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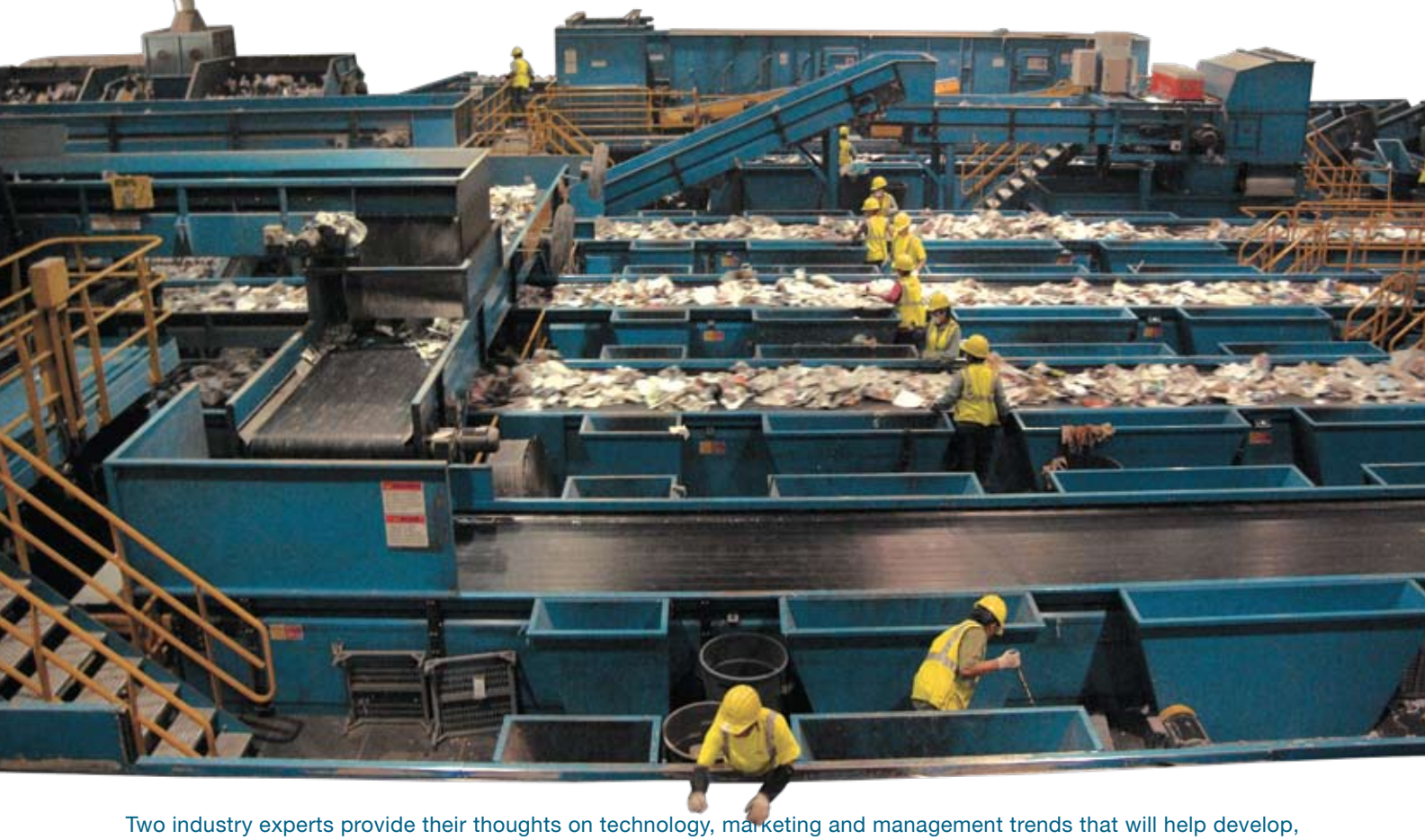
RESOURCE RECYCLING

THE MRF OF TOMORROW



Two industry experts provide their thoughts on technology, marketing and management trends that will help develop, and progress, the materials recovery facility of the future.

By Nathiel Egosi, P.E. and David Weitzman

The materials recovery facility (MRF) of tomorrow is a product of over two decades of continuing development in technology and an ever-increasing sophistication of management techniques. The evolution of technology, from primitive facilities for baling multi-source-separated grades to today's modern single-steam facilities capable of processing in excess of 100,000 tons per year, is, in itself, an interesting history worthy of a work much longer than this article.

However, what we have learned from that history is that the programs, processes and business of recycling residential- and commercially-generated recyclables has continued to become more and more complex, while, at the same time, growing immensely. Though there is little reason to believe that direction will change after considering all the factors, what can we glean from today's trends to project the future?

Changes in material composition

Every day we are made aware of the shrinking world of print media. This publication, in its January 2010 issue, editorialized about the decreasing advertising levels and overall decline in the number of pages in industry periodicals. While some of this is due to the recession that plagued the country in 2008 and 2009 (and continuing in 2010), we read or hear of numerous consolidations and downsizing in the magazine and newspaper business.

Newspaper has traditionally accounted for approximately 60 percent of the weight of residentially-generated recyclables; however, we believe this will decline in the future. Prominent fiber industry researcher and forecaster, Lauri Hetemaki, of the Finnish Forest Research Institute, noted in the organization's 2008 *Structural Change of Communication Paper Markets and the Implications* report that, "The forecast shows that newsprint consumption would decline from 8.4 million tons in 2007 to 2.9 million tons in 2020. In reality, there is likely to be even large variation around the trend, and the trend itself could change, particularly the further away in the future we look." Figure 1, from the same report, graphically represents this possible scenario.

It is impossible to predict the actual number in any given year.

Additionally, the rates of decline will vary according to current conditions and, of course, will never reach zero. However, we are seeing the beginning of the end of the age of print media.

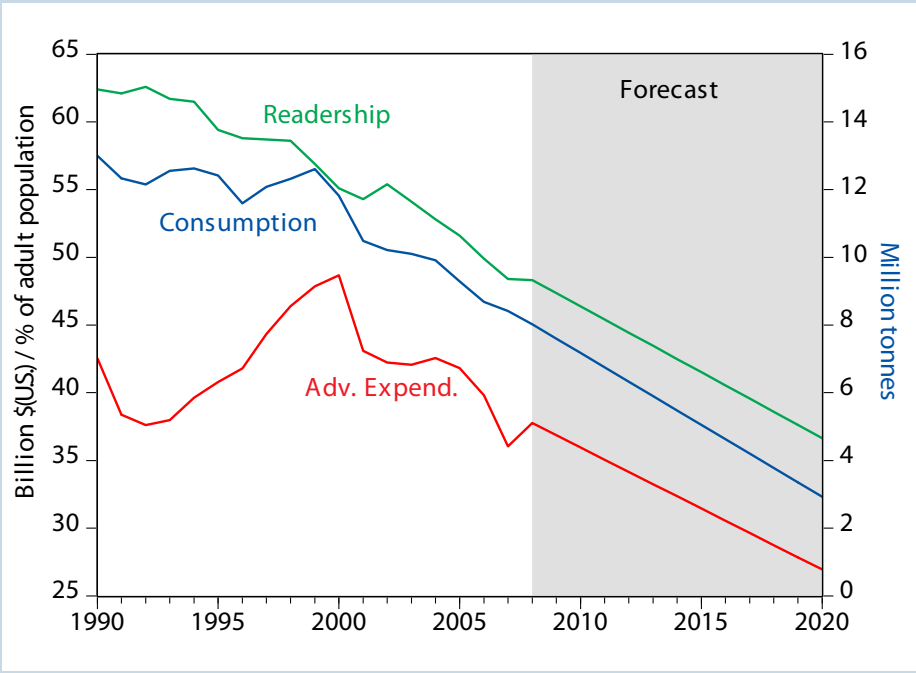
Offsetting the trend of declining newspaper consumption, to some extent, is an ever-increasing amount of old corrugated containers (OCC) in the residential stream. Figure 2 (on page 16) displays the percentage of online sales as a percentage of all sales. In terms of MRFs, this trend manifests itself as ever-increasing percentages of OCC, as more and more products are delivered to our residences in cardboard boxes.

Early MRF design relied on high percentages of old newsprint (ONP) input, which require modest levels of processing in exchange for a reliable market price. Operators enjoyed low operating costs for this stream, helping to offset the much higher cost to process commingled containers. Widespread interest to add materials led to the addition of OCC and virtually all paper grades, resulting in MRF designs that include an OCC separation screen. The screen's effectiveness relied predominantly on OCC being generally oversized with the incoming residential mixed paper (RMP) stream, retaining the same high content of input ONP. Proportions of OCC typically were less than 25 percent of the incoming stream; however, with the above-mentioned ongoing trend, many facilities are observing the ONP/OCC ratio quickly moving to 1:1. A MRF design with a reliance on an OCC separator, with a negative sort of ONP after a manual sort for missed OCC, is declining in effectiveness.

The MRF of tomorrow will require additional technology to remove more outthrows from ONP, in order to maintain that grade and allow the MRF to operate at the original design throughput. Until then, systems will either need to operate at lower throughput rates, add more manual sorters and/or reduce production of the ONP grade; of course, this does not bode well for the bottom line, in particular, when more work is required to process less material. Naturally, paper mills are seeing this consequence in bale quality. Continued development of automated sorting of outthrows is needed, as recent efforts in optical sorting have not produced the best results, though they are promising. Other types of mechanical separation are now in development, attempting to reliably overcome the challenges of a heterogeneous mixed stream.

Tomorrow, we will see further equipment developments to restore the low cost of producing the ONP grade; however, we feel that time is against this possibility, given the parallel shift of ONP decline. Consequently, the future MRF may produce small amounts of the ONP grade while shifting toward other paper grades serving packaging uses. Interestingly, we also expect ONP demand to grow while its supply shrinks; this too will change the MRF operations that previously considered ONP as a mid-level commodity value.

Figure 1 | U.S. daily newsprint consumption, readership and advertising expenditures, 1990-2007 (forecasted to 2020)



Source: Finnish Forest Research Institute, 2008

Additional materials for recovery

Municipal planners and officials at both the state and local levels are continuing to adopt management policies for increased diversion of materials. This effort has been backed by the passage of state recycling acts that mandate specific diversion rates. In terms of MRF materials, this may mean the widespread addition of diverse materials, including plastic film, all plastic containers (e.g., pill bottles, cups, trays, Nos. 3-7, etc.), rigid plastics (e.g., toys, buckets, packaging, etc.), aseptic containers, wood, batteries, and even scrap metal. Many communities have already shifted in this direction. This trend will require that the MRF of tomorrow be equipped with a full service pre-sort area, additional sorting equipment to remove materials that are not compatible, with traditional downstream processing systems, and a higher level of training for sorting staff.

For example, film plastics are being manually removed and conveyed via pneumatic systems to holding bins prior to densification. Further market development is needed in this area in order to establish greater demand. The practice of plastic film recovery will become standard in MRF design. Similarly, non-container or oversize plastics can be manually removed for further processing. Also, downstream residue processing systems will be needed to recover the small plastics, such as the plastic pill bottles and trays and small metals such as batteries. Overall, MRFs will be producing more grades of materials servicing a more diversified group of buyers. This offers challenges in bale storage, while

also requiring operators to be far more knowledgeable regarding market specifications. This is the path for greater diversion and recovery. Thus, without these tools, a MRF will be greatly challenged in the market.

Glass: To sort or not to sort

Most dual-stream MRFs color sort glass into three or more colors. It needs to be noted, though, that, even with these sort systems in place, typically, over 50 percent of the glass containers are not sorted, because the containers are broken in the collection process, or on the MRF tipping floor, and become mixed broken glass under the best of circumstances. And, unfortunately, efforts to optically sort glass at the MRF have proven largely uneconomical; we see this trend continuing. Our experience tells us that, each time a commingled stream of material is handled, approximately 50 percent of the whole glass containers that come into a facility unbroken will eventually end up broken.

With single-stream processing systems, the problem can be exacerbated by the use of vehicles designed to compact recyclables after pick up. With that being said, there still remains in the U.S. a robust industry of intermediate processors that economically sort and beneficiate glass into furnace-ready cullet. These sophisticated operations are centrally located in each region of the U.S. and use optical and metal detection technologies to color sort glass and remove contaminants. We believe the trend for glass will involve more MRFs being required to remove all glass as far upstream in the sorting process as possible.

While much of this glass will be processed on-site into aggregate based products, measurable amounts will still find their way to the facilities able to beneficiate the glass. We also see more glass moving toward higher end-uses, such as sand blasting medium. One of the important trends in glass marketing is the inclusion of glass cleaning systems, in particular for single-stream MRFs challenged with significant quantities of paper shreds. With increasing demand for recovered paper, lower residues and higher disposal, we expect the paper removed from glass to be recovered for marketing, though plenty of work will be needed to demonstrate to a mill that the paper is not embedded with fine glass particles.

Separation screen design: The evolution continues

Prior to the installation of the first dedicated OCC screens in the early '90s, MRF screens primarily consisted of a vibratory or shaker type design, or trommels, used mostly to remove mixed broken glass from the container streams of dual-stream MRFs. OCC screens employed the first use of disc screens in our industry, and this concept was quickly adapted for use in the first single-stream systems in the mid '90s. Single-stream screening technology has evolved over the past 15 years to include multiple screens of various sizes, disc shapes, speeds and angles oriented in series to bring about more effective separation of containers from fiber, glass breaking and removal, and fiber or container sizing. The basic technology of using multiple rows of rotating discs has not changed much, though reliability, maintenance-friendly features, and the quality of the output has.

The addition of certain materials to the MRF mix will necessitate the evolution of screen use and design. In addition to rotating disc designs, we see the potential for using finger screens to separate larger and smaller materials, and the further use of air knives to improve the quality of certain materials, where separating light from heavies will increase product quality. Ballistic separators previously used in MSW applications are being reconsidered and, more importantly, optical sorters used in conjunction with screen separators are gaining interest. Future technology improvements will need to address the problems of high wear, wrapping and inconsistent performance when material moisture and composition change. These screens depend not only on material size, shape and center of gravity, but also rigidity, moisture and adhesiveness. Given the many variables for each recyclable type, it remains difficult for one machine to do it all when high throughput levels are desired (above seven tons per hour). Consequently, multiple screens combined with optical sorters are bringing MRFs into the future.

Larger and larger

In the early 2000s, there were only a handful of MRFs processing in excess of 100,000 tons of recyclables per year. This included MRFs in California, Florida and Massachusetts. The 100,000-ton MRF is no longer the exception, but is quickly becoming the norm for state-of-the-art facilities.

Driven by the undeniable fact that per-unit operating costs rapidly decrease as tons go up and the increasing cost of processing systems, larger is better. The fact that the national, and larger regional, players in the MRF industry are consolidating smaller facilities, or building larger regional facilities based upon a core municipal contract, proves that this trend is continuing. Baling single-stream recyclables, as well as loose transfer, for long-haul transport to a SuperMRF (a large, fully-automated MRF that aggregates material regionally and processes diverse streams of incoming materials into a wider range of recovered materials compared to a traditional MRF) are becoming more and more popular; the added cost of transport is easily offset by the very low operating costs of a very large MRF with high automation.

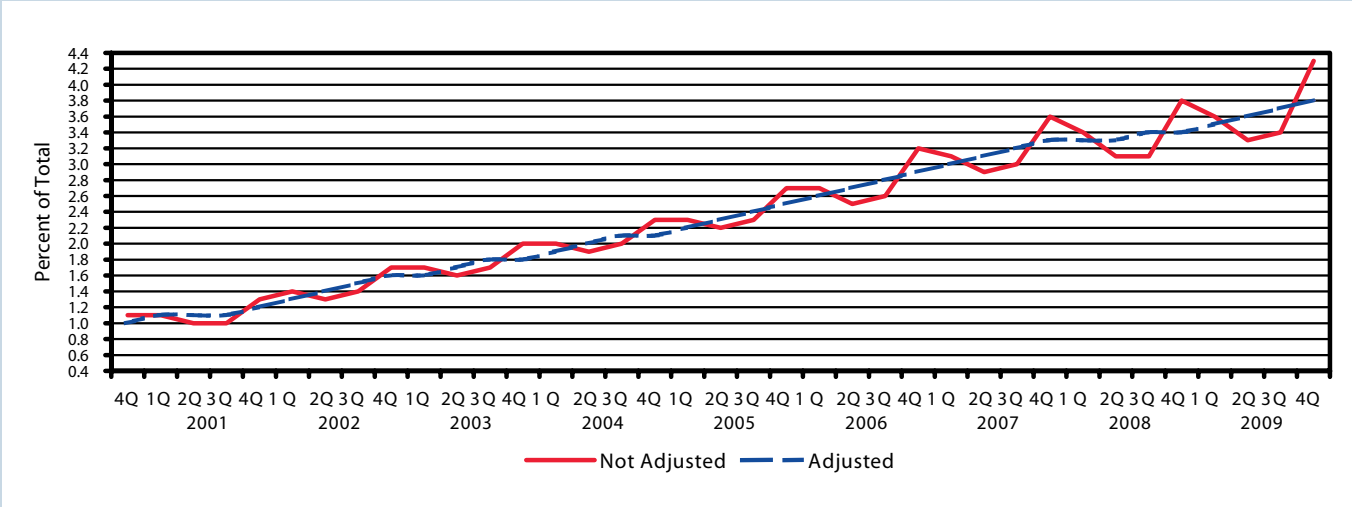
Taller and larger

A decade ago, the typical rule of thumb for MRF interior height was 30 feet – not only for the tipping area, but also for the processing area. Going forward, at least 40 feet is now desired for the processing area, and we expect plants to continue becoming vertical, with multiple floor levels for processing. Buildings are growing in size to fully incorporate bale storage indoors, as well as include adequate space for maintenance and parts storage. MRFs of tomorrow are including all the amenities to efficiently run a cost-efficient business.

The MRF as manufacturing plant

An axiom of modern management technique is, "If you cannot measure it, you cannot manage it." True or false, the modern MRF is no longer a secondary player in terms of management and ownership attention. The modern MRF represents a major investment and, whether it is competition for business and profits in the private sector or for resources in the public sector, the management of MRFs has become more professional as the years have gone by. MRF operators now know that the management of a recovery facility, like any manufacturing plant, must be governed by management systems that assure safe, compliant and efficient operations. Process controls include data logging and integration with financial

Figure 2 | Estimated quarterly U.S. retail e-commerce sales, as a percent of total quarterly retail sales (4Q 2000-4Q 2009)



Source: Source: U.S. Census Bureau News, 2010

management systems. With increased use of new technologies, personnel retention and training have, and will, continue to be a management trend. Of note is the widespread use of production standards that are increased each year through the process of continuous improvement. Employees are measured for their performance and clear expectations are established as part of their job, paralleling other industries.

The trend toward more sophisticated management systems is also seen in the area of commodity marketing. The management of most multi-material MRFs involves operators centralizing their materials marketing and logistics. One almost never sees materials marketing being conducted as a part-time side job for the facility manager; he or she is focused on reducing per-unit costs and running a compliant, safe facility. We see this trend continuing.

The standards for safety and training have continued to elevate. More attention is expected in the future for improving indoor work conditions. In particular, dust control and compliance with National Fire Protection Association standard 654 are becoming mandatory parts of MRF design. Widespread inclusion of maintenance service platforms is standard for a properly-integrated MRF design.

Reducing waste and residues

Presently, we estimate approximately half of the larger domestic MRFs process single-stream recyclables – larger equating to at least 2,000 tons processed per month. And, the debate between the believers in single-stream recycling and those who declare it unsustainable continues.

The heart of this debate involves material quality and residue generation. The issue of material quality is an unwinnable debate. There is no doubt that recovered paper from single-stream programs contain higher levels of contamination than materials recovered from dual-stream systems. In part, this is also attributed to the decline in ONP, along with the increase of plastic types included in a program. With that said, we believe three factors will tend to mitigate this problem in the future.

- The technologies involved in material separation have continued to evolve and become more efficient. More effective screens and optical technologies will help to narrow the gap between the two collection approaches.
- To some great extent, the issue of lower quality leading to lower yields at consuming mills is often an economic issue, not a technology issue. In certain markets and at certain times when demand is weak, we can foresee the possibility of multi-level pricing systems designed to allow consuming mills to, in effect, charge MRFs for lower yield materials. Such a system would quickly increase the pressure on MRF and program managers to reduce contamination levels by reducing their throughputs.
- Glass input is declining and, therefore, its presence at a MRF is being reduced by other factors.

Another trend in MRF design includes residue reduction. So much effort is put into the collection and processing of the recyclables, that the pressure to minimize residue is paramount, in particular, as disposal costs keep rising. The standard of 95-percent recovery already is exceeded by modern dual-stream MRFs, and many achieve half that amount. However, for many reasons, single-stream facilities typically operate at higher levels, with most at or above 10 percent, and, 20 percent to 30 percent is not unusual in certain market areas, too.

Residue is a function of several factors, including public education, type of collection program (automated verses manual), curbside container size and, of course, the MRF's choice of processing technology. Reducing residue is accomplished by focused efforts to reach that goal at all points of a recycling program, along with utilizing a well-designed MRF. We find public education programs to be inadequately funded and inconsistently applied (year to year, between municipalities, collection methods, etc.). On the other hand, children educated in the 90's are now active members of our communities and fully understand how and what to recycle. Nonetheless, the role of the private sector in public education has increased and is expected to grow. More emphasis in this area is expected, and

one can already see it happening with the "green movement."

MRF processes now must include added capacity to sort additional acceptable materials to realign the situation. Most interesting were recent results from plants that had installed optical plastic sorters – plastic recovery rates immediately increased and residue decreased. Other than periodic residue sampling, it was not until these units became operational that we definitively demonstrated the quantity of smaller plastics lost to residue. Much more work is expected in this area, including glass and paper recovery from the residue, in particular, as MRF plants get larger.

In summary, the MRF of tomorrow will be a product of both internal and external factors. Internal factors include continued advancements of processing equipment, while external factors involve the addition of more materials and changes to material compositions. MRFs across the United States will continue to differ, with performance data and equipment efficiencies often being incomparable from MRF to MRF and region to region. What will not change is the important place that material recycling facilities play in the future of waste management and waste reduction in our communities. RR

Nathiel Egosi, P.E. and David Weitzman are president and vice president, respectively, of RRT Design & Construction. The authors can be reached at negosi@rrtenviro.com or dweitzman@rrtenviro.com.

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