ENVIRONMENTAL BUSINESS JOURNAL®

Strategic Information for a Changing Industry

Vol. XXXVI, Numbers 7/8, 2023 | *Technology & the Environmental Industry* | Environmental Business International Inc.

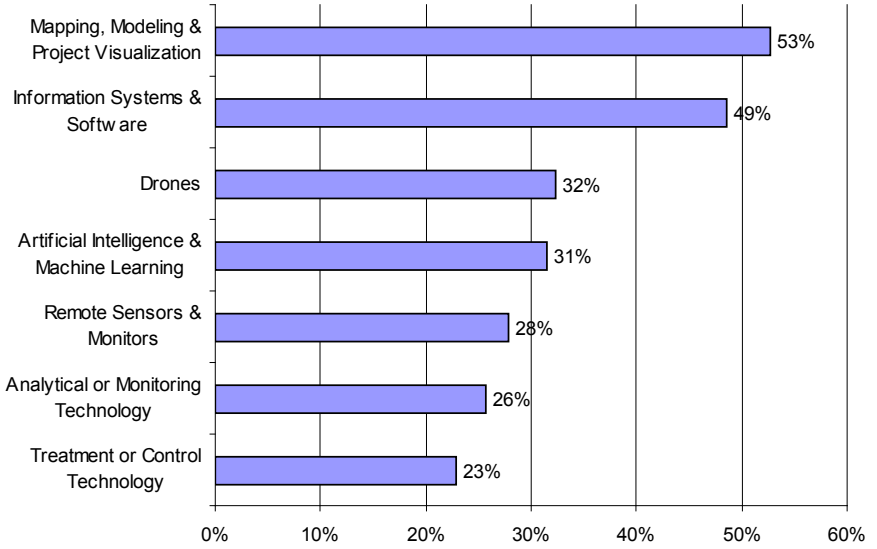
TECHNOLOGY AS THE DIFFERENTIATOR

Knowledge and perspective on technology has always been a differentiator in the environmental industry. Firms have developed $100 million value propositions on a single technology. Others are technology agnostic: purporting to equally represent every technology available in the tool bag to make the most cost-efficient and enduring solution for their clients. So whether a service provider or a technology developer, or whether a consultant or a contractor, staying at the forefront of technology development and implementation is a key element in environmental industry competitiveness.

But not all technology is created equal. And not all technology works as intended or expected. And few and far between is the client or project that is willing to be experimented on. Equally elusive is the client willing to fund innovation on a project by project basis. The traditional regulatory paradigm behind prescriptive technologies or guaranteed results for treatment, pollution control, analytical methods or other processes across the environmental industry also serve to suppress or inhibit innovation. And while these barriers to technology innovation are important, they aren't the primary focus of this review. And while treatment and pollution control technologies are also important, they aren't the primary focus of this review either.

The technology revolution of the 21st century is about Information Technology (IT), and the revolution continues to be in full gear, if not accelerating, in 2023. From the mainframe to the personal computer to the smartphone and the interconnection of devices, and from data sharing to the internet and the cloud to computational models and artificial intelligence today, the pace of change has been persistent—and an underlying challenge of being in any business.

Areas Where Firms Have Significant Investments in Technology



Source: 2023 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. Percentage are categories rated by respondents as 'very significant' or 'significant' investment in technology in 2023: just the top 7 of 18 displayed.

Inside EBJ: **Technology & the Environmental Industry**

Deployment of Technologies in Environmental Projects: 2020-2023

	2023 Deployment	2020 Deployment	2023 vs. 2020
IT Systems & Software	52.5%	52.2%	0.3%
Mapping, Modeling & Visualization	47.4%	41.1%	6.3%
Analytical or Monitoring Technology	34.3%	44.0%	-9.7%
Treatment or Control Technology	22.5%	31.0%	-8.5%
Remote Sensors & Monitors	20.3%	22.5%	-2.1%
Satellite Technology	19.1%	19.4%	-0.3%
IoT or Connectivity	17.8%	14.4%	3.4%
Power Generation Equipment	15.3%	11.9%	3.4%
Energy Efficiency Systems/Equipment	14.6%	14.2%	0.4%
Drones	13.3%	9.6%	3.7%
Automated O&M Systems	12.0%	n/a	
Artificial Intelligence & Machine Learning	8.2%	8.8%	-0.6%
Power Storage Equipment	6.6%	7.5%	-0.9%
Automated Compliance/Permits	5.7%	n/a	
Robotics	3.8%	4.2%	-0.4%
Augmented & Virtual Reality	3.4%	5.6%	-2.2%
3D Printing	0.6%	3.5%	-2.8%
Block Chain	0.5%	3.0%	-2.5%

Source: 2023 and 2020 EBJ 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.

EBJ Respondents by Segment

Environmental C&E	20%
Remediation	16%
IT & Tech	11%
NRM/CRM	8%
AEC	6%
Investigation	5%
Remediation Tech/Eq	5%
Air Quality	3%
Compliance	3%
Statistics/Risk	3%
Sustainability	3%
Water/Wastewater	3%
Energy	2%
Infrastructure	2%
RNG	2%
Renewable Energy	2%
Solid waste	2%
Transportation	2%
Waste Management	2%
Water Instrumentation	2%
Water Testing	2%

Source: 2023 EBJ Survey of Disruptive Technologies in the Environmental Industry,

DATA-INFO-INTEL

So where are we in the development of Information Technology in the environmental industry? And how are we advancing on the continuum in our ability to collect and manage data, produce data into aggregated information, and assemble the appropriate information into actionable intelligence? Managing this data-information-intelligence continuum is not easy, but the difficulty is compounded by the fact that we have more data due to better and more detailed data collection apparatus—putting pressure all the way along the continuum toward the ultimate goal of actually making a decision. And all this data and information taxes the human brain enough that we are becoming increasingly reliant on digital processes to make sense of the data and convert it into useful information and actionable intelligence. Hence today's obsession with artificial intelligence (AI) and debates about its ability to transform business and society in many ways.

But how are we using these tools to address today's challenges? And how is the environmental industry using technology to advance its ability to satisfy client needs and optimize its own business operations facing a changing future? Seeking answers to those questions, Environmental Business Journal conducted it's second thorough survey of environmental service and technology providers in the summer of 2023, repeating a similar survey conducted early in 2020.

The results of EBJ's 2023 Survey of Disruptive Technologies in the environmental Industry are summarized here on these pages, and indicate some key trends that are affecting, and will increasingly affect the environmental industry throughout the rest of the 2020s and beyond. Along with this analysis we present some results of surveys conducted by peers in the industry that find an unsurprising recent surge in capital expenditures and operating

Environmental Business Journal ® (ISSN 0145-8611) is published by Environmental Business International, Inc., 4452 Park Blvd., #306, San Diego, CA 92116. © 2023 Environmental Business International, Inc. All rights reserved. This publication, or any part, may not be duplicated, reprinted, or republished without the written permission of the publisher.

To order a subscription, email info@ebionline.org, call 619-295-7685 ext. 15 or visit www.ebionline.org/ebj. A corporate electronic subscription with internal reproduction license and access to data files starts at $1,500 and allows up to five registered users with rates increasing in five user increments. Individual editions or discounted corporate subscriptions are available for firms with under 100 employees.

Editor in Chief, Grant Ferrier
Federal Analyst, Andrew Paterson
Research Analyst, Laura Carranza
Managing Editor, Lyn Thwaites
Emeriti, George Stubbs, Jim Hight
Subscriber Services, Laura Fernandes

EBJ Editorial Advisory Board: Andrew Paterson; James Strock, Founder, Serve to Lead.; P.S. Reilly, President, NextGen Today; Al Spiers, 2020 Environmental Group; Steven Maxwell, TSG; Jessica Barclay, Environmental Financial Consulting Group

help SCS and our clients track compliance and maximize wellfields for odor control, migration control, and provide fuel for renewable energy projects.

EBJ: Are jobs at SCS changing as more technologies become available to perform tasks previously done by employees? What training has your company implemented to help employees adapt?

Hostetter: Overall each employee is doing more because of technology. For example, we used to send employees out to facilities to get readings on equipment; now, those same employees can access the cloud-based SCSRMC.com system for the facility and review the data from anywhere. Instead of just being a data collection person, they now review the data and figure out what to do about it. We've increased their capacity and their capabilities. We've moved most of our training online. Each month, several new online courses are available. This helps us invest in our employee-owners, providing even more value to our clients! And it is convenient. We also provide libraries of blogs, papers, articles, and videos free to our clients on our website.

Brynda: I do not believe that technological improvements have led to a loss of jobs. I believe we have created new positions that did not previously exist to help us provide better technical solutions for clients. From a landfill gas wellfield management perspective, our technicians are now better equipped with advanced analytical tools that did not exist until recently. Utilizing these tools has resulted in SCS winning more work, and we have added staff. Landfill technician jobs are a combination of hands-on work and learning and using technology – as with all SCS technology, each enhances the other.

EBJ: How have SCS' IT & R&D budgets grown in recent years?

Hostetter: Our R&D budgets have increased over the last several years, and I expect that to continue. Technology is changing quickly. If you don't understand and know how to apply it, you'll fall behind and not be able to serve your clients and create efficiencies for them as well as you can. □

SEAFARING DRONES PROPELLED BY RENEWABLE ENERGY GATHER DATA FOR OCEAN MAPPING, MARITIME SECURITY, AND CLIMATE SCIENCE

Saildrone (Alameda, Calif.) is a data company providing comprehensive turnkey solutions for maritime defense and security, ocean mapping, and ocean data. The company enables real-time access to critical data from any ocean and uses proprietary software applications and machine learning technology to transform that data into actionable insights and intelligence. Saildrone has a fleet of uncrewed surface vehicles (USVs) powered by wind and solar, making ocean data cost-effective at scale with a minimum carbon footprint. Saildrone vehicles operate around the clock without the need for a crewed support vessel and have sailed almost 1 million nautical miles from the Arctic to the Antarctic and spent nearly 25,000 days at sea in the harshest ocean conditions. Saildrone has 241 full-time employees, up from 84 in 2021, and also operates an office in Washington, D.C., in addition to an Ocean Mapping and Deployment facility in St. Petersburg, Fla. Saildrone has remote pilot teams in three major time zones in California, London, and Perth, that supervise the vehicle fleet.

***Tom Foldesi, Chief Revenue Officer of Saildrone**, leads global sales, sales operations, business development, partnerships, and marketing. Tom brings to Saildrone more than 25 years of experience in strategy, enterprise sales, and the federal sector. Most recently, he served as SVP of Global Partner Sales at DataStax, where he led the development of the company's cloud partner ecosystem and related channel sales. Previously, he was Director of Commercial Engagement for Defense Innovation Unit in the Department of Defense, where he led the team that deployed the first sustainable DOD engagement model for innovation ecosystems. Prior to DIU, Tom held senior executive roles at LVMH and Intel. Earlier in his career, he served honorably in the United States Navy as a SEAL officer. Tom holds a BS in Quantitative Economics from the University of Pennsylvania.*

EBJ: What technological advances over the past five years have enhanced Saildrone's ability to collect maritime data?

Tom Foldesi: Saildrone continues to evolve its fleet. In the past five years, the 7 m Explorer has transitioned from performing proof-of-concept and demonstration missions to operational missions for a variety of customers. We have added the 20 m Surveyor and 10 m Voyager, both of which offer more advanced data collection and security capabilities, and are scaling production of both of these vehicles. We are extending the capabilities of our two larger vehicle platforms by integrating best-in-class third-party components. For example, the integration of Starlink enables high-resolution data offloading in near real time.

Recent advancements in edge computing devices have enabled Saildrone to run increasingly powerful machine learning algorithms onboard the vehicles. These algorithms, which can prioritize and generate insights over high volumes of data in real time, ensure that our customers have actionable and quality information about remote maritime environments anywhere on Earth.

EBJ: How is technology changing, and what major problems will be addressed in the near future that would have been unimaginable a few years ago?

Foldesi: Saildrone is already delivering ocean insights and performing a number of missions that were unimaginable just a few years ago. Explorer-class vehicles, equipped with a specially designed "hurricane" wing, are collecting never-before-seen data for **National Oceanic and Atmospheric Administration** (NOAA) from inside hurricanes. Saildrones, paired with underwater gliders and aerial assets, create a complete picture of the exchange of energy and momentum between the ocean and the atmosphere from 30,000

feet above the sea surface to several thousand feet below. While buoys collect similar metrics to saildrones, they are stationary and consequently require a storm to pass over them. Saildrones can sail into storms, creating not only a temporal but also a spatial time series of how the ocean and the atmosphere are interacting.

EBJ: What makes Saildrone's technology unique, and what problems can it solve?

Foldesi: What makes Saildrone technology unique is the persistence of our platforms. The use of wind power for propulsion allows our vehicles to stay at sea virtually indefinitely. Saildrones can consequently gather vast amounts of data over long periods of time to support multiple use cases.

- **Maritime defense and security:** There are a number of maritime challenges ideally suited to using uncrewed systems, including combating illegal, unreported, and unregulated fishing, drug interdiction, safety of life at sea, border integrity, and asset protection. Saildrone has developed proprietary machine-learning models that run on GPU compute processors at the edge to deliver real-time visual detection of targets that are otherwise not transmitting their position. These detection events are then fused with other data sources, including AIS and radar, to deliver a fully informed picture of the surrounding maritime domain.

- **Ocean Mapping:** Accurate and up-to-date topography of the ocean floor is essential to understanding how ocean currents move heat and carbon around the planet, sustainably managing resources, forecasting tsunamis and storm surges, safety of navigation, telecommunications, developing and maintaining coastal infrastructure, and establishing new offshore energy sites. Oceans cover more than 70% of Earth's surface, but less than 24% of the global ocean has been mapped using modern technology. The U.S. Exclusive Economic Zone (EEZ) is one of the largest in the world, but it is largely still unmapped, unobserved, and unexplored. Saildrone USVs represent a paradigm shift in how we explore our oceans, carrying the same cutting-edge sonar equipment as survey ships to deliver high-resolution data to the global community. We are able to deliver these capabilities at a fraction of the cost and carbon footprint.

- **Ocean Research Data:** Humanity has been observing Earth's oceans for centuries, but we've only just begun to learn about the carbon cycle, how hurricanes intensify, how a change in sea surface temperature creates an El Niño or La Niña year on land, how the shape of the ocean floor affects the distribution of heat around the planet, and much more. We are not scientists and defer to experts on the interpretation of the data we provide. But we see increasing evidence that humanity's current understanding of our oceans is insufficient to confront the global challenges we will face in the coming decades. Oceans are the final frontier of exploration here on Earth. Saildrone USVs are equipped with a payload of oceanographic and meteorological sensors to collect measurements at the air-sea interface. These measurements are necessary to address research on air-sea exchanges of heat and carbon dioxide, ocean dynamics, and populations of fish and marine mammals.

EBJ: When was Saildrone founded, and how did you find your niche?

Foldesi: Saildrone was founded by Richard Jenkins in 2012. After successfully working for 10 years to break the land speed record for a wind-powered vehicle (126.1 mph), Jenkins applied his innovations to the design of an autonomous ocean vehicle. An early Saildrone Explorer prototype sailed from San Francisco to Hawaii in 2013. Saildrone partnered with the NOAA Pacific Marine Environmental Laboratory in 2015 to develop and refine the Saildrone sensor suite for oceanographic and meteorological data collection. Once the Explorer platform was proven, Jenkins designed the larger Voyager and Surveyor class vehicles to expand the company's data offerings.

EBJ: How have you grown the company?

Foldesi: Saildrone has grown organically as we repeatedly demonstrate the ability to perform persistent ocean operations and operate in increasingly challenging conditions. This rugged persistence is accompanied by the integration of new, more sophisticated sensors and components, opening up new possibilities for data collection for different types of customers.

Saildrones, paired with underwater gliders and aerial assets, create a complete picture of the exchange of energy and momentum between the ocean and the atmosphere from 30,000 feet above the sea surface to several thousand feet below

EBJ: How has growth been financed?

Foldesi: In 2021, Saildrone closed a Series C funding round of $100 million to bring total investment to $190 million.

EBJ: Tell us about Saildrone's company culture and the traits you look for in employees.

Foldesi: Saildrone's culture is cross functional, collaborative, and community based. We work at an efficient, fast pace and look for employees who show enthusiasm for our product and space, have grit (no task is too small), and are, overall, team players. The company has grown from 75 to 245 in two years with an extremely low turnover rate. We consistently focus on employee engagement and use continuous feedback loops to ensure we are keeping up with employee sentiments.

EBJ: Where are Saildrone's personnel located, and what type of presence is required for a project?

Foldesi: Saildrone is based in Alameda, California, with remote pilot teams stationed around the world. Saildrone's vehicle operations technicians (VOTs) and vehicle assembly and service technicians (VASTs) are primarily based in Alameda and travel to remote deployment locations as necessary. Depending on the complexity of the mission requirements and number of vehicles, two to four technicians are re-

quired to deploy a mission fleet.

EBJ: What do you consider to be some of Saildrone's outstanding projects?

Foldesi: Saildrone has sailed nearly 1 million nm from the Arctic to the Antarctic and spent more than 25,000 days at sea.

Highlighted missions:

• **2019 Antarctic Circumnavigation:** When a Saildrone uncrewed surface vehicle (USV) circumnavigated Antarctica in 2019, it marked a technological triumph over some of the most extreme marine conditions on Earth. The Southern Ocean has long been thought to play a significant role in the uptake of CO2 from the atmosphere. However, previous assumptions were based on ship-based data, which are temporally and spatially limited, given the harsh ocean conditions. The Saildrone USV was deployed from Bluff, New Zealand, on January 19, 2019, returning to the same port on August 3 after sailing over 11,879 nautical miles around Antarctica. The 196-day mission provided data that alters the science community's understanding of the Southern Ocean as both a source and a sink for atmospheric CO2.

• **Atlantic Hurricane Monitoring (2021 – ongoing):** Hurricane track forecasting has steadily improved in recent years. However, predicting rapid intensification—when wind speeds increase at least 35 mph over 24 hours—is still a significant challenge. To understand how these large and destructive storms grow, scientists need to collect data about the surface fluxes—the exchanges of energy in the forms of heat and momentum—a task that Saildrone's uncrewed surface vehicles (USVs) are uniquely equipped to perform. As part of this mission, Saildrone has sailed several vehicles into the eye of major hurricanes, notably Hurricane Sam in 2021 and Hurricane Fiona in 2022. 12 vehicles are deployed for this year's mission.

• **2022-2023 Aleutian Islands Exploration:** Saildrone Surveyor SD 1200 departed Saildrone HQ in Alameda, Calif., to sail across the North Pacific to the survey area in July 2022. Between August and October, it mapped 16,254 square kilometers (4,739 square nautical miles) of unknown seafloor around the Aleutian Islands over 52 days. During the second half of the mission off the coast of California, the Surveyor mapped an additional 29,720 square kilometers (8,665 square nautical miles) of the US EEZ and discovered a previously unknown seamount standing approximately 1,000 meters (3,200 feet) high. Identifying such seamounts improves our understanding of the physical processes of the ocean and identifies areas needing further exploration as unique habitats.

• **2021-2022 Eurosea:** The EuroSea project, coordinated by GEOMAR Helmholtz Centre for Ocean Research Kiel, is a multi-national effort to enhance the European ocean observing and forecasting system. Two of EuroSea's primary goals are to: 1) Deliver ocean observations and forecasts that will advance scientific knowledge about ocean climate, marine ecosystems, and their vulnerability to human impacts; and 2) demonstrate how the ocean is an essential part of an economically viable and healthy society. The mission was conducted in a biologically productive and nutrient-rich area of the ocean but an incredibly difficult area for navigation, with extremely strong currents and light winds. This is an incredible testament to the endurance of the Saildrone Explorer class of vehicles. SD 1079 sailed 11,910 nautical miles and spent 370 days at sea collecting CO2 data to improve global carbon projections and help enable sustainable ocean resource management.

• **2020 Alaska Pollock Survey:** A 6,000 nautical mile round trip mission on behalf of NOAA Fisheries' Alaska Fisheries Science Center to perform an acoustic survey of Alaska pollock in the eastern Bering Sea. This data was intended for use in the formal stock assessment and to continue the existing time series. The mission was conceived as a contingency plan after NOAA's ship-based surveys were canceled due to the COVID-19 pandemic. All three vehicles functioned as expected, and the resulting data set will be used by the Fisheries Management Council to inform the sustainable management of the Alaska pollock fishery.

• **2017-ongoing TPOS mission:** The Tropical Pacific Observation System was developed to monitor oceanographic and meteorological conditions to improve early predictions of major weather events like El Niño and La Niña, critical for emergency management and economic planning. In September 2017, Saildrone partnered with NOAA to launch a series of six-month missions to the Tropical Pacific to test how unmanned surface vehicles (USVs) could augment TPOS data collection and improve long-term weather forecasting.

EBJ: Tell us about Saildrone's partnership with NASA.

Foldesi: Saildrone has worked with **National Aeronautics and Space Administration** on several missions, notably the MISST and S-MODE. NASA's Multi-Sensor Improved Sea Surface Temperature project (MISST) is an international and inter-agency collaboration to improve weather and climate research and prediction by providing better-quality ocean temperature measurements from satellites. Over a period of five years (skipping 2020), Saildrone will send a group of vehicles to the Chukchi Sea to collect surface and subsurface data, including air temperature, sea surface skin and bulk temperatures, salinity, oxygen and chlorophyll-a concentrations, barometric pressure, and wind speed and direction.

The Sub-Mesoscale Ocean Dynamics Experiment (S-MODE) is an ambitious project led by scientists at NASA, Woods Hole Oceanographic Institution (WHOI), and the Applied Physics Laboratory at the University of Washington to understand how ocean whirlpools and eddies affect the vertical transport of heat, carbon, and nutrients that impact climate and are important for biological productivity. In October 2021, a wide variety of platforms were deployed from San Francisco, including aircraft equipped with remote sensing equipment, the research vessel Oceanus, surface and underwater gliders, floats, and a group of five Saildrone Explorers. The experiment took place about 75 nautical miles off the coast of California, in the California Current system. The area is historically significant as the site of several early, influential studies of submesoscale variability. A similar experiment was performed in 2022 using Saildrone vehicles. □