects.

IMPACT & INFLUENCE

By no means does one expect that new technology needs to be or should be deployed on all projects, but with the expectation that productivity and differentiation will be a result of enhanced deployment of innovation, then one might expect these figures to double or triple in the 2020s. The table above shows the expected business benefits or detriments of disruptive technologies, and is an indicator of why firms may, or may not, chose to deploy them. Here roughly 2/3 of respondents indicate that differentiation of their services or the ability to deliver higher quality service is a significant positive impact, a very significant positive impact or the most significant impact. Along with the enhanced productivity of their staff, cost efficiency (likely manifested as the reduced need for labor), was a significant positive impact for about half of respondents, although about 1 in 5 respondents indicated technology's impact on productivity was only a moderately positive contributor to their business.

Employee retention and having a corporate culture of innovation was rated as a significant or greater positive impact for 38% of respondents, although 60% indicated that it didn't have much impact. The impact of technology on greenhouse gas emissions or on the carbon footprint of the company was largely dismissed as not having much impact by the majority of respondents, although 10% indicated it was one of the most significant factors. The generational question later in the survey (see page 15) indicates this likely is a more important issue for the entry level generation of employees.

Considerable negative impacts show up in almost a third of respondents when considering the obsolescence of existing technology, the demands on staff for learning to use new technology, and the time required to evaluate, deploy and acquire new technology. These three factors ranked

at the bottom of the 'impact' table. Whether innovations make working in the environmental industry a more 'desk-bound' existence or make practitioners more tied to screens at desktop, laptop or in the field was also included on this question, and the general response was balanced positive and negative impact on overexposure to technology devices.

Ranking what environmental industry executives think will be the most influential technologies in the 2020s is presented on the table at the bottom of page 5. Here monitoring separates itself from all other applications with almost 90% of respondents agreeing that it will be one of the more influential technologies in the 2020s. Also ranking high are modeling, mapping and project visualization systems with 53% of respondents rating those as either very influential or one of the most influential technologies to the evolution of the industry.

Investment Expected by Environmental Companies by Technology Type

	Very Significant Investment	Significant Investment	Moderate Investment	No Investment
Information Systems & Software	23%	39%	33%	5%
Analytical or Monitoring Technology	21%	19%	48%	11%
Mapping, Modeling & Project Visualization	9%	35%	41%	15%
Remote Sensors & Monitors	8%	25%	44%	23%
Treatment or Control Technology	10%	13%	46%	32%
Drones	9%	11%	45%	34%
IoT	6%	13%	35%	46%
Artificial Intelligence & Machine Learning	9%	3%	44%	44%
Energy Efficiency Systems or Equipment	2%	13%	41%	45%
Satellite Technology	0%	11%	38%	51%
Augmented & Virtual Reality	3%	3%	36%	58%
Power Generation Equipment	6%	2%	28%	64%
Power Storage Equipment	2%	5%	33%	61%
3D Printing	0%	8%	21%	71%
Robotics	2%	10%	8%	81%
Block Chain	0%	5%	8%	87%

Source: 2020 Survey of Disruptive Technologies in the Environmental Industry, EBI, Inc. Question was:What is the level of investment that your company is putting into the following technologies.

Technology Impact by Media in the Environmental Industry in the 2020s

Media or Project Area	Extreme Impact	V. Significant Impact	Significant Impact	Moderate Impact	No Impact
Infrastructure: Electricity Grids	18%	40%	23%	14%	5%
Infrastructure: Communications	11%	52%	19%	11%	8%
Visualization / Project Mapping	13%	39%	26%	17%	4%
Project Mgmt / CAD / Design / Software Apps	10%	31%	31%	22%	4%
Infrastructure: Transportation	6%	35%	35%	18%	6%
Water Quality Monitoring	10%	24%	30%	34%	1%
Drinking Water Treatment	11%	23%	28%	37%	2%
Wastewater Treatment	5%	29%	32%	35%	0%
Remediation	12%	20%	26%	38%	5%
Sample Collection / Measurements / Lab Analysis	8%	22%	30%	39%	2%
Infrastructure: Water/WW	9%	23%	27%	35%	6%
Air Quality Monitoring	12%	13%	37%	30%	7%
Recycling, Resource Recovery & Reuse	9%	18%	30%	42%	1%
Air Pollution Control	12%	12%	35%	33%	8%
EIS / Environmental Assessments	8%	21%	27%	33%	11%
Environmental Health & Safety	9%	18%	23%	45%	5%
Hazardous Waste Management	7%	10%	26%	51%	4%
Solid Waste Management	6%	11%	27%	53%	3%
Permitting & Compliance	7%	13%	22%	40%	16%

Source: 2020 Survey of Disruptive Technologies in the Environmental Industry, EBI, Inc. Question was: How do you think that the following media or service segments will be impacted by technology in the 2020s.