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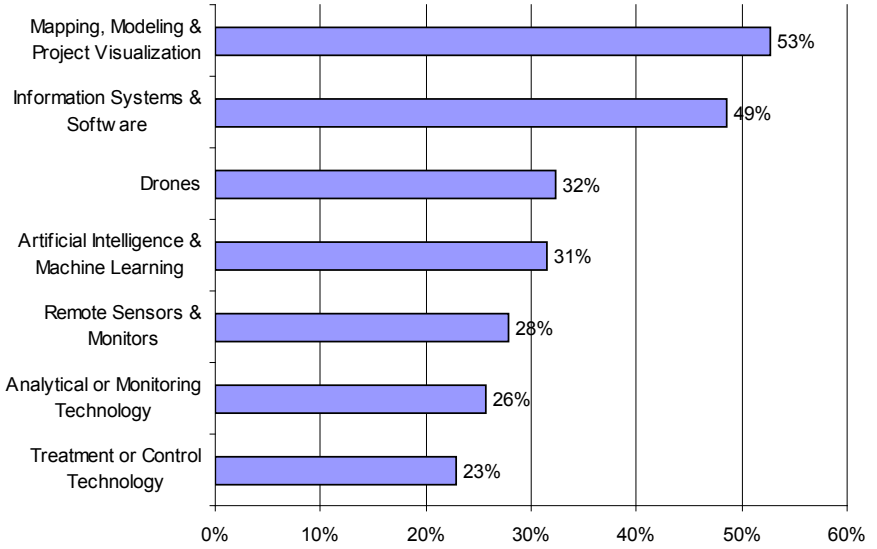
TECHNOLOGY AS THE DIFFERENTIATOR

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.

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SCS REFLECTS ON IMPACT OF TECHNOLOGY INNOVATION IN LANDFILL ENVIRONMENTS

Environmental engineers, consultants, and scientists at **SCS Engineers** (Long Beach, Calif.) work on solutions for pollution, energy consumption and emissions reductions, land remediation, water/wastewater treatment, and waste management. Core capabilities are solid and hazardous waste management, renewable energy, remediation, carbon capture, measurement and verification. Enhancing the firm's environmental engineering and consulting work are specialized in-house groups producing technologies and programs that lower industrial operating costs and reduce greenhouse gases for private and public clients establishing goals to reduce their environmental impact. These technologies and programs serve the agricultural, industrial, and manufacturing sectors. SCS Engineers reported a record year of gross and net revenues in 2022, its 16th consecutive fiscal year with record net revenues. Gross revenue for 2022 increased to $423 million, supported by 1,100 employee-owners.

Ken Brynda, SCS Field Services OM&M Quality Advisor, *is an active member of SWANA's Landfill Gas and Biogas Technical Division, Field Practices Committee serving clients for over 30 years. Ken's expertise includes the design, construction, operation and maintenance, evaluation, troubleshooting, and assessment of landfill gas collection and control systems and LFG-to-energy production facilities.. Ken is a SWANA-certified as a Landfill Technical Associate in the Manager of Landfill Operations (MOLO) program, and has also taught the SWANA introductory Landfill Gas System Operation and Maintenance training course.*

David Hostetter, SCS Engineers Business Manager*, manages remote monitoring and controls (RMC) work across the United States and internationally. His experience includes RMC systems engineering, construction, and operation; landfill gas and leachate engineering; and mechanical engineering. He is a graduate of Messiah College's mechanical engineering program. He is a registered Professional Engineer in Pennsylvania and Virginia, a Certified Energy Manager, and a LEED Accredited Professional. His projects have received an Environmental Business Journal Technology Merit Award and an Inductive Automation Firebrand Award.*

Note: Responses relate to landfill technologies and do not include technologies developed and used for other environmental services such as due diligence, land remediation, general air, water, and soil testing, mitigation/prevention, and compliance.

EBJ: How has technology changed the way in which SCS operates on a day-to-day basis?

Hostetter: One big change I've seen is the proliferation of remote monitoring and control (RMC) technologies. The underlying technologies are not new this year, but we've seen the technology's capabilities improve and the cost drop. We're now where these technologies are the starting point, not an afterthought. We're using these technologies to lower operations and maintenance costs, decrease greenhouse gas emissions, lower environmental risks for our clients and their local communities, and improve the quality of life for the people that interact with the facilities and live around them while lowering the health and safety risks associated with our industry. The main challenge that we've faced with this is keeping up with the demand to provide these technologies.

Brynda: Technology has equipped us with better tools to perform our jobs. It has allowed easier and quicker access to data, incorporating multiple tools for collecting data and the subsequent review and analysis of that data. This speed and accuracy allow us to perform complex and comprehensive troubleshooting, assessments, and deeper data dives from which we can make better operational, compliance, and financial decisions.

EBJ: Which parts of SCS' environmental practice have reaped the greatest advantage from technological change?

Hostetter: The two major areas in our environmental practice that have had the greatest advantage due to adopting RMC technologies are our operations and maintenance group and our engineering group. Both groups benefit from knowing how facilities are operating at any time from anywhere and having the critical data to make intelligent decisions on how to operate and design these facilities.

Beyond this, our O&M team can remotely control the equipment from anywhere. The days of driving several hours in the middle of the night on a holiday weekend in a snowstorm to restart a critical piece of equipment are gone.

Brynda: We easily upload and securely store data from multiple monitoring sources within our internal landfill gas wellfield data management application. Once uploaded, data integrates with historical data for a site. In turn, we can review landfill gas data with liquids data, surface emissions monitoring data, and the location of gas collection system piping and extraction devices. The ability to query the data for specific parameters also helps us manage our client's wellfields and maximize landfill gas extraction.

EBJ: Which digital platforms has SCS adopted to improve collaboration among employees and with clients?

Hostetter: We use Microsoft Teams to communicate with our internal and external teams. Yesterday alone, I had Teams meetings with people in California, Alaska, Wyoming, Kansas, New York, Pennsylvania, Wisconsin, and Alberta, Canada. Beyond meetings, we use it to share files, collaborate, and communicate effectively. We use SharePoint with limited AI developed by SCS for our intranet. The AI helps SCSers find internal resources, training, or staff with specific skill sets. After over 50 years, we've accumulated valuable insight, practices, and culture to pass along to our younger professionals and for them to share their ideas with those with tenure. Having access to knowledge and open communications helps us continue innovating.

We also use our SCSRMC.com platform to enable our distributed engineer-

ing and O&M teams to have one source of truth for their facility data. We use the platform to review and analyze data, make intelligent and proactive decisions, and then implement those decisions via remote operational adjustments.

EBJ: How rapidly are the industry and public agencies adopting these types of platforms?

Hostetter: The industry is quickly adopting both of these platforms. Teams is the de facto leader for online meetings and engagement. Similarly, public agencies and private enterprises nationwide are adopting the SCSRMC.com platform.

We can create images from the integrated data to view underground conditions, pump locations, liquid levels, and gas concentrations. Then we can virtually walk through a landfill and view each well.

One of the biggest ways we see the public engaging with this type of technology is via response to aerial methane monitoring surveys. The public is very interested in the results presented. This engagement seems to drive public agencies to adopt new methane monitoring technologies and regulations. We've collected data via satellite, drone, and hand collected at the same landfills. The results show all three methods work, and the data is consistent.

EBJ: How does the data ecosystem need to evolve and expand to support the next generation of compliance and problem solving?

Hostetter: We've seen the data ecosystem expand greatly due to the accessibility of field data through RMC systems. That said, we need more data and more tools to process this data. We need lower-cost hardware so that we can continue to achieve this.

We're encouraged to see regulators moving toward working with industry to approve newer monitoring technologies that enable the industry to continue lowering greenhouse gas emissions. Currently approved technologies give an incomplete picture of emissions and drive the industry toward meeting regulations, not holistic greenhouse gas emissions reductions.

EBJ: How is advanced imagery adding value to our industry? What new technologies are coming to market, and how will they evolve over the next five years?

Hostetter: Continuing with the theme from the previous question, tunable diode laser (TDL) methane monitoring technology, particularly when paired with drones, is an industry-changing technology enabling facilities to routinely get an accurate picture of where they emit methane. Facilities can then use this data and the pictures and topographical data from the drone to rapidly repair the identified issues.

In the next five years, drone-based monitoring will become ubiquitous. We'll also see states and some large county governments and corporations implement their own satellite-based methane monitoring technologies. Using data, who would have thought we could see underground conditions three years ago? Now we see in 3-D the locations of pumps and liquid levels, silt, and other conditions that could interfere with capturing methane.

Brynda: Images are extremely valuable now and will only get better as technology improves. We are a very visual species. Data tells a story, and data mapping paints the picture. We can often see issues through data mapping first, which leads us to dig deeper into the tabular data. For example, we can create images from the integrated data to view underground conditions, pump locations, liquid levels, and gas concentrations. Then we can virtually walk through a landfill and view each well. We know what is wrong and where and who to send to fix it. Diagnosing and fixing more common issues creates more value and convenience for more clients.

EBJ: How is the industry leveraging emerging capabilities in artificial intelligence to lower costs and increase insight?

Hostetter: AI is coming to industry, but it's not quite ready for wide-scale adoption due to several factors, including the validity of the produced "intelligence," costs, intellectual property, and data security concerns. Before wide adoption, we need to get accurate AI systems that don't produce incorrect responses, are less expensive, and have addressed data ownership concerns. We have always been very protective of our clients and their data. We are studying how to apply AI's potential to our work and systems, but as with everything we do, it must prove to work safely and scale for industry.

EBJ: Tell us about the technologies that SCS has developed recently for the solid waste industry and renewable energy?

Hostetter: Our SCS Remote Monitoring and Control (RMC) technology was conceived and developed specifically within the solid waste industry. From its beginnings here, it is useful in the wider renewable energy and environmental industry.

It's a cloud-based system that allows users to operate and manage their facilities from anywhere with an internet connection. It's their one source of truth and one location that they go to understand their facilities and make changes to how their facilities are operating. It's their facility dashboard and control room.

To create this technology, we combine capabilities from supervisory, control, and data acquisition systems (SCADA), geographic information systems (GIS), and remote monitoring technologies (e.g., drones, satellites, planes, etc.) into one packaged seamless system.

Users access the system from their phone, laptop, PC, tablet, or anything with an HTML-5 web browser. They view live and historical data, aerial imagery, and data, receive alarms and automatic reports, and use this information to control their facilities from anywhere proactively. We've seen simple payback periods of as short as three months with SCS RMC systems.

Brynda: We have continued to add data review tools to our landfill gas wellfield data review applications through customizable analytic reports, parameter and filter maps, and trend charts. These tools

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