Imagine a world with sensors that offer recycling managers a minute-by-minute look at how much material residents are tossing in carts and that advise truck operators of the best routes for collection. Or where food waste from industrial kitchens is turned into a soil amendment for an on-site garden that grows the food for the kitchen. Or even where systems of underground pipes suck away waste and recyclables from dense urban districts and deliver them to remote processing facilities.

You may think that’s all “Jetsons” material, but thanks to a raft of cutting-edge technologies, such innovations are already becoming a reality both in the U.S. and around the world. Faster computers, wireless sensors and “big data” aggregation techniques are together spawning a smarter, better breed of materials management systems.

The abundant information we can now cultivate when it comes to waste diversion can help firms and municipalities open the door to operational cost savings, more intelligent commodity pricing, reduced carbon emissions, improved impacts on customer behavior and greater protection against weather and unforeseen risks.

With those possibilities in mind, here are a number of the technologies that have our caught our attention in recent years. This is not an exhaustive list, but it should give readers a flavor of how the recycling industry can use digital tools and analytics to revolutionize operating efficiency.

From data to diversion

A number of emerging enterprise systems are starting to bring big data to life for communities and large organizations, and the pillars of these systems are dashboards, real-time tracking and forecasting functions.

Computer giant IBM, for example, recently began a research pilot program for its Intelligent Waste Management Platform, which is based on IBM’s Smarter Planet suite of services. This system features analytic and dashboard tools that enable faster and more insightful decision-making to improve waste diversion, reduce operations costs, and where applicable, increase income. It’s being tested with select municipal and corporate partners internationally with the aim of automating data collection and improving data integrity.

Another data organization innovation is Emerge Knowledge’s ReTRAC Connect Tracker, a tool that allows operators to move off of traditional spreadsheets and begin tracking figures using a secure Web-based system that is backed up on a daily basis. The Tracker enables comparison of data across all of an organization’s locations and gives users the ability to chart performance at a system-wide level, building level or even at a bin-by-bin level.

A third tool in this realm is the ECO Diversion Calculator, which our firm, Cascadia Consulting Group, developed with Emerge Knowledge. It’s a Web-based waste optimization tool that makes commercial waste audits more efficient for outreach staff at municipalities, universities and other commercial and institutional organizations. Leveraging more than $2 million in waste characterization data, the calculator determines site- and sector-specific benefits of increased waste reduction and diversion in terms of cost savings, material diverted and greenhouse gas emissions eliminated.

The wise manager will look to adopt systems that integrate data from haulers, customers and local municipalities to get a holistic understanding of the waste stream.
snapshot of a given waste sphere. Each of the systems described above, when fully utilized, can enable more informed decision-making while creating beneficial cost and operational savings.

A sensory experience
We'll now shift from technologies focused on entire systems and get down to the individual receptacle or container level, where sensor innovations have recently undergone a remarkable evolution.

An increasingly diverse array of sensors provides wireless measurement of volumetric fill levels using ultrasonic sonar or optical technologies. In addition to fill-level sensing, these devices include motion sensors, allowing the devices to track when bins are emptied, as well as temperature sensors, which help alert users of fires or chemical reactions. Furthermore, RFID (radio frequency identification) technology enables bin-specific information and location tracking to help manage fleets and inventories on a real-time basis.

Enevo, Compology and Smart Bin are three brands in this sector that are pushing forward in the U.S. market. Each offers small sensor devices that can be mounted in nearly any kind of container, including tanks for liquid wastes. These companies use software-as-a-service models in which customers pay a monthly or annual fee for access to a Web portal. From there, subscribers monitor real-time fill-level data on each container and can use the portal’s routing software to maximize collection efficiencies.

Though implementation of such services is only just beginning, pilot program communities have thus far realized 20 to 50 percent collection-related cost savings when using these sensors and their accompanying dynamic routing capabilities.

The hardware pieces behind these technologies feature long battery life (over 10 years, thanks to lithium components) and are highly durable – some are cast in polycarbonate and can withstand extreme temperatures and conditions, as is typically required for a device that is mounted within a collection container. The standard measurement intervals provide about one reading per hour, and data is automatically uploaded using a cellular network.

Some of these systems have already been in use in Europe for several years. Pilot initiatives for some of these technologies are under way in North America currently, and are likely to see widespread adoption as the waste industry moves toward a model where dynamic routing is a reality.

An organic approach
On the food front, data management advancements are quickly opening new pathways for organics generators as they strive to identify and reduce waste.

An appliance developed by WISErg, for instance, offers a technology solution that combines on-site organic food scrap management and a Microsoft Azure cloud-based business analytics and reporting system. The system includes a piece of equipment dubbed the Harvester, which utilizes built-in cameras and sensors to record and track the type of food loaded into the machine along with details such as weight, time and ambient temperature.

Another food scraps-focused technology is MintScraps, a New York-based startup offering organics management dashboards that help food service businesses affected by New York City’s organic recycling regulations. The application tracks and manages organic scraps diversion, collection and related costs.

A third entrant in this area is Carbon Foodprint. This proprietary tool was developed by WISErg, for instance, offers a technology solution that combines on-site organic food scrap management and a Microsoft Azure cloud-based business analytics and reporting system. The system includes a piece of equipment dubbed the Harvester, which utilizes built-in cameras and sensors to record and track the type of food loaded into the machine along with details such as weight, time and ambient temperature.

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A photo uploaded to Litterati's Digital Landfill project, which harnesses social media to document and reduce improper discards.

IBM’s Intelligent Waste Management Platform is currently being tested by municipalities and aims to more effectively organize disposal data for cities and companies. It’s one of several such systems presently in development.

Notes from the underground
Perhaps the most attention-grabbing (and farthest-fetched) possibilities in waste management technology bring the entire collection process underground. Some subterranean systems have actually existed for decades but are primarily in use in other countries – in Europe, the Middle East and Asia – though the idea has garnered some support in the U.S at places such as Disneyland.

The International Solid Waste Association (ISWA) published a report last year on underground systems, and it gave details on automated vacuum waste collection systems, also known as pneumatic refuse collection, or automated vacuum collection (AVAC). This setup uses an underground pipe network that transports waste to a central terminus with large collection containers. The report stated 700 systems have been installed across 40 countries. The firm Envac is the largest provider of this technology and has been developing these systems since the 1960s.

In Mecca, Saudi Arabia, MariMatic is building an underground solid waste transfer network using 74 gravity chutes with over 400 chute doors that will have a daily collection capacity of 900 metric tons. Using the Metro Taifun system, material will be collected and transferred through a system of pipes 18 miles long and ultimately arrive at a transfer station, where it will be compacted into containers. Installation began in 2014 and is expected to be completed by 2017.

These suck-it-away systems free up real estate, remove the safety hazards that come with collection trucks, reduce pollution (noise and air), curb theft of recyclables and improve hygiene. As the ISWA report states, pneumatic systems offer operating cost savings on the order of two to three times that of conventional collection.

However, the approach has some obvious limitations as well. The upfront capital investment can be 30 to 50 percent more than the traditional surface collection model, according to the ISWA report, and the model is not useful for bulky items.

The subterranean model may be a particularly compelling consideration for campuses and urban districts where space is at a premium and where there is sufficient density to support system costs and investments.

Closing the loop
With this wide range of technologies bubbling up in the materials management space,
not all ideas will be suitable for every firm or municipality. When viewed together, however, these innovations point toward a future where each may play its part helping the industry more effectively close the loop on waste.

By putting systems to work to analyze and harvest big data, we can make informed planning decisions about how to best produce and distribute goods while enhancing end-of-life collection. In addition, we can capture more of the value in discarded materials through smart reuse/recycling bins and tools that facilitate redistribution of surplus items and even influence customer behavior at the bin as we move to a true pay-as-you-throw model.

It’s worth noting that the biggest barrier to wider scale implementation of these emerging technologies will likely be collection and processing contracts that are structured to maintain the status quo, especially in terms of the financial models and pricing. There is an opportunity for public-private partnerships to develop and test new contracting standards and accompanying pricing models that create win-win situations while minimizing downside risks.

As demonstrated in many other industries in recent decades, the players that harness technology to bolster efficiency and keep pace with consumers are often the ones that end up coming out ahead. We’ve laid out some of the innovations that offer great potential, and now we challenge you to find the right systems to move your own organization forward. RR

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