

Introduction

A single strand of burned-out Christmas tree lights weighs almost nothing in the hand. But a hay-bale-sized block? That weighs around 2,200 pounds, according to Raymond Li, the fresh-faced but steely general manager of Yong Chang Processing, a scrap-metal processor in the southern Chinese town of Shijiao.

He would know.

I am standing between him and three such bales, or 6,600 pounds of Christmas tree lights that Americans tossed into recycling bins, or dropped off at the Salvation Army, or sold to someone in a “We Buy Junk” truck. Eventually they found their way to a scrapyard that pressed them into a cube and shipped them off to Raymond Li’s Christmas tree light recycling factory.

Raymond is anxious to show me how it works.

But first off, he needs to tell me that, though 6,600 pounds might seem like a large volume of American Christmas tree lights to find in a small Chinese village, it isn’t. Mid-November is actually low season for buying imported old Christmas tree lights. High-season starts after the New Year and reaches its peak in the spring, when Americans in the northern states start to empty their homes and garages of the pesky tangles. Those who take them to the local recycling center or sell them to the local scrapyard most likely have no idea where they’re going next. But I do: right here, to Shijiao, China, population maybe 20,000. Raymond Li tells me that his company recycles around 2.2 million pounds of imported Christmas tree lights per year, and he estimates that Shijiao is home to at least nine other factories that import and process similar volumes. That’s 20 million pounds annually, conservatively estimated.

How did an anonymous village in southern China become the Christmas Tree Light Recycling Capital of the World? Here's one answer: Shijiao is within driving distance of thousands of factories that need copper to make things like wires, power cords, and smartphones. Those factories have a choice: they can use copper mined in far-off, environmentally-sensitive places like the Brazilian Amazon. Or, alternatively, they can use copper mined from imported Christmas tree lights in Shijiao.

But Raymond's answer as to how Shijiao achieved its odd status is much simpler: "People wanted to make money," he says softly, his distant gaze pointed away from me. "That's all."

Raymond knows the history as well as anyone, and he tells it quickly, with no adornment. In the early 1990s economic opportunities were limited in Shijiao: you either farmed, or you left. The area lacked decent roads, an educated workforce, or raw materials. All it really had was space—vast, remote space. And as it happens, remote space, a box of matches, and some fuel are all you need to extract copper from a pile of old Christmas tree lights. Just douse the wire, set it on fire, and try not to breathe the fumes as the insulation burns off.

Raymond leads me into a cramped office where cloudy windows face Yong Chang Processing's factory floor. I'm offered a seat on a dusty leather sofa. Taking the seat to my right is Cousin Yao, brother to Raymond's wife, Yao Yei, who is seated across from me. Low-key Raymond, native of Shijiao, takes a seat beside his wife. It's a family business, they tell me, and everyone helps out.

I glance out the window at the factory floor, but from the sofa's low vantage point I can't see past additional piles of scrap wire (not Christmas tree lights) worth tens of thousands of dollars that Raymond imported a few days ago. If Raymond feels like it, he's flush enough to buy millions of dollars' worth of U.S. scrap metal per month. That may seem like a large number. But really, it's not. The global recycling industry turns over as much as \$500 billion annually—roughly equal to the GDP of Norway—and employs more people than any other industry on the planet except agriculture. Raymond Li is big in Shijiao, but here in Guangdong Province, the de facto headquarters of China's recycling industry, he has many peers.

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We chat more about the history of Shijiao, its wire recyclers, and how it's changed the lives of thousands of former farmers. Then, abruptly, Cousin Yao announces that he received a degree in engineering from a top university. Rather than join a traditional manufacturer, he says, he returned to Shijiao to join Raymond's scrap business. He could have gone anywhere, he could have done other things. China, after all, doesn't lack opportunities for engineers. But Cousin Yao knows a better opportunity when he sees one, and scrap metal was that opportunity. As he and Raymond see it, China's economy is expanding quickly, and its government planners and businessmen are desperate to find copper, steel, paper pulp, and other raw materials to feed the factories that drive the growth. Copper mines are great, but Raymond and his family don't have the money or connections to open a copper mine. Then again, why would they want to do that, when there's an endless supply of perfectly recyclable and reusable copper—worth billions!—available in the junkyards and recycling bins of America?

Raymond lights a cigarette and explains that he didn't have Cousin Yao's choices. Fifteen years ago he was twenty-seven and working as a laborer in a dead-end job at a paint and chemical factory. "I wanted to be rich and successful," he explains softly. "So I joined the scrap business." His wife's family was already engaged in scrapping on a small scale. They knew how and where to get recyclable scrap, and better yet, they knew the potential that foreign throwaways have to make a family rich—much richer than rice farmers, storekeepers, and office workers.

Since Raymond's fateful decision, China's raw material needs have only grown, and so has Raymond's business. Take, for example, China's demand for oil. As late as 2009 visitors to Shijiao were confronted with clouds of black smoke churning off giant piles of burning wire (not just Christmas tree wire, either). The rubber insulation was worthless; back then it was the copper that everyone wanted, and burning was the quickest way to liberate it. Then something important happened. Chinese started buying cars, driving up the price of oil and things made from oil—like the plastic used to insulate Christmas tree lights. As the price of plastic rose, Chinese manufacturers started looking for alternatives to "virgin" plastic made from oil. The most obvious solution was the cheapest: instead of burning plastic off copper wire, figure out a way to strip and recover it for reuse. Wire insulation isn't the highest quality plastic, but it's good enough to make simple products like . . . slipper

soles! These days, the biggest customers for Raymond's Christmas tree insulation are slipper sole manufacturers.

Of course, getting from Christmas lights to slipper soles isn't easy or obvious. It took Cousin Yao more than a year of tinkering and testing to get Yong Chang's Christmas tree light recycling system right. I look around the room and ask whether I might see it. Raymond nods, and we walk out to the factory floor.

The process begins with workers paid as much as \$500 per month to toss handfuls of Christmas tree lights into small shredders (they look like wood chippers). With thunderous groans, the shredders pulverize the tangles into millimeter-sized bits of plastic and metal and then spit them out as a mudlike goop. Next to those shredders are three vibrating ten-foot-long tables. As workers shovel the goopy shredded lights onto their surface, a thin film of water washes over them, bleeding out very distinct green and gold streaks. I step closer: the green streak is plastic, and it washes off the table's edge; the gold streak is copper, and it slowly moves down the length of the table until it falls off the end, into a basket, 95 percent pure and ready for remelting.

The principle at work is simple: think of a streambed covered in gravel. A flowing current will pick up the smaller pieces and carry them downstream quickly, while the bigger piece, the rocks, will stay in place, only occasionally moving. The same physics is at work on Raymond's tables, only it's not gravel that's carried away, it's Christmas tree light insulation.

Recycling. A generation of Americans defines it as: the act of sorting cans from bottles from cardboard from newspapers and setting them out on the curbside, or down in the trash room, for somebody to pick up. It's an act of faith, a bet that the local recycling company or trash collector is committed to doing the environmentally sound thing as the person who sorted the recyclables in the first place. But what is that right thing? And is it really recycling if your carefully sorted newspapers, cans, and bottles are shipped off to Asia?

Definitions are important, and from the standpoint of the recycling industry, what most Americans think of as "recycling" is actually more akin to harvesting. That is, a home recycler harvests cardboard from trash and other recyclables, and a paper mill recycles that used

cardboard into new cardboard. Recycling is what happens *after* the recycling bin leaves your curb. Home recycling—what you most likely do—is just the first step. Nonetheless, it's the key step: no machine can harvest recyclables from your trash as cheaply and efficiently as you can.

In fact, compared to harvesting, the actual recycling is often the easy part. After all, the process by which old paper is transformed into new paper is centuries old; turning old computers into new ones is more difficult, but only because the machines are complicated to pull apart. But harvesting enough paper to make a paper mill run? That's difficult. Finding enough computers to justify opening a computer reuse or recycling business? That might even be harder.

This book aims to explain why the hidden world of globalized recycling and reclamation is the most logical (and greenest) endpoint in a long chain that begins with the harvest in your home recycling bin, or down at the local junkyard. There are few moral certainties here, but there is a guarantee: if what you toss into your recycling bin can be used in some way, the international scrap recycling business will manage to deliver it to the person or company who can do so most profitably. Usually, but not always, that profitable option is going to be the most sustainable one. To be sure, not every recycler is an environmentalist, and not every recycling facility is the sort of place you'd want to take kindergartners for a field trip. But in an age of conspicuous consumption, the global recycling business has taken on the burden of cleaning up what you don't want, and turning it into something you can't wait to buy.

In the pages to follow I'll tell the story of how the very simplest of human activities—reusing an object—evolved into an international business that has played a key role in the globalization of the world economy over the last three decades. It's a murky story, obscure even to those who care very much about what happens to what they toss in their recycling bins. Like most stories that are at least partly hidden from view, the story of globalized recycling reveals uncomfortable truths and the singular, sometimes brilliant, characters who grapple with them on our behalf.

Most of those characters, like Raymond Li, share a talent for spotting value in what others throw away. In colonial-era America, Paul Revere demonstrated that talent, smartly buying scrap metal from his neighbors for remelting in his blacksmith shop. In late 1950s America, that

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talent was applied to finding a way to make a living by recycling the tens of millions of automobiles abandoned across the American countryside. Today, it's a talent being applied to recycling the rare and valuable elements buried inside the smartphones, computers, and other high-tech devices that middle-class people throw away like candy wrappers. More often than not, though, the genius is commercial, not technical. Today recycling is as risky and rewarding as any global business, if not more so. Huge, mind-bending, Silicon Valley-scale fortunes have been built by figuring out how to move the scrap newspapers in your recycling bin to the country where they're most in demand.

Of course, for most Americans and other people living in wealthy developed countries, recycling is an environmental imperative, not a business. From that perspective, recycling consumes fewer trees, digs fewer holes, and consumes less energy than manufacturing from virgin materials (a recycled beer can requires 92 percent less energy to manufacture than one made from virgin ore). But without financial incentives, no ethical system is going to transform an old beer can into a new one.

The global recycling business, no matter how sustainable or green, is 100 percent dependent upon consumers consuming goods made from other goods. This unbreakable bond—between raw material demand, consumption, and recycling—is one of the dominant themes of the pages to follow. The calculus is simple: the only reason you can recycle is because you've consumed, and the only reason you can consume certain products is because somebody else recycled. Around the world, we recycle what we buy, and we buy a lot.

Nonetheless, despite what some recycling companies will tell you, many goods—such as smartphones—are only partially recyclable, and some—like paper—can only be recycled a finite number of times. In that sense, recycling is just a means to stave off the trash man for a little longer. If your first priority is the environment, recycling is merely the third-best option in the well-known pyramid that every American schoolchild learns: reduce, reuse, recycle. Alas, most people have very little interest in reducing their consumption or reusing their goods. So recycling, all things considered, is the worst best solution.

But what a solution! According to the Institute of Scrap Recycling Industries (ISRI), a Washington, DC-based trade group, in 2012 the 46.35 million tons of paper and cardboard recycled in the United States saved 1.53 billion cubic yards of landfill space; the 75.19 million tons of

recycled iron and steel saved 188 billion pounds of iron ore and 105 billion pounds of coal (roughly 60 percent of American steel comes from scrap metal); the 5.45 million tons of recycled aluminum saved more than 76 million megawatt hours of electricity. In China, where industry is far more polluting than in the United States, the numbers are even more astonishing, and arguably more important. According to the China Nonferrous Metals Industry Association, recycling of metals (not including iron and steel) between 2001 and 2011 saved China 110 million tons of coal and the need to excavate 9 billion tons of ore. During that same decade, China's devotion to recycled aluminum prevented 552 million tons of carbon dioxide from being released into the country's notoriously polluted skies. Today, China is the world's biggest consumer of copper, and fully 50 percent of its copper needs come from recycling. Wherever there's a recycling industry—and it's everywhere—there are examples like these covering every type of recyclable good, clothing to car batteries.

If this book succeeds, it won't necessarily convince you to embrace the oft-gritty reality of the recycling industry, but it will certainly help you understand why junkyards look like they look, and why that's not such a bad thing. In my experience, the worst, dirtiest recycling is still better than the very best clear-cut forest or the most up-to-date open-pit mine.

Notably, there are no blue or green recycling bins at Raymond Li's Yong Chang Processing, no posters encouraging people to "Reduce, Reuse, Recycle," no cardboard boxes filled with used office paper next to the copy machine. It's a tough factory in a tough industrial town cut from ancient farm fields and staffed by migrant laborers looking for a better life. Superficially, at least, it doesn't seem to have much to do with the neatly sorted cans, bottles, and newspapers that so many Americans set onto curbsides, or carefully sort in the trash rooms of their apartments, co-ops, and condos.

It's important to keep in mind that Raymond Li's success isn't about exploitation, any more than an American junkyard exploits its employees. Rather, Raymond Li is an opportunist who long ago recognized a simple fact: China's development into what will soon be the world's largest economy created an appetite that can only be filled by importing

scrap metal, paper, and plastic. If China didn't import those resources, it'd have to dig and drill for them.

As I stand in Raymond Li's factory, watching his employees mine copper from Christmas tree lights, the question that immediately comes to mind is: Why can't somebody recycle Christmas tree lights in the United States?

The reason, as I've learned over a decade visiting recycling facilities all over the world, isn't technology (Raymond Li's water table is just a fancier version of the pan that gold prospectors once used to separate gold nuggets from gravel). Rather, the issue is business: as of 2012, fast-growing China accounted for 43.1 percent of total global copper demand. Meanwhile, the slow-growth United States accounted for only 8.5 percent. That's the difference between a country (China) that has a growing middle class and lots of buildings and infrastructure yet to build, and one (the United States) where incomes have stagnated and infrastructure spending peaked decades ago. If you're building a copper factory somewhere in the world these days, it's likely in China. If you're building a recycling plant to feed that copper factory, it might as well be in Shijiao.

But that doesn't mean there's no hope for recycling in the United States. In fact, U.S. manufacturers (second only to China in total output) still use roughly two-thirds of the recycled materials that are generated within U.S. borders. The problem, if you care to view it as a problem, is that Americans don't just buy U.S.-made products; they also import vast amounts of manufactured merchandise. The result is an American economy that consumes—and throws away—much more than what is manufactured at home. That excess recyclable waste has to go somewhere. Export is one option, the landfill another. Thus it should come as no surprise to anyone that China is both the largest exporter of new goods to the United States and the largest importer of American recycling.

The story told here explains how China became America's recycling export destination of choice, and why that's mostly a good thing for the environment. After all, China and other developing countries are willing and able to recycle what the American recycling industry won't—or can't—recycle on its own (Christmas tree lights are just one minor example). When China stops buying American recyclables, those recyclables start to flow to landfills; it happened on a large scale in 2008, when Chinese factories shut down in the wake of the global financial crisis.

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INTRODUCTION

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As a result, much of this book takes place in the United States and China. But not exclusively so: the global recycling industry is truly global, and so the narrative to follow touches on many countries, especially in the developing world.

CHAPTER 1

Making Soup

Here's something true in all places and times: the richer you are, and the more educated you are, the more stuff you will throw away. In the United States, wealthy people not only buy more stuff but they buy more recyclable stuff, like the recyclable cans, bottles, and boxes that contain the goods they covet. That's why, if you take a drive through a high-income, highly educated neighborhood on recycling day, you'll see green and blue bins overflowing with neatly sorted newspapers, iPad boxes, wine bottles, and Diet Coke cans. Meanwhile, take a drive through a poor neighborhood, and you'll invariably see fewer bins, and fewer recyclables.

The people in the wealthier neighborhoods who did that sorting, that harvesting, were good stewards of their trash. But they wouldn't have had the chance to be good stewards if they weren't also very good consumers of stuff (just as poor people don't harvest as much recycling in part because they don't buy as much). There's statistical support for the observation: between 1960 and 2010 (the most recent date for which the U.S. Environmental Protection Agency provides data) the volume of recyclables that Americans harvested from their homes and workplaces rose from 5.6 to 65 million tons. Yet during that same period the total volume of waste generated tripled, from 88.1 to 249.9 million tons. No doubt Americans were doing a better job of recycling their waste, but

they were also doing an equally fine job of generating it. The more numerous and wealthier they became—and the period from 1960 to 2010 was a period of intense wealth accumulation—the more waste they generated. In fact, over the course of the last five decades, the only significant annual decline in total generated waste occurred in the wake of the 2008 financial crisis and recession.

The correlation between income and recycling has been well established for decades. Consider, for example, Hennepin County, Minnesota, population 1.168 million. I was born in Minneapolis, Hennepin's largest city, and as of 2010, my hometown's recycling rate ranked thirty-sixth out of forty-one Hennepin County communities, with an average annual household recycling harvest of 388 pounds. Meanwhile, west of Minneapolis, households in the highly affluent lakeside community of Minnetonka Beach had an annual household recycling harvest of 838 pounds, putting them atop the county rankings. Why? One reason is that the median household income in Minnetonka Beach was \$168,868 in 2010, compared to \$45,838 for Minneapolis, a city with large pockets of poverty. Sure, there are other factors at play (at the time the data was taken, Minneapolis required residents to sort recyclables into an irritating and time-consuming seven different categories, while Minnetonka Beach required only one), but it's hard to escape the fact that places like Minnetonka Beach generate many more neat white recyclable iPad boxes, and Sunday editions of the *New York Times*, than the housing projects of Minneapolis.

Back when I lived in the United States, I had blue bins and green bins, and I felt an ethical compulsion to fill them—and, if possible, fill them more than I filled the trash bin. The paper went into one, and everything else went into the other. Then I'd drop them at the curb, but—owing to a childhood spent in my family's scrapyard—I felt as if I'd just cheated myself. Aluminum cans, I knew, were priced by the pound; during summer breaks from school I'd often be the person assigned to weigh the ones dropped off by bums, college students, and thrifty home recyclers at our family business. In her later years, my grandmother—raised in a depression-era household that saw value in everything reusable—would still insist on driving her modest number of cans to the business, rather than give them away to a municipal recycling program for free.

More often than not, in the United States and the rest of the developed world, the people who have to figure out what to do with the trash

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that we toss out of our homes are not teenagers on can machines but cities and a handful of large corporate waste-handling companies. In some cases they have no choice but to take what's tossed into those bins. If they had a choice, they'd take only the stuff that they can sell for a profit—like the cans that my grandmother liked to deny them. Those things that can be sold for a profit are generally things that can be easily remade into something new. An aluminum can is easy to remake into a new aluminum can; a leather suitcase, however, is hard to remake into anything at all.

Occasionally, when I drive through an American neighborhood on recycling day, I'll notice bins filled with things like old luggage, placed there out of a misplaced but righteous conviction that the companies need to do the right thing and "recycle" them too—whatever that means. But the recycling companies aren't resisting the chance to do the right thing. They just haven't found a profitable way to separate, for example, the plastic that constitutes the luggage handle from the different kind of plastic that constitutes the luggage itself. That sort of work has to be done by people who can see a profit in it, and so far the large-scale recycling companies that pick up blue and green bins haven't figured it out. But what they have started to figure out is how to dig deeper into your trash to get at the stuff that can be recycled profitably. It's not the most glamorous work, and it's generally not the sort of thing that politicians and environmentalists discuss when they discuss "green jobs." But for the right person, it's an opportunity as endless as anything dreamed up by Silicon Valley.

Alan Bachrach is the right kind of person. As director of recycling for the South Texas region of Waste Management Corporation, North America's largest recycler of household waste, he has a professional, profit-driven interest in recycling. Like so many of his peers in the global scrap and recycling trade, he has a youthfulness to him that belies his late middle age—a youthfulness that suggests nothing so much as that he really, really enjoys machines that sort trash. If there are those who feel shame for working in an industry that handles other people's waste, Alan Bachrach isn't one of them. He loves it.

We meet early in January 2012 in the visitor's area of Waste Management's \$15 million new Walmart-sized recycling plant. Bachrach played

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visitor's area of Waste Manage-
recycling plant. Bachrach played

a major role in designing the facility, and he's now responsible for run-
ning it. But even though we're *kind of* having a conversation, Bachrach's
eyes don't focus on me, but rather on what's on the other side of a plate-
glass window and two stories down: swiftly moving Class A rapids of
plastic bottles, cardboard, and paper, riding up and down conveyors,
over and under, around and around, until they emerge as perfectly
sorted hay-bale-sized blocks of bottles, cardboard, and paper, tied to-
gether with steel ties. "You either love it or you hate it," he tells me about
those who work in the industry. "You're either gone after six weeks,
probably before six weeks, or you don't ever leave."

In a sense this is Green Heaven, the place where all that home recy-
cling set out on recycling day—the paper, bottles, and cans lovingly
harvested—eventually ends up. Alan Bachrach isn't exactly Saint Peter
at the gates, but he's definitely in the chain of command. But then if this,
the Houston Material Recovery Facility, is Green Heaven, then it must be
said that Houston itself is a kind of Green Hell—at least if you care
about what happens to residential waste and recycling.

The numbers tell the story. In 2010 the United States recycled ap-
proximately 34 percent of its "municipal solid waste." That is, 34 percent
of the waste generated by homes, schools, and office-based businesses
(but not industrial facilities, construction sites, farms, and mines) was
diverted from landfills into some kind of facility that sent it on its way
to a reusable afterlife. Give or take a few percentage points, that 34 per-
cent is roughly the same percentage achieved by New York, Minneapo-
lis, and other U.S. cities with long-standing recycling programs. But
Houston? As recently as 2008 Houston only managed to recycle 2.6
percent of its municipal solid waste. The other 97.4 percent? By and large,
it was landfilled. Since 2008, the rate has been pushed up to "six or seven
percent," according to a sheepish Alan. That's not good, by any defini-
tion. How to explain it?

For people who live in places like San Francisco, where the recycling
rate exceeds 70 percent, a popular explanation is that rednecks don't like
recycling. But that's not only condescending, it demonstrates a pro-
found misunderstanding of how and why San Francisco's trash is recy-
cled at such a high rate.

No doubt culture, education, and income play a role in how much
actual waste a particular person or place recycles. But in my experience,
no culture encourages a high recycling *rate* quite like the culture of

poverty. In essence: if you can afford very little, you'll tend to reuse a lot. So in San Francisco a glass jar of Trader Joe's bruschetta is likely headed directly to the recycling bin; in the slums of Mumbai that same jar—if somebody could afford it—might very well become a kitchen implement. The slum dwellers of Mumbai have a far higher recycling rate than the suburbs of San Francisco because (a) they consume less—for example, no iPad boxes to recycle—and (b) daily survival requires thriftiness. But no matter how poor or eco-conscious a particular population is, the degree to which they recycle primarily comes down to whether or not someone can derive some economic benefit from reusing waste. In Mumbai the benefit is largely a matter of personal economy; in wealthy San Francisco, where few residents worry about the pennies they might generate from a pile of newspapers, it's a recycling company that has to find an answer to the question of whether there's economic benefit in picking up someone else's waste.

Houstonians, like most Americans, don't share an interest in practicing Mumbai-style thriftiness. So that places pressure on recycling companies, who unfortunately have found it very, very difficult to be profitable in Houston. The problems are several. First, Houston is big, but its population density is very low—around 3,300 people per square mile. San Francisco, by contrast, has a population density that exceeds 17,000 people per square mile. From a demographic standpoint, that means there will be more recycling bins per square mile in San Francisco—because there will be more households per square mile—than in Houston. What that means, from a recycling business standpoint, is that a recycling truck has to drive much farther to pick up, say, a thousand pounds of newspaper in Houston than it does to pick up the same weight of newspaper in San Francisco. In other words: a Houston recycling company has to work harder, and pay more money, for the same revenue as a San Francisco recycling company.

One way to overcome this problem is for local governments to subsidize recycling—and some do. But in tax- and fee-averse Houston, that's a tough proposition, especially because Texas has some of the cheapest landfill rates in the United States. Reasonable taxpayers—not to mention politicians—might ask why they're being asked to pay more to recycle, when the same trash can be landfilled for so much less.

The other way to overcome the problem is to encourage Houston's households to harvest more recyclables so that each pickup is

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potentially richer for the recycling companies. Believe it or not, that's really easy to do (and to do without encouraging an increase in consumption). Here's how: take away the two, three, and sometimes seven bins into which some American households are expected to sort waste recyclables, and replace them with one big bin where everything recyclable can be dumped. This is called single-stream recycling (as opposed to dual-stream recycling, which requires one bin for paper and another for everything else). In communities where this has been tried, recycling rates have increased by as much as 30 percent. And why not? Like it or not, even eco-conscious people are sometimes too busy to be bothered with the need to separate their trash into multiple containers ("playing with garbage" is how I like to describe it). So Waste Management has spent the last several years rolling out single-stream recycling in Houston.

But if Houston's households aren't sorting all of the extra recycling they're dumping into Waste Management's trucks, how is Waste Management supposed to extract more recycling from it? That's where Alan Bachrach, a bunch of engineers, and \$15 million comes in.

In high school, some kids look for jobs at McDonald's, and some kids are happy mowing lawns. Alan Bachrach wasn't that kind of kid. Rather, he was the entrepreneurial kind, the sort who looked for things that could be sold for more than they cost to buy. He found two: the computer punch cards that were, until the late 1960s, the primary means of feeding data into mainframes, and continuous-feed computer paper. Both were 100 percent salable, for cash, to local paper scrapyards, where they were prepared for processing into new paper. Thus, Alan Bachrach had plenty of pocket money in high school. In fact, I'm guessing he had more money than most.

"I got very lucky," he tells me when I ask about how he was attracted to the recycling business. "It fit my aptitudes and my ADD and my OCD very well." As with many young entrepreneurs who find their calling early, Alan's college career didn't last long, and after dropping out he went to work for a friend's trash-hauling company. There he introduced the trash men to the revenue potential of selling recyclable paper and cardboard to scrapyards, and for the next three decades he devoted his life to recycling paper and cardboard generated in Houston-area

businesses (not homes). Everything changed, however, in 2008, when Waste Management, in search of recycling companies that could help it establish a residential recycling business in Houston, decided that Gulf Coast Recycling—the company where Alan had spent nearly three decades—was the one to help them do it. This was well timed. Alan wanted Gulf Coast to move into residential recycling, but they lacked access to large volumes of recyclables. “Those are collected by trash companies,” he explains. “And so it’s very difficult to justify fifteen, twenty million dollars of equipment when you don’t have the feed materials secured.”

“You need scale,” I respond.

Standing beside him, Lynn Brown, Waste Management’s VP for communications, pipes up: “Or you need a municipal contract in the city of Houston.”

Alan smiles widely. “Scale is very important in this business.”

Waste Management acquired Gulf Coast Recycling in 2008, and in 2010 it began to transform this GCR facility into a single-stream recycling plant that opened in February 2011. Today it sorts between 600,000 and 700,000 pounds of single-stream recycling per day. That’s roughly the weight of an Airbus A380 jet—measured out in newspapers, plastic milk jugs, beer cans, and shoe boxes. When I ask for an estimate of just how many households those pounds represent, Alan tells me that, on average, a Houston family generates fifty pounds of single-stream recycling per month. However, not everybody recycles, not everybody rolls out their container on a weekly basis, and some—like Alan’s family, which rolls out six (!) containers per week—recycle more than the average. At the same time, a small percentage of the material handled at this facility continues to come from commercial sites, such as the Dumpsters filled with cardboard behind supermarkets. Still, a rough calculation suggests that—on a daily basis—the Houston Material Recovery Facility processes a volume equivalent to the monthly recycling generated by approximately 12,000 Houston households.

“You ready to take a walk?” Alan asks me with that childlike gleam. We’re accompanied by Matt Coz, the Waste Management VP in charge of growth and commodity sales—that is, making money off the stuff processed at this plant—and Lynn Brown. Both of them have been through the plant many times—Matt was intimately involved in its planning—but I don’t sense any weariness at the thought of touring it again.

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The four of us walk outside and around the building, to an enclosed receiving area where a truck is tipping a load of recycling onto the concrete floor. Single-stream recycling hisses more than it clanks, mostly due to the fact that 70 percent of it is paper—junk mail, newspaper, office paper. A front-end loader of the sort most people are accustomed to seeing dig in the dirt at construction sites rolls up and digs into this mass of well-intentioned waste, picks it up, and dumps it into what Alan tells me is a device that feeds the stuff onto conveyors at a steady, uniform pace. "That's really important," Alan says, "if everything you're about to see is going to work properly and consistently."

We enter into the Walmart-sized space that I saw from above, and I swear, the first thing that comes to mind is Willy Wonka's chocolate factory: conveyors of trash rush upward and release their cargo into spinning stars that toss it about in a manner that I can only describe as joyful, like popcorn jumping in a frying pan. Some continues along, some drops away. I see detergent and shampoo bottles zipping by at a pace that exceeds 400 feet per second (Alan asks me to keep the actual speed to myself—it's a trade secret), and I see milk bottles dropping, from points unknown, into a giant cage. Something occurs to me: "Kids would love this place," I call out to him, but he doesn't respond, perhaps because (a) it's so obvious; or (b) he can't hear me because my voice is completely lost in the roar of machines, the hiss of paper, and the crash and bang of glass, aluminum, and plastic.

We climb a stairway to what Alan calls the "pre-sort." Here two workers stand over a high-speed conveyor that carries freshly arrived, unsorted "recycling" that needs to be, well, recycled! One of them reaches out and grabs a brown plastic bag from the blur, and just as quickly it disappears, sucked up by a large vacuum tube positioned directly above them, all Willy Wonka-like. Then he does it again! "Not everybody can hack this job," Alan leans over to say, nodding at the speeding, blurry line. "Some people get dizzy, throw up."

That's not what interests me, however. "What happens to the plastic bags?"

"Plastic bags are the worst," Alan calls out to me. "They get tied up in the axles and we spend hours pulling them out."

I make a mental note to myself: never again use plastic bags to contain my old beer cans. "But can you still recycle them?"

"Sure!"

One of the sorters grabs a hunk of something—it happens so fast I can't tell what—and drops it down a square chute that leads to—where? It could be the other side of the planet, for all I know (China?). “The other job is to pull out big pieces of plastic and trash,” he adds and points me farther along to the spinning stars I saw from below. I don't have a chance to ask where that chute goes.

The conveyor feeds into the stars and newspaper bounces and froths atop them like white water on churning waves. The stars—they're made of a specialized plastic that wears well—are spaced at intervals to allow plastic, glass, and aluminum to fall down onto another line. The newspaper, meanwhile, dances right across the stars and emerges on the other end, separated. Meanwhile, below, the material that dropped through the stars, including more paper, is conveyed into yet more stars, spaced at smaller intervals that convey out even more paper—in smaller sizes—while the plastics, glass, and cans continue to fall away. It's a cascade, each step angled steeper than the last, and at each level paper and plastic are separated. It's a key process—perhaps *the* key process—in cleaning up a waste stream that's roughly 65 to 70 percent newsprint, office paper, and junk mail.

Below, aluminum cans are literally ejected from the system by a device that creates an electrical current that repulses metals. To me, it looks as if the cans are jumping to their deaths from the streams of paper and plastics, into a cage where they're collected for companies that remelt them. The glass, meanwhile, is removed by several processes that take advantage of the obvious fact that glass is heavier than paper. Think of it this way: if you place a beer bottle next to a pile of newspaper coupons, and aim a hair dryer at both, you'll likely be left with only a beer bottle. That's a rough approximation of the physics that Waste Management uses to separate the two materials.

I must admit, I'm really getting into this when, suddenly, the entire line grinds to a groaning halt. I turn to Alan. “Everything okay?”

“Something probably got stuck,” he says with a wave of the hand indicating that this is common. “Probably a bad piece of material. It shuts down the whole thing.”

As we wait for it to restart, I lean over a rail and realize I'm maybe twenty feet off the ground, and we've only just begun to tour this behemoth. Alan tells me that it takes a piece of recycling roughly twelve minutes to go through the entire system, beginning to end. Below, I watch a

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forklift race across the floor with a bale of what looks like junk mail—
thousands and thousands of pieces of junk mail. That bale will be placed
into a shipping container and, more likely than not, shipped to China
for recycling into new paper.

With no warning, the engines start to roar, the conveyors start to
run, and the giant recycling machine slowly comes back to life, one dis-
tant conveyor, star screen, shaker table, and goodness knows what else
at a time. “You can’t just turn it all on at once,” Alan explains. “It’s so
complicated you have to stage it.” If my ears can be trusted, it takes a
good fifteen seconds or so before the conveyors are all running again.

We climb more stairs, moving ever higher into the system. There’s no
more paper up this high—that’s all been pulled from the system. Now
it’s all about separating the different kinds of plastics. “This is my guys’
favorite one,” Alan tells me, and he nods at a yellow device that hangs
over a blur of bottles. It contains two hundred sensors that shine infra-
red light onto the trash passing beneath them. When the light reflects
off, say, a red Tide detergent bottle, nothing happens; if it reflects off a
white Minute Maid orange juice bottle, nothing happens. But if, as the
trash whizzes by, the light reflects off a clear Coca-Cola bottle, the com-
puter records exactly where it is on the precisely timed conveyor.

“Hear that?” Alan asks loudly, with an impish grin.

Through the clamor, I hear irregular, sharp pops of compressed air,
like tiny gun bursts. A few feet from the sensors, I see an Aquafina bottle
stagger backward onto another conveyor, as if shot dead, followed by
a Coke bottle—also shot dead. The computer knows exactly where the
bottles are, and how long it takes for them to arrive at the air guns. I can
see the nozzles, now, tiny needle tips capable of sending an empty bottle
flying. The rate of fire reminds me of nothing so much as what you might
hear at a crowded gun range. *Phhht phht*. Two bottles down. *Phht Phht*
Phht. Three more bottles down. Pause. *Phht*. According to Alan, this one
machine, its sensors and air guns, replaces six to ten manual sorters,
who, unlike machines, might become fatigued and nauseated, watching
the swirl of plastic beneath them.

Still, infrared light sensors, for all of their sophistication, have limita-
tions. One of them, according to Alan, is that “they can’t sort white poly-
ethylene bottles from colored polyethylene bottles.” In layman’s terms,
that’s the process of sorting a red Tide detergent bottle from a white
Minute Maid orange juice bottle. But have no fear: “We have the most

sophisticated equipment available: a person." Sure enough, three human beings stand over a conveyor, grabbing the white bottles and tossing them down chutes. At their best, people can handle perhaps forty-five "sorts" per minute—not bad, but certainly not nearly the hundreds that an array of air guns and sensors can handle. The technology doesn't exist for this type of plastics, so people will have to do.

For all of Alan's joking about people as technology, however, he never once diminishes the dignity of the work done by his sorters. Like many of the scrap entrepreneurs I've met over a lifetime around this industry, he identifies with them. After all, they're all in the business of sorting other people's waste. "These are people I'd stop bullets for," he tells me. "These are wonderful . . ." He hesitates for a second, and then revs right back up. "People think that because these are minimum wage jobs or close to minimum wage jobs, it's a very high-turnover position. I've got ten, fifteen, twenty years folks."

It may not be the highest paying job, and it may not be glamorous or the sort of thing that your kid will want to tell his friends about. But if you're looking for a consistent job, with benefits, where layoffs are almost unknown, then it doesn't get much more consistent than American recycling. In Houston, a town that knows the heartbreak of boom and bust better than most areas, a stable job like that is worth more than just salary. "My boss," Alan tells me, his smile widening again, "the guy that runs this area for Waste Management, is in the business because his dad was in the oil business and he watched him during his youth, boom and bust. And he said, 'I gotta find an industry that's always steady.'"

Far away from Houston, in offices located in Denver, Milwaukee, Boston, and Chicago, thirty-five men and women arrive at work each day tasked with finding a home for the sorted recyclables that come out of Houston, and Waste Management's dozens of other recycling plants throughout North America. To them, a bale of recycled detergent bottles is no more or less virtuous than the barrel of oil from which those bottles were originally made. There's nothing sentimental in the work that these men and women do, nothing particularly green or eco-conscious. Their job, pure and simple, is to obtain the best price. So, for example, if a factory in Fuyang, China, is offering a better price for those bottles,

n.” Sure enough, three hundred of the white bottles and tossing them, an employee can handle perhaps forty-five bottles an hour, not nearly the hundreds that would be needed to handle the waste. The technology doesn't do what I have to do.

The technology, however, he never complains about by his sorters. Like many of the people who have spent their lifetime around this industry, he is all in the business of sorting and recycling. “I stop bullets for,” he tells me. “I get paid a second, and then revs right up. The jobs are minimum wage jobs or high-turnover position. I've got

and it may not be glamorous or exciting to tell his friends about. But if you look at the benefits, where layoffs are almost more consistent than American history, he knows the heartbreak of boom and bust. “A job like that is worth more than anything else,” he smiles, widening again, “the guy who stays in it, is in the business because his dad told him during his youth, boom and bust, an industry that's always steady.”

He was born in Denver, Milwaukee, Boston, and women arrive at work each day to sort through the recycled recyclables that come out of the plants. He told me of other recycling plants where a bale of recycled detergent bottles is worth a barrel of oil from which those bottles were made. It's particularly sentimental in the work that he does, particularly green or eco-conscious. “I get the best price. So, for example, if I can get a better price for those bottles,

then those bottles will very likely go to Fuyang; but if, as is quite likely, a U.S.-based manufacturer needs them more, and is willing to pay to prove it, then they'll stay in the United States. It's just business, constrained only by the cost of shipping and the laws and regulations of the United States and wherever Waste Management would like to export to.

Matt Coz, the VP for growth and commodity sales, who has accompanied Alan and me on our tour of the Houston facility, is in charge of that marketing. As my tour winds up, we stop into a room where bales of what was once recycling, and now qualifies as commodities, are stacked in columns that reach fifteen feet off the floor. “The aluminum cans,” Matt says to me, pointing at a shiny bale. “They're a small percentage of the overall weight that comes in here, but a big percentage of the overall value that comes out.” Put differently: a pound of newspaper is worth a couple of pennies; a pound of cans extracted from that bale is—as I stand with Matt—worth around 54 cents on the North American markets. Now imagine that you have tons of those cans, and you've paid nothing for them: that's the kind of profit that a scrap man, a recycler, is in business to achieve.

I turn to look back into the main room, where a forklift is pulling away with a bale of newspaper, and then I turn my attention back to the storage room. There I notice, stuck between bales of plastic detergent bottles, several bales of what look like large plastic Waste Management recycling bins, wheels and all. “Are those what I think they are?”

Alan laughs. “They sometimes drop into the trucks when the drivers are trying to empty them. Happens all of the time.”

I walk closer to one of the bales. The recycling bins look perfectly good, but for the fact that they've effectively been flattened into two dimensions. They're trapped among two-dimensional buckets, laundry baskets, and a few milk bottles, like a dinosaur skeleton amid fossil clam shells. I recall that in 2008 a group of San Francisco writers—including Jonathan Franzen—held a fund-raiser to buy those nonrecycling hicks in Houston a gift of 276 recycling bins. It was a well-intentioned if somewhat condescending idea, but I'm pretty sure that—if what I'm seeing before me is representative—those bins were long ago flattened, shipped to China, and made into laundry baskets for Shanghai's up-and-coming middle class. Practicality and profits nearly always

trump good intentions, condescending or not, in the global scrap business. "You don't pull them out?" I ask.

"It's not worth it," Alan answers. "By the time they arrive here they've been smashed down in the truck. Doesn't pay to shut down the machine, pull them out, and drive them to someone's house."

This Houston recycling line is one of the newest and most advanced facilities of its kind in Waste Management's growing arsenal of thirty-six single-stream recycling lines. That means, in all likelihood, it's one of the most technologically advanced household waste sorting lines in the world. Still, for all of the things that the Houston facility is, what it's not—and this is very, very important—is static. It can't be: the consuming habits of Houstonians are constantly changing, and thus so is what they waste. This single-stream line will evolve with those changes.

Today, the line is designed and tuned to receive a single stream that's roughly 70 percent newsprint, magazines, and junk mail. But that's changing: more and more Houstonians are reading their papers on e-readers. There are good statistics to back up the shift: according to Moore & Associates, an Atlanta paper recycling consultancy, in 2002 Americans recycled 10.492 million tons of newsprint. In 2011 they recycled 6.615 million tons. As a direct result, junk mail, as a percentage of the recyclable waste stream, is growing. For the purposes of a mechanical sorting line, that's a big shift: junk mail weighs less, and is worth less, than newsprint. In time, perhaps when newspaper drops another 5 percent as an overall percentage of the waste stream, Alan and Waste Management's engineers will have to tweak the machine—maybe add a star screen or two, maybe change the speed of some conveyors—to keep up with the times.

"I like to think of it as making soup," Alan tells me. "Soup can handle a little pepper, a little garlic, but you just can't make pepper and garlic soup. It's a constant mixing, it really is a craft." "It" is sorting what Americans throw away, and if Americans can't be bothered to do it themselves, then Alan and Waste Management's engineers are more than happy to create a multimillion-dollar technology to do it for them. "Those of us who love this part of the business love it because most of us are ADD and need it to be changing," he tells me. "You'd kinda get bored if it were static."

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As it happens, demand for newsprint is growing in China, too, and so is the junk mail. But you won't find a Chinese version of Alan Bachrach making soup, just as you won't find an Indian, Kenyan, Vietnamese, or Jordanian one, either. The reason is that most of the world remains poor enough to justify employing people to do what Alan does with star screens and air guns: sort and harvest recycling. Likewise, if a place is too poor to justify a setup like Alan's, it's probably still too poor to generate enough recyclables to justify investing in the setup.

Consider what happens every night in the courtyard of the Shanghai high-rise where I've lived for nine years. Just past midnight you'll likely hear the clank of a bottle bouncing across concrete. If you follow that bounce back to its source, you'll come to a concrete hut, not much larger than a single-car garage, from which fragrant trash has been spilled several feet into the narrow asphalt road. It doesn't look like American trash: there are few boxes, cans, bottles, or anything else rigid that might have once contained something else. Rather, it's mostly food waste—peels, husks, bones.

Move a little closer, and you might see two or three hunched shadows atop the oozing mess, canvas bags swung over their shoulders, scrounging through it with bare hands, searching for metal cans, plastic bottles, or perhaps something better yet—a stray coin. They're not Shanghainese—the proud Shanghainese would never be caught scrounging through their neighbors' garbage, even in the middle of the night—but often families of poor migrants from farms in the less wealthy provinces, making the best living that they can. For the privilege of scrounging, I have it on good authority, they need to pay a small bribe to the attendant at my building's front desk, and agree to clean up everything by daylight. Both requirements are accepted without complaint, but the latter, in particular, is no problem: the families engaged in this kind of raw material extraction need to visit several compounds in a night if they're going to make a decent living. They need density.

China does not lack for trash to be mined by migrant families. In fact, as of 2008 or so, China generates more trash than the exceedingly wasteful United States—roughly 300 million tons per year, compared to around 250 million tons in the United States. Still, on a per capita basis the Americans have the Chinese beat four to five times over (Americans are richer). For example, Americans consume 653.62 pounds of paper

per capita per year, while Chinese consume 98.34 pounds, and Indians, on average, consume an unimaginably paltry 18.7 pounds. Even accounting for the much larger populations of the two developing countries, and the resulting larger total volume of paper, it's definitely the case that smaller per capita consumption means that households, and scrap peddlers in these countries, face a much easier task sorting recyclables.

The trend is not positive if you care about resource conservation. Chinese consumers are joining the global middle class in droves, adapting the consumption habits that go with that status. For example, between 2000 and 2008—a period of historic economic growth in China—the prepackaged food industry in China grew 10.8 percent. That shift, from buying fresh food to buying food in plastic, aluminum, and glass containers, has had a profound impact on what happens behind my apartment building in the middle of the night—and in Chinese landfills every day.

The good news, for now, is that China sends very, very little recyclable waste to landfills or incinerators. Families that pick through trash in the middle of the night are just the last screen in a profit-driven process that, if you wait outside my building through the night, begins at the gate at first light. There you'll see a squat and brawny migrant woman—she looks fifty, but she's actually in her thirties—waddle across the street wearing a fanny pack stuffed with small money, and carrying a small hand scale. If anyone is the Chinese equivalent of Alan Bachrach, presiding over a system that harvests recyclables from the trash, she is it. Her destination is the pile of cardboard tied with twine that's waited beneath the night watchman's gaze, and a waist-high balance scale of the sort that you might find in a doctor's office. As she pulls out the big scale, the early-rising old ladies in my building wander downstairs carrying a few plastic bottles, perhaps a small cardboard box or two, and maybe a small plastic bag filled with cans. The bottles and cans are priced individually; the boxes are attached to a small hook on the hand scale and weighed. Payment is equivalent to a few pennies, which the early risers take to the wet market, in search of the day's vegetables.

Morning brightens, traffic thickens, and the recycling lady is joined by her slight husband. While he handles the walk-up transactions, his wife ventures up into my building, responding to dispatches relayed through the guard booth: somebody bought a television, and wants the big box in which it was delivered removed; somebody else might've been

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collecting newspapers for weeks, and—at the prodding of a fed-up spouse—wants to sell them. Through the morning, she rides the elevator, up and down, paying a few pennies—the market price—for whatever's available for recycling. Then she carries it down and sorts it into the appropriate piles.

While she does, men on bicycles that pull small trailers begin to arrive. Some are there to buy newspapers, others for cans. Whatever it is they want, they pay more for it than what she paid for it in the building, then tie the goods to their trailers and pedal off. Before the end of the day, they'll sell the collections to a small scrap company, one with a warehouse rather than a street corner. But the concept is the same: buy low and sell high. At the small scrap company, the bicycle recyclers will be joined by other bicycle recyclers, each with similarly modest trailers full of scrap ready to be sold and—later—combined into bigger loads that can be sold to paper mills, aluminum smelters, and other manufacturers in need of raw materials.

There are no good statistics on how much of China's household waste is recycled, and with much of China still rural and undeveloped, collecting such statistics would be prohibitively expensive, if not impossible. But one thing that everyone agrees upon—from government officials to midnight garbage scroungers—is that by the time a load of Chinese trash arrives at a landfill, very little that's reusable or recyclable is left in it. Houston and San Francisco would be very glad to say the same.

And yet: Shanghai doesn't distribute recycling bins to its residents; it doesn't have a local equivalent to the multimillion-dollar Houston Material Recovery Facility; it doesn't have infrared sensors that machine-gun plastic bottles off speeding conveyors. Rather, it has hundreds of thousands of small businesspeople who make their livings by buying cardboard, paper, and cans from millions of people who would never give away perfectly reusable material for free. Whatever is left over is scrounged, completely. There's no need for single-stream schemes to raise the recycling rate in Chinese cities because, in the end, my Chinese neighbors have something that most Americans don't: a recognition that "the recycling" is worth more than virtue.

It's worth money.