Austin AI News

Volume 1, April 2006
ISRI EDITION

Your Guide to Advanced Automated Sorting and Separating Technology For The Recycling Industry

INSIDE THIS ISSUE

Metal News

Figure 1: Post eddy current separation, metals on take-away conveyor.

Austin AI QXR-M

Technology to improve metal recovery from non-ferrous residues (NFR)

Automated Equipment Increases Asset Recovery for Shredder Operators

Existing technology has been used for some time to separate light non-ferrous alloys from heavier non-ferrous alloys; however, over the past three years, there is a significant added value in performing additional separations to recover specific high dollar alloys. Examples of such are separating pure copper from copper alloys (brass and bronze) or wrought from cast aluminum. The only way to do this reliably is by alloy chemistry. Austin AI's QXR-M, an automated tool with integrated feeder, conveyor and separation mechanics, was recently evaluated and approved as the only tool capable of processing economically viable quantities of NFR metals and accurately separating them by alloy chemistry. This same proprietary technology can also be used on the fluff line to clean up induction system output, by increasing the total metal content, removing copper from the stainless steel, and even grading the recovered stainless steel.

continued on page 3...

New Demo Facility

Opens April 1 in Austin, TX

Starting April 1, prospective clients will be able to view material separations at Austin AI's new demonstration facility at its headquarters in Austin, Texas. The facility includes state of the art QXR technology, with integrated feeder, conveyor and diverter mechanics. This unveiling is part of Austin AI's commitment to providing clients with tangible assurances of performance, specific to their materials and process requirements.

The demonstration unit is specifically engineered to be quickly configured to sort a wide variety of Metals; Plastics (RoHS and PVC/PET); Glass (CRT, glass ceramic, leaded crystal); Treated Wood (CCA, Brominated, Cu); and E-Waste and Mixed Solid Streams. Contact us with your application and arrange to see the power of the QXR technology in person.

A Word From The President...

by Rick Comtois, President & CEO, Austin AI, LLC

Welcome to the ISRI edition of the Austin AI News. Since its inception three years ago, Austin AI has successfully developed solutions to improve asset recovery and reduce waste for most processors of recycled goods. 2005 was a benchmark year for us, with the following achievements:

- Delivered a QXR-M system to the world's #1 scrap aluminum broker for sorting viable quantities of wrought aluminum by its alloy content.
- Received recognition for the QXR-P as best technology for automatically sorting engineered plastics for RoHS Compliance.
- Installed a QXR-G into Germany's #2 glass recycler to remove glass ceramic from its cullet and flat glass product lines.
- Delivered the world's first automatic Al wheel sorter, processing up to 10 tons/hr of clean wheels (no Fe, Cu, Pb, Cr contaminants).

Our commercial success is credited in part to technology, in part by corporate culture, but mostly by our people. An employee owned and operated company; Austin AI's staff respects the uniqueness of each client's requirements and realizes we are only truly successful as our products are in addressing specific needs. Our advanced analytical technology may be the back bone to solving the problem, but it is our experience in customizing a product for each user that has made the difference.

We are excited about the upside for 2006 and beyond. Come and see what the future holds for automated sorting and separating systems.

About Austin AI, LLC

AUSTIN AI
Automation & Instrumentation

Established in 2003, Austin AI is a developer, manufacturer and marketer of state-of-the-art, custom and automated Energy Dispersive X-ray Fluorescence (EDXRF) systems. We are dedicated to developing the highest quality and most cost-effective products to expand our clients' economic growth and technological advancement. We are 100% owner-managed and are headquartered in the heart of the high-tech industrial area of Austin, TX.

Business Philosophy

Operations are structured around a Resource Mobilization (ReMo) business philosophy – a commitment to provide clients cost-effective, advanced analytical technology and services. Optimal price-performance ratios are achieved through efforts in three areas; (1) focusing on business within areas of employee experience and contracting outside these areas from experts within the analytical community, (2) partnering with component manufacturers for discount prices, and finally (3) encouraging clients to participate in projects via contribution of labor and expertise. The end result is a customized system placed with a well trained client, for a high degree of customer satisfaction.

Team & Experience

No other company has the depth of knowledge and experience in XRF product and market development as the AAI team. Over the past 20 years, AAI founders and employees are responsible for growing several small instrument and analytical companies in a highly competitive marketplace based upon sound business practices and creative application of technology. A small sampling of the history of successes enjoyed by the AAI principals includes:

- Successful start ups: VHG Labs, UTILE, and USR
- Successful MBO's and/or rescue: Jordan Valley AR, Image Concepts
- Developer or co-developer of automated plastic bottle sorter; automated CRT glass sorter; system for measuring S in crude and refined fuel process streams; automated plating bath analyzer; on-line raw meal cement analyzer; on-line salt in snack food analyzer; plus a wide variety of real time chemical process stream analyzers
- Published over 30 technical papers, invited speaker for many worldwide seminars, SBIR contracts awardee, USCC Blue Ribbon Enterprise Award winner, exposure to CNN Business Today and several national business magazines

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Widely used by automotive shredders, eddy current systems provide a first pass metal/non-metal separation on the NFR. A long-throw splitter or additional eddy current can be used to further separate the aluminum and copper products from the mixed metals fraction. Though these products can be separated, comingling is expected. The separated piles of materials if further split, would result in higher profit margins. For example, at the time of this writing pure copper is selling for approximately 33% over mixed copper based alloys.

Low zinc bearing aluminum is a similarly valued commodity by secondary smelters specializing in low alloy wrought material. Shredder profits increase by selectively targeting these high market value materials for individual resale. Additionally, fixing a reliable relationship with a more local secondary smelter goes a long way towards securing future stability and profits as a hedge against the uncertain Chinese market demands.

Recently introduced induction systems are being used to recover stainless steel from the waste (or fluff) line from the first eddy current. Due to low recovery efficiencies, it is common practice to reprocess products two, or even three, times to achieve a material stream containing 80% or better metal content. Although the recovered stainless steel contains a significant portion of fluff (<20%) and copper (poisonous to stainless reprocessing), it is deemed economically viable saleable material. A cost justification of 6 months or less would be realized by most yards by adding a tool that 1) increased the weight % of stainless steel; 2) eliminated—or reduced—the copper content; and 3) could grade sort the stainless steel.

Austin AI recently commercialized the QXR-M, an automated X-ray fluorescence spectrometer based sorting system, to complement and improve upon eddy current and induction sorting capabilities. The system was evaluated by one of the largest Aluminum Processors and Scrap Metal brokers in the US. In comparison to other methodologies, the QXR-M proved to be the best in accuracy of separation, versatility and throughput volumes. The company has since purchased a system dedicated for high volume (~ 5 ton/hour) scrap aluminum separations.

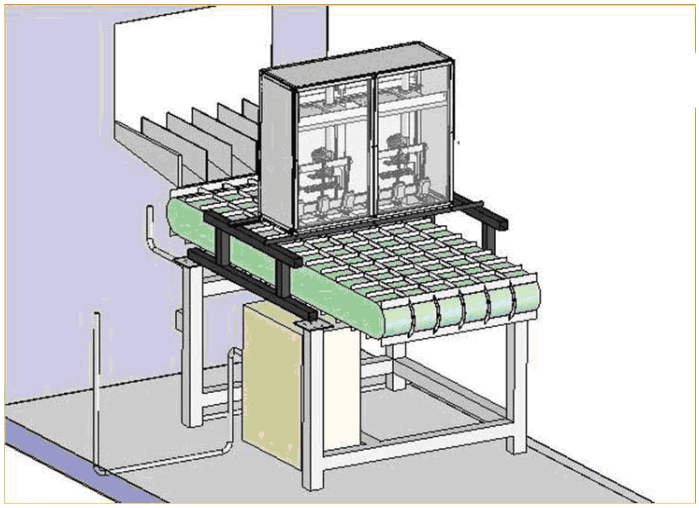

Figure 2: QXR-M Multi-channel System

The QXR-M is based upon a spectrometric technique known as Energy Dispersive X-ray Fluorescence (EDXRF). The technique employs X-rays to stimulate fluorescence, which provides elemental composition information. The energy of the fluorescence identifies the element(s) present, while the intensity indicates concentration. The technique is ideal for real-time measurements of moving materials – being fast, non-contacting, and, in most cases, equally accurate on clean, wet, dry, dirty or painted material.

The QXR-M is composed of a conveyor-mounted XRF spectrometer with integrated infrared (IR) camera. The camera determines the presence of material, while the XRF device determines elemental composition. The results actuate a paddle-type diverter down line of the spectrometer, which directs the materials to the appropriate collection bins or take-away conveyors. LSI paddle diverters are most desirable for their reliability and accuracy, yet as with other components, the user will have options that best suit their unique operations.

Figure 3: QXR-M paddle diverters, manufactured by LSI, shown mounted over pocket-conveyor belt.

High-speed, high-volume singulation of material is also performed prior to analysis by the QXR-M to aid diverter mechanics and achieve overall spectrometric separation accuracies in the range of 95 – 99 % for the aforementioned applications, regardless of cleanliness or wetness of the material.

That XRF has been successfully employed as a tool for metals analysis is not new, or exciting. The first QXR-M pre-production system developed was installed nearly 6 years ago and is still in use. The true value added by Austin AI to this mature technique include: the software programs containing the deconvolution algorithms, signal processing, and speed of decision. To illustrate this, the laboratory person has been analyzing metals for decades by XRF with measurement times of 30 – 300 seconds per sample . In the last 5 – 6 years, a new generation of handheld- XRF devices have opened up a $100 MM per year industry. These devices are good screening tools that are portable, reasonably accurate and measure material manually, one at a

time, and take 3 – 10 seconds per measurement. Austin AI's QXR-M technology can perform nearly 100% of the applications that these hand-held devices can do, yet it is totally automatic (feeding, analyzing, and sorting by class), can process tons of material per hour, with individual measurement times under 100 milliseconds!

Figure 4: QXR-M multi-channel feeder with pocket conveyor belt, for high-speed singulation of materials.

To run at optimal throughput speeds, like eddy currents, the QXR-M works best on pre-sized materials. Examples are ½" to 4", or 4" to 8" cuts from any size classifier such as trommel or shaker sieve. It is recommended, for optimal processing efficiency, to run down-stream of the eddy current or induction sorter to further increase material value by isolating the highest dollar materials in the recovered metal stream. Rick Comtois, the President of Austin AI, notes, "QXR-M selection parameters are easily modified to perform new selections based on market conditions. While copper, aluminum with low alloying zinc, or graded stainless steel may be interest today, in the future it could be a different metal or alloy grade. The beauty of the QXR product line is that the software program can be easily and quickly changed by the customer, in the field, to screen product by those new criteria. No additional cost or additional hardware is required."

The main interest for shredder facilities is in improving recoveries of high valued metals; though other applications of the technology have been developed. An example of which would be engineered plastics. Found in automobiles, most of these plastics are petroleum based, easily recyclable, and expensive in their virgin state. However, the European Union has promulgated legislation (RoHS , ELV and WEEE) restricting the reuse of materials containing certain metals formerly used as fire retardants. In fact, these laws mandate that such plastics must be treated as hazardous waste. Processors of these plastics thereby have a double incentive to sort to maximize their value of "good stuff", and minimize the amount of material (RoHS) that is a liability and must be treated as HazMat with its related high cost of disposal.

The QXR core technology can easily be applied to this industry's needs, as well as glass recycling (removing Pb crystal and Glass Ceramic); e-waste (metal, plastics, and CRT glass); wood recycling (removal of toxic wood preservatives); and even trash prior to burning in a WTE facility. Austin AI already has several endorsements backing the QXR performance claims, which include winning product evaluations and orders from top aluminum processors, plastic reclamation and processing partners, and glass recycling operations.

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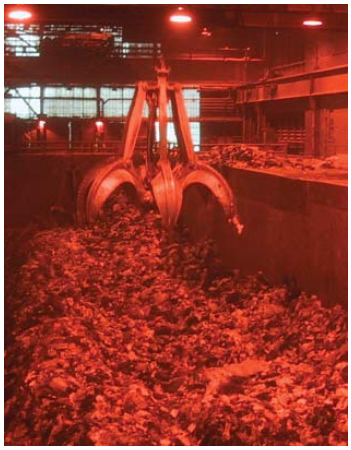
[1]London Metal Exchange, Copper ($2.35/lb) and Brass/Bronze ($ 1.565/lb) prices as of 21-March 2006.
[2]LSI Electronics, Siemensstrausse 22b, D-61130 Nidderau, Germany.
[3]ASTM Standard E1476-97, Guide for Metals Identification, Grade Verification, and Sorting.
[4]European Union Directive 2002/95/EC on the Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS).
[5]European Union Directive 2000/53/EC on End-of Life Vehicles.
[6]European Union Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE).

WTE News — One Man's Garbage Is Another Man's Treasure…



Many Waste-To-Energy (WTE) facilities primary goal is to reduce the volume of materials headed for land-fill, there is significant value in refuse.

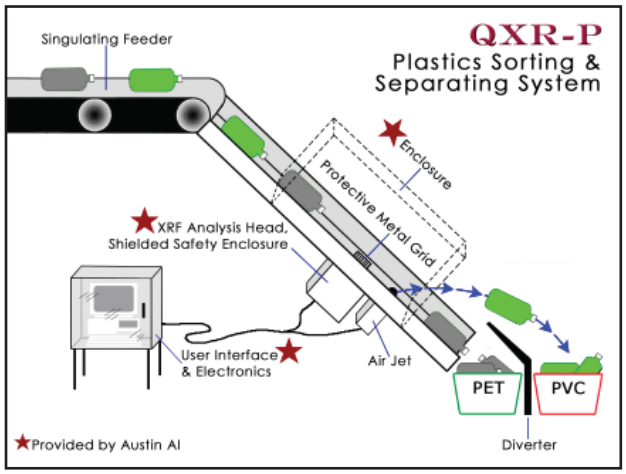
Facilities using pre-furnace processing equipment generate a revenue stream via material recovery. Plastics, metals and glass materials, when adequately separated can be resold to recycling organizations for sizeable profit. For example, typical post consumer waste contains >1% iron and even more aluminum. For facilities receiving 1 million tons of trash yearly, there are approximately 20 million lbs of Al valued roughly at $0.35 per pound, and 10,000 tons of ferrous material at $50 per ton. This is more than $5 million in metal recovery per year.

The identification and removal of these items leaves a larger, hotter burning fuel input to the furnace, resulting in overall increased electricity production. They also reduce furnace wear, emissions and landfill requirements for over-all improvement in operating costs.

Austin's AI QXR-WTE was designed with WTE requirements in mind. The system comes embedded with programs for metal, glass and plastics separations; and is scaleable to fit the processing capacities of both small and large WTE facilities.

Plastics News — Recovering Value with the QXR-P

The power and versatility of the QXR-P is evident by its ability to sort engineered plastics for RoHS bearing materials based on elemental content; more and more automobile shredders are looking to recover these key industrial plastics found in eddy current separator waste streams. The value of these plastics is high—if they can be shown to contain low levels of fire retardants and heavy metals. The QXR-P is ideally suited to sort viable quantities of these plastics from eddy current waste. Recovering value, rather than paying for disposal, is the advantage any shredder operator wants their site to have.



Moreover, it's the QXR-P's improved performance for traditional uses in plastic recycling that make it stand out above competitors. For post consumer plastics, the QXR-P is easily integrated over conveyor or bottle chute to rapidly identify and remove PVC from PET recyclable material stream. Though XRF technology has been used for several decades in this regard, Austin AI QXR technology provides significant improvement upon speed and accuracy of analysis. The power and versatility of the QXR-P is such that it can be installed in-line, down stream of the shredder to aide in production of PVC free material stream.

Wood News — Recycling Wood Products via QXR-W

Maximizing the Reusable Fraction and Minimizing the Quantity of Hazardous Waste

From papers recently presented at the 2005 COST E31 Conference on Management of Recovered Wood, it is clear that current regional rules and regulations, such as the EPF's (European Panel Federation), or Germany's Alholzverordnung, and those supplied by one the of the world's largest supplier of composite wood for furniture use, dictate acceptable levels of contaminants when using recycled wood in wood based panels and particle board. These vary depending on the governing body, but for the most part are within a general range of agreement per contaminant.

Limits for Recovered Wood (mg/kg or ppm)				
	EPF	Alholz.	Processor	Virgin Wood
As	25	2	2	1
Cd	50	2	2	1
Cr	25	30	25	20
Cu	40	20	40	20
Pb	90	30	50	30
Hg	25	0.4	0.2	<1
Cl	1000	600	1000	550

The testing for these contaminants are also generally the same, that is, random, manual sampling should be performed per incoming lot, such as truckload. These samples are mixed via grinding and further sampled and prepared for analysis via common laboratory techniques such as AA, ICP, IR, etc.

The above listed allowable limits of detection for each of the contaminants is set for this blended sample—not individual piece. The assumption is that manually extracted samples would be adequate representation of the whole lot of incoming material. That is to say, when the entire load is prepared for use in the new product the extracted sample is hopefully indicative of what the values of each of the contaminants will be in any prepared product.

There are several concerns with this analytical approach and the limits set forth. First, unless the whole lot of wood supplied for recycling is homogeneous, there will be sampling errors. These errors are highly speculative and significantly dependent on the sampler itself. But it is not unreasonable to consider that sampling errors alone may contribute in the range of 100-1000% error. Therefore sampling errors may make acceptable incoming material appear to be bad—or worse, it may indicate that unacceptably high contaminated material is good for use.

Second, the nature of contaminated wood (such as pressure treated wood) is that is it is present in large concentrations. A piece of 0.25 lb/ft3 CCA rated pressure treated wood contains nearly 1% by weight of that chemical. Again, when a piece of incoming material is contaminated, it is highly contaminated when viewed against the above limits. It is extremely important to note that a single piece of contaminated material can adversely affect the value of an entire lot of incoming material.

Third, as can be seen from the above table, typical virgin wood values—averaged over many types and times—can be at, or near, the set limit for blended incoming material for recycling. Some maximum values reported were as high as 400 ppm Cu, 340 ppm Pb and 1.2% Cl! This can only mean that some virgin wood is also unacceptable per the limits established by some governing bodies. So these must be considered contaminants as well.

Therefore, the opinion held here is that there is only one way to truly guarantee that only acceptable product is manufactured—and that is to make sure that only acceptable incoming product is used in the manufacturing process.

The Austin AI QXR-W is the only technology currently available that is economically feasible to ensure all incoming material is screened to ensure acceptable finished product. This is achieved by rapidly and automatically screening ALL incoming material, one piece at a time, with powerful analytical XRF technology, engineered to perform very fast analyses with low levels of detection of all the elements listed as contaminants.

Austin AI's QXR-G Aids in Glass Recycling

Identification and removal of contaminants from cullet (furnace ready, recycled glass) is a growing concern for glass processors and manufacturers. The most common contaminants include glass ceramic, crystal, metals, and commingled colored glass. While metals and color contaminants can be removed via magnetic separators, eddy current systems and optical inspection equipment; glass ceramic and crystal are problematic. The rate of contamination from these products has grown proportionally with market demand, increasing the quality assurance risk for glass manufacturers using recyclable materials. Austin AI has developed the QXR-G, an in-line process analyzer, to selectively target these difficult contaminants for removal. The system installed and tested at Reiling Glass in Marienfeld, Germany; has proven to be an efficient quality assurance tool in guarding against glass ceramic and crystal contamination.

Figure 1: Austin AI's QXR-G, In-Line Cullet Inspection System

Glass manufacturers benefit significantly through the use of cullet, that there is no shortage in demand for a high quality cullet. For example, with every 10% of cullet used, there is 2 to 3% energy savings, approximately 15% material savings, and considerable reduction in gas emissions in comparison to use of raw materials. Further, cullet has lower melting temperatures and requires shorter furnace cycles than raw materials; which is credited to extending furnace life and lowering operational costs. The attractiveness of cullet use is only tempered by the increased risk of contaminants on product quality.

Container glass is by far the most common application for cullet, and is adversely affected by commingling of colored glass, as well as the presence of metal, glass ceramic and crystal. Glass recyclers and cullet processors keep clear, green and brown glass separated so as not to degrade color properties of the final product. Metal, glass ceramics, and crystal are also targeted for removal. They have significantly different physical properties than container glass, melting at much higher temperatures to create inclusions (faults) in the final product, affecting glass stability and increasing breakage. Separate color bins are provided at most collection facilities along with placards displaying proper

Figure 2: Glass recycling line, material entering crusher.

recycling techniques to aide recycling efforts; however, these materials continue to enter the recycling stream and are problematic for removal as breakage and mixing propagate the contamination through the recycling process.

Automated equipment is employed by cullet processors to remove most unwanted contaminants entering the recycling process. Optical equipment is able to select undesirable colored glass, while a combination of magnetic and eddy current devices reliably eliminate metal contaminants. Mid-Infrared spectrometers may also be used to identify and remove opaque glass ceramic, but as many glass ceramic and crystal materials are transparent and physically similar to container glass, a sizeable portion of these contaminants pass undetected . This contamination can cause the cullet material to be rejected by glass manufacturers, and may damage glass manufacturing equipment.

In the past, the amount of these contaminants was limited and could be addressed through grinding to sufficient fineness to induce melting . This is not the case today, as markets for glass ceramic glass (Pyrex and Visionware cookware, glass stove tops, and microwave ovens) and crystal materials (crystal, plate glass and automotive glass) have steadily increased over the past 10 years. This has lead to increased amounts of contamination entering the recycling stream, that a new technology is required to selectively target these materials for removal.

Figure 3: Common household sources of glass ceramic & crystal contamination in cullet.

Austin AI's QXR-G was evaluated and subsequently purchased Reiling Glass, for its' ability to detect glass ceramic and crystal contaminants in the cullet processing line.

Figure 4: QXR-G mounted on production stand.

The QXR-G is placed before or after the crusher for optimal detection capabilities, before the contaminants are mixed and diluted by subsequent processing. It employs an automated spectrometer to scan a thin layer of cullet in free fall, moving over slide-way, or traveling on a conveyor belt.

In the case of glass ceramic and crystal materials, the spectral signatures were observed to be significantly different than container glass.

When these materials are detected by the instrument, a diverter is activated to redirect the contaminants away from the processing line. When they are no longer present, the stream is allowed to pass untouched, through the remainder of the cullet processing line. The QXR-G's time to recognize and redirect the cullet is as little as 0.14 of a second. This short cycling time lends well to automation, minimizing the amount of quality cullet rejected.

The system is not designed to replace existing separation technologies, but rather another safe guard to enhance cullet quality, to minimize rejected product and wear and tear on furnaces created by glass ceramic and crystal contaminants. Early estimates are a one year or less return on investment.

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[1]*Glass Packaging Institute, "Glass Recycling & the Environment". www.gpi.org/recycling/environment, March 23, 2006.*
[2]*Ray, Carrie. "Debunking the Glass Myth", Iowa's Recycling Association, I!Recycle Newletter, July 2005.*
[3]*Clean Washington Center, "Best Practices in Glass Recycling, Ceramic Contaminant Removal." November 1996.*
[4]*Clean Washington Center, "Best Practices in Glass Recycling; Fine-Sizing of Recycled Glass". November 1996.*
[5]*Austin AI, "Proof of Principal, Reiling Glass". April 2005.*

E-Waste News

Are Profits Possible Without Subsidization?

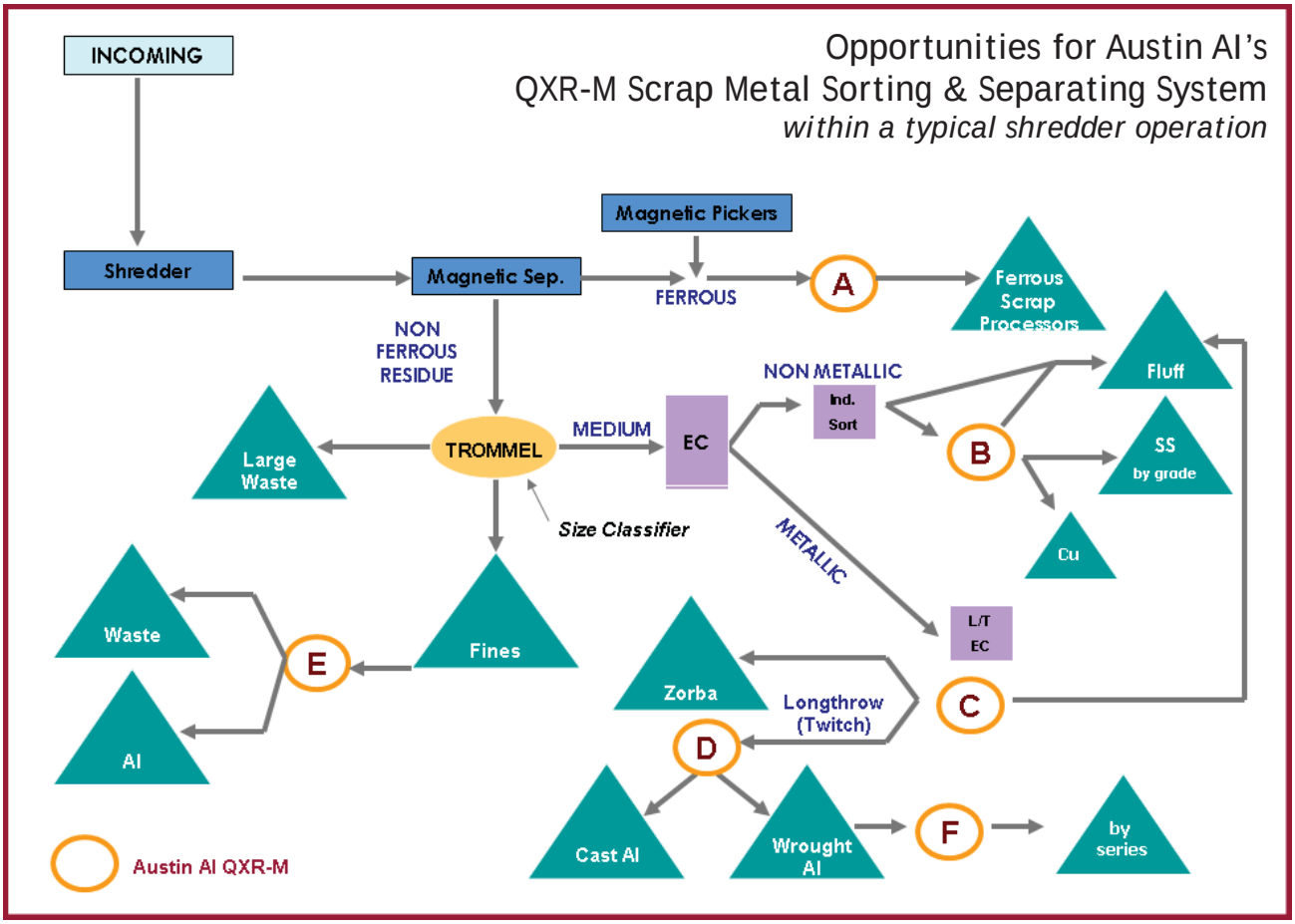
The recycling of electronic waste (E-Waste) is becoming a hot industry. Historically this business has not been economically viable—without significant subsidization or proceeds from penalties and fees collected for disposal of electronic goods, the recycling of such material would never be a for profit business. Despite recent laws (WEE, ELV, etc.), and general popular mandates, the key barrier to success for totally independent entities is the high cost associated with recycling e-waste.

Currently most e-waste processors operate under the false premise that e-waste is unique in many ways. So they also falsely conclude that unique processing is required to properly recycle this class of goods. Steps such as removal of CRT monitor cases, slicing of frit from funnel on the CRT itself, removing hard drives (US DHS mandate), and so on, are not only costly (manpower intensive), slow (many manual steps), but typically result in piles of material still not sufficiently sorted to yield good value for the assets contained therein.

Austin AI believes that the future for success in this area is to stop treating e-waste as specialty material. A computer system has a certain percentage of engineered plastics, some ferrous and non-ferrous metal, glass, and some waste material that can either be land-filled or needs to be further treated (HazMat). Although not as difficult to process, or as metal heavy, a computer has enough similarities to an automobile to warrant consideration of treatment in a like-kind fashion. The sequence could easily be modeled after a modified version of an auto shredder process. The key is to get all the e-waste into a processable piece size range and let technology take over. Shredding and size classifiers can achieve this easily. Then magnetic separation and eddy current stages can sort and separate general classes of metals.

Austin AI's QXR family of products can be extremely useful to e-waste processors. The QXR-P can sort recyclable engineered plastics into those deemed HazMat by RoHS criteria and those of high asset value. The QXR-M can class nonferrous metals into Al and Cu groupings or even more specific alloy types. A key automated sorting stage would be CRT glass sortation. The QXR-G can automatically sort CRT glass pieces by their OEM chemistry specifications. That is, heavily leaded glass—normally considered hazardous material—can be completely turned around into an asset if sorted in this manner. Most CRT glass manufacturers will buy back their own glass, if the chemistry meets their own recipe.

The future of achieving goals of truly recycling e-waste rests upon the ability of processors being able to make a reasonable return on this venture. This can only be realized through automation and viable through put quantities. The QXR technology will play a major part in this developing story.



Wood News

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The QXR-W, material and situationally dependent, can produce 3-5 tons per hour of screened incoming product, automatically and accurately. This is possible due to the following facts:

1. Incoming material, when contaminated via human intervention such as preservatives, coatings, and other treatments, yields a level that is many times above the limits imposed for recycling. For example, referring to the CCA example previously mentioned, 0.25 rated material contains about 8000 ppm of the CCA chemical. Gravimetric factor corrections yield approximate metal equivalent values of 1600 ppm Cr, 1100 ppm Cu, and 1400 ppm As. This value is several orders of magnitude above the allowable limits—and more importantly, above the high values found naturally in some virgin wood.
2. The QXR-W can "see" a piece of 0.25 rated CCA pressure treated wood in less than 100 milliseconds. So material moving along a conveyor belt or slide-way device at rapid speeds (100 feet/minute) still has sufficient residence time in the "analytical zone" to be recognized and rejected.
3. Most contaminants listed can be "seen" even when the piece is wet, or dirty, stained, or even painted. Cl, and to some extent Cr, are susceptible to some degradation of performance under these conditions.
4. XRF is listed as an approved method by most regulating agencies for determining metal contaminants in recyclable and recoverable wood. And unlike other techniques, XRF can be set for screening all these elements of interest at one time.

In summary, the QXR-W is a viable tool for minimizing the amount of hazardous waste (contaminated wood) and coincidentally maximizing the amount of legally recyclable material--a true liability/asset management tool. Return on investment analysis is dependent on many critical and changing parameters, but typical ROI results have been determined in the 6-12 month time frame.