Recycling Online

The robots are coming (maybe)

by Roger Guttentag

The supply side of recycling always aims to achieve the most efficient combination of collection and sorting. Initially, sorting was part of the collection system and recycling facilities were primarily focused on materials consolidation and transfer.

However, starting in the 1980s, the sorting task slowly shifted to the receiving sites that evolved into the modern materials recovery facility (MRF). Current MRF process flow designs rely on electro-mechanical screening systems supplemented, where needed, by manual sorting. The most advanced MRF designs also incorporate the use of programmable sensors to enable high-speed sorting of specific materials such as plastics and glass.

The next stage of sorting is now starting to emerge through the application of industrial robotic technology to combine sophisticated sensor arrays with programmable mechanical grippers to sort mixed material streams. Since a potential impediment to understanding this topic is the technical terminology used to discuss it, I recommend bookmarking a reference glossary such as the one on the Motoman Robotics site.

The sorting challenge

While there are some incredibly sophisticated robots that have been developed for applications such as space or underwater exploration, the vast majority of industrial robots are used to handle repetitive tasks over a sustained period of time with a very high degree of accuracy – think welding or painting. Auto manufacturing, not surprisingly, is one of the largest markets for industrial robots.

The task of sorting, on the other hand, represents an enormous challenge for industrial robotics as made clear in a recent article available of the website of *Design Engineering*. The material stream in a MRF is highly variable, requiring a sophisticated sensory and artificial intelligence system to differentiate correctly the items to be sorted. In addition, a robotic sorting system needs to be able to pick items with widely differing geometries, adjust its manipulators to apply the correct grip on the material being picked, and then place the picked item into the correct receiving bin.

Zen and the art of sorting

ZenRobotics, located in Helsinki, Finland, is one of the first companies to offer a commercially available recycling system incorporating industrial robotics technology for the sorting of construction and demolition (C&D) waste. Information on how the ZenRobotics Recycler works along with videos showing it in operation can be found on the company's site. According to ZenRobotics, testing of its system has been in progress in Finland since 2011. Additional photos showing various aspects of the ZenRobotics Recycler system can be seen in a June 2013 Business Insider article.

The system is based on using commercially available robotic and sensor technology that is linked and managed by a proprietary artificial intelligence capable of addressing the sorting challenges discussed earlier. The gripper utilized by the arm for the ZenRobotics Recycler was also developed by the company specifically for handling C&D materials. The capacity of the system has been reported to be about 10,000 tons per year.

The first of the systems to be installed outside Finland will be operated by Baetsen Recycling near Eindhoven, in the Netherlands. According to Baetsen, the first Recycler system will replace five manual sorters. In recent years, the company says, worker recruitment has become more challenging and high turnover rates added to training and productivity costs. Baetsen plans to eventually transition completely away from a reliance on manual C&D sorting using the ZenRobotics Recycler systems.

Other robotic developments

Bremen University Robotics Innovation Center ROSA Project – This project was conducted between 2009 and 2011 and looked to develop a robotic C&D sorting line that works in a similar fashion to the ZenRobotics Recycler system.

ERO Concrete Recycling Robot – This is a 2013 Industrial Design Education Association winner by a student from Sweden's Umea Institute of Design. The robot, after conducting a sensor analysis for determining the optimal processing route to take, uses a high-speed water jet to disassemble concrete structures. The concrete aggregate slurry is then moved by vacuum suction to a bag container for transfer to a reprocessing unit. The water in the slurry is then reused for the robot's cutting jets.

MetroSense RFID Waste Sorting – This system is based on the concept of providing RFID strips that identify what materials are placed into a plastic bag. The bags, with different material contents, are collected together and then sorted by robotic arms, which use the RFID tags to determine bag contents. The bags are then opened and the contents processed with the bags being recycled as well.

Osaka University Advanced Photonics Center Plastic Sorting Robot – This robotic system, which was announced in 2010, is being tested in Japan and uses a laser sensor array to identify and sort six different plastic types.

Robotics by Bollegraaf (RoBB) – According to Bollegraaf, the RoBB will be capable of sorting different grades of plastics and paper. The unit is currently being tested by Hanbury Plastics Recycling in Stoke-on-Trent, England.

On the road

In general, the robotics applications discussed in this column are focused on the processing side of the recycling supply management system. However, we should not forget that the collection side can also benefit from the application of robotics technology. While there has been a lot of news coverage over the development of driverless cars by companies such as Google, many knowledgeable technology observers predict trucking will be the first area where driverless vehicles truly emerge – the topic is covered well in an August 2013 *Tech Hive* article.

Collection routes would be an excellent candidate for experimentation in this area: The collection process requires following standardized routes on a consistent and accurate basis. In addition, since the collection trend is favoring the use of automated vehicles, it is not far-fetched to consider upgrading the collection arm into a robotic one that is guided by sensors located on the truck or micro devices embedded in the cart such as a RFID chip (which is already being done today for other purposes in smart carts).

Web Address Directory

Baetsen Recycling – ZenRobotics Recycler	tinyurl.com/ZenRecycling
Bollegraaf Recycling Solutions – Robotic sorting	tinyurl.com/BollegraafRobotics
Core77 – ERO Concrete Recycling Robot	tinyurl.com/Core77Robot
Design Engineering	tinyurl.com/DE-Robot
European Commission – Research Project on Robotic Recycling Sorting	tinyurl.com/EC-RecyclingRobot
MetroSense – RFID based Waste Sorting	tinyurl.com/MetroSenseRFID
Motoman Robotics – Glossary of Robotics Terms	tinyurl.com/MotoGlossary
Robotics Business Review	roboticsbusinessreview.com
Robotics Online	robotics.org
Japanese plastics recycling robot	tinyurl.com/JapanLaserRobot
Tech Hive	tinyurl.com/DriverlessTrucks
Wikipedia – Industrial Robot entry	tinyurl.com/WikiIndRobots
ZenRobotics Recycler	zenrobotics.com
ZenRobotics Recycler – Business Insider	tinyurl.com/BI-ZenRobotics

Effects on the workforce?

The recycling and waste management industry, not surprisingly, is now tentatively dipping its toes into waters that other industries know well. For this reason, don't expect any near-term radical changes in how recyclables are collected or processed. However, there is no question these changes are coming and they will permanently affect how recycling work will be done and who will do it. The recycling and waste management industry has historically been one that has provided good career opportunities for people with modest educational credentials. However, as the industry evolves to incorporate higher technologies like robotics for competitive reasons, employment opportunities may steer principally to those with advanced vocational or academic training.

Roger M. Guttentag is a recycling and solid waste consultant located in Harleysville, Pennsylvania. He can be contacted at (610) 584-8836 or rguttentag@comcast.net. Guttentag has a website, recyclingandreuse.com, which houses all of his Recycling Online columns and other resources for recycling professionals of all stripes.