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Virtuous Disassembly: Material and Ethical Practice of a Global Electronic Waste Regime

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(VIRTUOUS DISASSEMBLY: MATERIAL AND ETHICAL PRACTICE OF A GLOBAL ELECTRONIC WASTE REGIME)

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ABSTRACT

International regulations have sought to curb illicit flows of electronic waste (e-waste) from Global North countries to Global South countries. At the same time, they provide a means for certified recyclers to imagine themselves as moral entrepreneurs with coherent industrial practices. Making the most value from discarded machines, however, is a process that requires careful attention to the indeterminate materiality of their supply. Used machines' materiality is made indeterminate by the unpredictable amount of human wear on each machine. What this entails for the recycler is a process in negotiation with these unique conditions. Based on fieldwork and interviews with Euroamerican recyclers, brokers, auditors, and regulations staff, this thesis studies the moment a certified recycler decides how to process a discarded machine. It argues that the materiality of used electronics guides the production of ethical meanings and economic value.

VIRTUOUS DISSASSEMBLY: ETHICAL AND MATERIAL PRACTICE IN A GLOBAL ELECTRONIC WASTE REGIME

INTRODUCTION

Global exchange networks, detailed guidelines, and formalized procedures regarding electronic waste have proliferated in the past several decades alongside increasingly rapid technological development cycles. Discarded electronics, I argue, situate its recyclers within an "indeterminate" moment. Electronic waste, otherwise known as "e-waste," encompasses all discarded electronics; it includes, but is not limited to: computers, printers, wires, and batteries. E-waste has gathered increasing international attention in the past several decades due to flows of e-waste from Global North countries to Global South countries (Lepawsky 2015) and the dangers associated with extracting resources from them (Perkins, Drisse, Nxele, and Sly 2014). Machines are made of increasingly complex combinations of elements, and thus require safer conditions and equipment to extract these resources from them.

In European and United States recycling sites, discarded machines are traded in a global network of exchange across multiple facilities. The amount of different processes involved in dismantling machines is due to the rare, valuable elements inside and the potential toxicity in disassembly. A computer, for example, is first evaluated based on the possibility of repairing or reusing it. Should no easily accessible or profitable market exist for it, the computer is taken apart, and valuable components—including common components such as hard drives and parts with ample precious metals such as processing boards—are sectioned off to be resold. If a client's data is sensitive, the hard drive's information is erased and the hard drive itself is physically destroyed. The rest of the torn apart pieces are grouped along with other materials,

and sent to someone who can run them through a shredder, which transforms parts into fine grain pieces. The metals from these pieces are separated with various magnets, and then the remainder is sent to a smelting facility that melts it into a purified resource. E-waste recycling facilities will take on various parts of these processes, but often specialize in different areas or categories of e-waste to keep business manageable. For my research, I am concerned with the beginning stage of the recycling process when recyclers receive electronics that were just discarded. Across these processes is an understanding of the consistent demand for the raw materials in e-waste to produce newer versions of existing machines.

Alongside these highly regulated spaces are the informal sectors found in Global South countries (Oteng-Ababio, Amankwaa, and Chama 2014), where discarded machines are broken down without the specialized tools found in the Euroamerican context. In areas with a heavy amount of recycling, the practices in the informal sector can have serious effects on public health and the surrounding environment (Huo, Peng, Xu, Zheng, Qiu, Qi, Zhang, Han, and Piao 2007). Euroamerican regulations on e-waste recycling have largely been made in response to seeing the potential danger of e-waste recycling and the forms of human and environmental suffering that the West has been complicit in creating. However, these social justice narratives are not the sole reason regulations have come to define the Euroamerican recycling context.

Processing discarded machines involves coming to terms with the varying degrees of human use on each machine. Due to each machine's unique materiality, recyclers produce different material outcomes from each machine to get the most value from it. Regulations of how to treat materials provide recyclers with a lens to approach their industrial processes; at the same time, these regulations imbue e-waste with a morality informed by the illicit flows and informal

recycling these regulations aim to curb[1]. In my fieldwork, I found that although regulations were profoundly important to recyclers in articulating and managing their businesses, their "production processes" were always in negotiation with the material agency of their own machines. Machines have their own force and autonomy, and constituted a productive force for meaning and how recyclers made them determinate. Through disassembly and regulations, the indeterminate value of e-waste is translated back into commodity based capitalism. I argue that by attending to this complex matrix of materials, recyclers, and regulations, e-waste displays the tension between the capitalist call for optimal, efficient business and heterogeneous materials that cannot be easily organized, as well as how this dialectic is contended with at the level of human practice.

For this thesis, e-waste encompasses discarded things containing electronics with varying levels of use and wear. Other phrases used in academic and international literature to refer to discarded machines include "e-scrap" and "used electrical and electronic equipment," or UEE (Pickren 2014). My intention with using "e-*waste*" is to emphasize the cultural, industrial, and geopolitical processes that produce and designate these machines as *waste*. The global e-waste regime is necessarily a process that revolves around physical materials. E-waste is simultaneously made up of both physical, discarded electronics and the network of global actors that break them down. These productive processes move in relation to the varied conditions of each used machine. At each stage of the disassembly process, different specialized actors transform these electronics while at the same time reproducing them as "e-waste." For the

[1] Martinez (2019), drawing on Gregson, Metcalfe, and Crewel (2007), touches on discard from the perspective of the consumer, and has its own implications for the consumers' "moralities of practice." For my work however, I am concerned with discarded things from the perspective of the person who receives the object, and the ethics involved in their approach to the thing-as-waste.

purposes of this work, "e-waste" includes the social problems associated with Global North-Global South export/import patterns, the different ways to disassemble machines, environmental discourse, consumer patterns, and the technical intervention involved in maintaining regulations. Thus, I use "e-waste" moving forward sparingly, only to reference a global phenomena with material and social stakes; I use "discarded machines" and similar phrases to describe the physical waste items. What ties all of these spheres under e-waste is the indeterminacy of used machines.

Indeterminacy of E-waste

As varied as used machines' shape, form, and conditions are, each machine shares something in common: a previous existence as a person's possession. I refer to the moment where electronics are traded or sold to recycler's as "the discard moment." By highlighting the importance of this moment, my aim is to shed light on how these electronics *become* "e-waste," and how this affects their commodification. How can we begin to understand how recyclers refer to regulations not as restrictions to abide by, but as crucial to understanding their supply?

The global e-waste regime is filled with indeterminate moments and encounters. "Indeterminacy," a term I borrow from new materialist scholars, refers to the uncertainty that arises in specific circumstances or conditions. During indeterminate moments, the outcomes of the "encounter" between actants cannot be predicted through any sort of deterministic model. I utilize the term here to speak to the uncertain condition of discarded machines as well as how recyclers make their own informed decisions in relation to extracting value from each machine.

Commodifying discarded machines is unique due to their history of human use and their hybridity; electronics are discarded due to an immeasurable amount of reasons. Discard can be motivated by extensive use to the point an electronic can no longer work—such as a depleted

battery, or physical damage that hinders its use (e.g. cracks in a phone screen), and cases where repair is a less economical option than replacement. Alternatively, discard may have nothing to do with the immediately recognizable forms of wear and instead be motivated by professional or recreational demands that require newer technology, or the person may simply buy into the allure of advertisements for the machine's newest version. No matter the reason, waste items are touched by human possession; this includes the less common, but still notable, cases where recyclers are given nearly perfectly functioning machines.

METHODS

Between May 2018 and July 2018 I, along with another undergraduate researcher, Nhi Nguyen, and my research mentor Dr. Tahir Naqvi, made two site visits to recycling facilities. Nhi and I interviewed numerous actors in the e-waste regime by phone, ranging from the Basel Action Network officials to staff in other e-waste sites we could not visit in person. A third field visit was made to ECS—at the time, it was one of the leading figures in the industry with regards to its size, scope, and historical impact. However, we witnessed the volatility of the industry firsthand, as ECS shut down nationwide the afternoon before our meeting, and we arrived to find a building closed off in chains. Following this I traveled to E-Scrap 2018, an annual international conference for people in the e-waste industry to learn more about the state of the business and network with other people. There, I had dozens of informal conversations between sessions and outside of the conference with recyclers.

LITERATURE

Commodity Criteria

Discarded machines as capitalist supply calls on us to expand our understanding of commodities in order to account for how indeterminacy shapes the outcomes of recyclers' productive processes. Labor transforms the material of waste items, imbuing them with new value (Marx 1976), but production process negotiated with the specific condition of each machine. This model presumes the economic inputs are raw, unprocessed materials, so how can we account for the fact that discarded machines were once brand new commodities? Appadurai (1986) expands and critiques Marx's labor theory of value by rethinking how things can become commodities. Building on Simmel's (1978) assertion that series of exchanges can themselves produce value in an object, Appadurai brackets Marx's assertion that labor is the only way things can gain value. Use-value then is an emergent property of social exchange that does not precede the exchange. Similarly, discarded machines gain value as they move through facilities and are processed in an exchange network. Although influenced by market prices of various precious metals, exchanges are negotiated at the individual level, and these market metrics are influential references, yet not deterministic. Appadurai continues to expand our imagination of value and commodities by proposing that anything is a commodity that is simply gifted, traded, or sold. To be a commodity, a thing must be "at a certain *phase* in their careers and in a particular *context*, [and] meet the requirements of commodity candidacy" (16). His definition allows us to understand how things may become commodities at different times without assuming any labor-time transforms its materiality. A commodity then, is simply anything that is exchanged, given, or traded between people. "Commodity candidacy" helps us understand the circumstances "legitimate" waste is exchanged under; it describes the "exchangeability of things in any

particular social and historical context" (14). For certified recyclers, this exchangeability encompasses prices agreed upon, the conditions the waste was processed in, and the seller's trust in the buyer's ability to continue processing the material in compliance with the former's recycling standard.[2]

In the Euroamerican context, I propose that recycled machines' value is composite. It is both moral, by virtue of the regulations that standardize it (Dunn 2005), and economic, in that electronics are exchanged across geopolitical contexts through agreed upon prices. As I explain later, the e-waste regime is not merely just a question of pricing or even of representation. Regulations prescribe meaning to various actors in disparate contexts with facilities of varying compliance. These same regulations provide a framework for excavating and searching for use-value within the machines.

Slater (1997), drawing on Haug (1986), posits that a commodity's use value is only realized the moment the consumer uses the object. That is, the commodity before it is bought merely represents the promise of use-value for the consumer. At this stage, the commodity's drawing power comes from what Haug calls "commodity aesthetics," the "representation of the commodity's promise not only through advertising, but through salesmanship, brand names, design, packaging and display" (Slater 1997:113). Discarded machines are imbued with a particularly powerful commodity aesthetic, an effect of carefully crafted regulations discourse and the effect of other social institutions. Newsletter accounts of e-waste are charged with visceral images of what regulations claim happens when machines are broken down by uncertified parties. Images circulate of unnamed children stranded in forlorn scrap yards,

[2] E-waste regulations stipulate that a recycler's "downstream," whom they sell their processed materials to, is also compliant with the original recycler's standards. If a downstream vendor is found out to be in violation of these standards, then both recyclers are reprimanded based on the violation's severity.

providing a sentimental backing to regulations' existence. The onset of the "Anthropocene" has also played a role in e-waste's urgent narrative[3]. Lastly, the promise of a "circular economy" (Isenhour and Reno 2019) inspires a moral duty on behalf of the recycler towards combating larger techno-consumption patterns. While I do not deny formal recyclers' efforts in curbing the harmful effects the heaps of machines pose to environmental systems, their collective work is, at best, a system of damage control. A recent report from the Basel Action Network (BAN) states that approximately 61% of waste electronics originating in Europe is exported to "developing nations" and were "highly likely to be illegal" (Puckett, Brandt, and Palmer 2019:3). Thus, at worst, formal e-waste recycling can be the guise for illegal processes and the continuation of the very global flows the regulations sought to eliminate. As I will show later, this commodity aesthetic is leveraged and reified as certified recyclers organize their materials and navigate the market.

For the recycler, the discard moment complicates commodifying these objects, as a machine's designation as "waste" calls on the recycler to understand the implications of "waste" on the machine's condition. This waste commodity candidacy (Appadurai 1987) is related to, but radically different from the types of commodification that happen when someone decides to sell a phone (for example) on eBay. Second-hand fully functioning machines sold in online marketplaces differ, in that they are commodified in terms of what they "lack;" their value is fluid and relative to its fully functional counterpart. The reseller's value decision making process is negotiated with the price of fully functional units. The used machine's indeterminate value is affected by the market prices of fully functional units when recyclers resell or repair machines, *a*

[3] The Anthropocene is a geological epoch wherein the bulk of earth's environmental changes are due to human processes, and humans in turn are (in general) conscious of these changes (Clark 2015). Anthropocene discourse is implicit in conversations that frame e-waste as a shared international problem that requires international solutions.

crucial difference is in the recycler's relation to the machine. Whereas a reseller is aware of their own history of use, recyclers are left to make sense of new and unique machines that enter their warehouses. Moreover, as recyclers have a business built on waste—as opposed to just selling a used phone for extra side money—they have must have more options available to them for getting value out of their supply[4]. While my informants would introduce themselves to others saying phrases like "I specialize in repair," it was understood that in no manner did they *just* repair machines. Rather, to make profit out of discarded machines requires a broader sense of the possibilities of value. As I show later, this imaginary is mediated by my informants with the ongoing uncertainty used electronics' materiality poses. For the recycler, confronting the agency of machines is already in motion the moment they receive their supply. At each stage of the disassembly process, different specialized actors transform these electronics while at the same time reproducing them as "e-waste."

Waste, E-Waste

Waste studies have increasingly considered the material agency of discarded things (Colloredo-Mansfeld 2003; Hird 2012; Pickren 2014; Reno 2015). Following actor-network theory (Latour 1987), scholars have described waste and waste sites as assemblages whose qualities pose challenges managing it (Reno 2015). Waste's unpredictable qualities—such as bacteria flourishing in a landfill (Hird 2012) or an electronic's history of use—constitute nuanced elements of waste's ontology that no regime of human knowledge or practice can completely take into account (Pickren 2014). I draw on and continue their efforts by studying discarded machines' specific materiality as objects that are both non-human, in that it is

[4] See Isenhour and Reno (2019) for more on repair's specific relation to materiality.

composed of various elements, and human, in that its form was created by human labour and its condition is a result of human usage (Gille 2010:1051).

Alongside these new materialist scholars, a diverse body literature has risen in the last two decades tracing international waste flows (typically from Global North to Global South countries). These articles focus on the social justice issues that arise from replicating colonial relationships. Rather than exploiting Global South countries for their raw resources, these countries become sites for waste exile, where the Global North is able to leverage underpaid labor to procure further raw resources (Furniss 2015; Gregson and Crang 2015; Gregson and Crang 2018; Inverardi-Ferri 2017; Lepawsky 2015; Oteng-Ababio et. al 2014; Perkins et. al 2014). E-waste is often written about in the context of China (Tong, Li, Tao, and Cai 2014; Gregson and Chang 2018; Inverardi-Ferri 2017) or in various West African countries such as Ghana (Amankwah-Amoah 2016; Oteng-Ababio et. al 2014). Ghana, China, and more recently Pakistan[5] have been studied extensively as major sites for waste exportation. In these accounts, the Global North actors involved in the waste exchange network are sidelined in favor of shedding light on the forms of suffering, environmental degradation, and informal markets that emerge out of these international relations. My intention is to add to this literature by unpacking the way waste is produced by the various industrial actors in the formal, certified sector of e-waste. I mention this body of literature on illicit flows of e-waste because in my talks with certified recyclers, these sites of abjection are drawn on to construct their identity as moral entrepreneurs whose regulations provide a legitimate structure to their workplace. Thus, while these conversations on human rights are certainly pressing and represent real suffering, I bracket

[5] In April 2018, China declared that it would no longer be importing several types of metals contained in e-waste starting December 31, 2018 (Redling and Toto 2018). Pakistan was already importing e-waste; my informants explained that this policy directed more of the flow south towards Pakistan and other South Asian countries.

these topics for the purpose of elucidating on other important components to the global e-waste regime: the series of decisions that are made in response to its materiality in the formal, regulated e-waste network.

Pointing to e-waste as a global phenomena, I am not suggesting that electronics are discarded in identical or even similar contexts across the globe, nor am I claiming that those who exchange it subscribe to identical representations of what constitutes "waste." Rather, by referring to e-waste as a global assemblage, I highlight the collection of actors involved in its production, exchange, and dissassembly processes who are interconnected through material relationships but not guided by a singular rationality. Using global assemblages as a heuristic allows us to attend to what Ong and Collier have referred to as "a source of tension and dynamism for the forms and values of human life" (Ong and Collier 2005:10-11). What constitutes as "valuable," what means must be taken to achieve it, and complex sets of morality are constant sources of tension for those who deal in e-waste.

My approach to e-waste is predominantly informed by Gille's work on "waste regimes" (2010). Gille critiques previous accounts of waste that hyphenate it onto existing social categories, such as "waste citizenship" and "waste management," claiming that these accounts do not consider the way material "becomes materially, socially, and spatially *waste*" (1050). Utilizing Actor Network Theory, Gille calls on us to see waste as something other than a socially constructed category, and instead see how waste itself can be constitutive of social life. Her work merges the macro, institutional processes that categorize waste, and the micro, material agency of waste, together in her notion of the "waste regime." If an analysis concerning waste does not attend to the production of waste, then it runs the risk of reifying waste as a natural outcome of exchanges. Moreover, in my fieldwork recyclers and regulations both implicitly recognized the

material challenges e-waste presented to making a business out of discarded machines.

In my analysis I claim e-waste constitutes a global waste regime. Gille's concept originally takes nation-states as its plane of analysis in that different countries have specific histories that inform the way its institutions come to define waste. However, as e-waste's productive process encompasses a global network, and since the regulations that govern it are created towards an international constituency, the e-waste regime is certainly a global phenomena. Waste is generated at one nation, but often times travels to others to be processed with equipment not found in the host country, or, more often the case, is illegally shipped to exploit informal markets. In each case, e-waste is a global waste regime in the sense that it operates under a shared set of meanings—in this context, what constitutes as waste is no longer just culturally informed. E-waste's commodity candidacy is not contingent on any shared culture, as this would be an impossible claim if we accept e-waste as global in nature. Rather, e-waste's shared meanings derive from the centrality of regulations in order for its actors to make sense of the materials they work with and exchange. By treating it as an assemblage and regime, I consider the human ways of life that constitute waste (the productive processes, human decisions when faced with machines). Attending to e-waste as a global but shared regime requires consideration of the practice that move in relation and response to waste, varying across international lines and regulations, at times in resonance and at others in stark contrast. This allows us to account for the dissonant processes that constitute e-waste as it moves across international lines. Expanding our plane of analysis to the global scale is necessary to account for the actors and actants involved in it. If commodities can themselves be constitutive of social life (Miller 1995), rather simply representations of it, then waste can be too—so long as we accept it as something more than the "extra" unwanted commodity, the "surplus" of exchange (Gille

2010).

Regulations

Through an ethnographic study of how R2 certified recyclers structure and practice their businesses, I elucidate how the production of e-waste is a process of commodification and regulation. Scholars have written about how regulations impose morality on different production processes (Dunn 2005), or the technologies that regulations use to manage practices (Wynne-Hughes 2015). In this work I attend to e-waste's complex creation cycles through an ethnography of what De Neve (2009) refers to as "the politics of ethical compliance." Ethical compliance describes how "ethical corporate regulations are shaped by and constitutive of power relations and inequalities in the global market. It explores the ways in which ethical and social standards… mold social relationships between different actors in transnational production chains" (63). De Neve's work influences my approach to understanding these practices guided by regulations as a type of "ethics," a series of constant evaluations made in regards to their material inputs. My interest lies in how international e-waste regulations are understood and implemented in certified recyclers' industrial processes and decision making. These evaluations are necessary to increase profit margins. However, the materiality of machines actively presents difficulty in being converted into easily comprehensible, efficient business models.

I find that recyclers carefully mediate the "indeterminacy" of their waste items by relying on regulations to help categorize them, tear down them efficiently, and choose which actor to send their byproduct to. Regulations intervene and guide practice. That is, while they provide a set of rules to legally process waste and ship it overseas, the machines' commodity candidacy as "waste" entails a production process that is not concerned with making identical material outcomes (i.e. a product) of each input (the individual electronics). Instead, recycling machines

is always in pursuit of whatever material outcome makes the most profit from that specific machine. Thus, I argue, regulations *guide* e-waste practice in compliance by giving recyclers a sense of themselves as managing a coherent, industrial process—as opposed to the enduring decisions they make with their supply. By attending to indeterminate recycling practices guided by regulations, my hope is to create a picture of compliance that moves past a dialectic relationship between capitalist actor and regulations.

MAKING SENSE OF WASTE

Taking Inventory in a New Orleans Ballroom

E-Scrap 2018 was the latest iteration of the well-known international conference during my fieldwork. The conference attracted a diverse body of attendees from around the globe and from different sectors of the e-waste regime. On its second day, the coordinators arranged networking lunch as a brief interlude between the conference sessions. Dozens of recyclers, brokers, auditors and consultants filled the Hyatt's ballroom and sat at its many tables. At my table, I was joined by four recyclers and a broker. Jason, the youngest of them, explained that he was two months into the business and had been running a small facility with few clients in southern California. Eager to help, the table's discussion quickly became centered on the types of struggles he was encountering that were familiar to the others.

"How do you guys sort things out?" Jason asked, plainly.

Scott, who had earlier claimed he had recycled for fifteen years, was visibly confused, "What do you mean?"

"I mean … how do you categorize all of the different types of things you're getting from your clients?"

Mark suddenly understood what he was poking at, and said, “Well, what kind of things *are* you getting?”

Over the next ten minutes, Mark and Scott helped him make sense of his inventory, asking him questions about how much waste was coming in, what grade their parts were, and how often it came in. Jason was partnered with several local businesses to take in their office technology, ranging from the highly valuable leased computers to the nearly valueless printers[6]. His problem was twofold: one, he needed to have clear categories to put all of the computers in so he could make his industrial process smoother and at the same time make his resell market simpler to view. Two, he needed a way to keep a record of everything that could keep up with his supply. Since he was uncertified (but was looking into certification), Scott recapped R2’s “hierarchy” of reuse, repair, and recycling, adding that he would have to figure out to what extent he wanted to repair machines. “You’ll have three categories of computers,” Scott explained, and it was up to Jason to decide when repair was more feasible or if it should be scrapped and resold. Scott’s three categories could be split between high end machines, middle ground machines, and the bare minimum someone might buy on a budget. Although regulations were invoked to provide meaning to *the process* of categorizing inventory by these industry veterans, this merely provided a rationale for what he might consider doing with the computers. Decisions regarding what to do with machines were always contingent on what Jason was actually working with, rather than some overbearing model. To think through what he ought to do with his supply, the table needed information about what models these computers were generally, what shape they were in, and what they might have been used for before he received

[6] Printers are difficult to make a profit out of since they are for the most part, large plastic shells with few precious metals in them.

them. Used machines, I realized, were a fickle material that had to be forced into easily identifiable categories so these capitalist actors could move towards an efficient industrial model.

Tsing (2015) has discussed this process of making indeterminate supply "legible" for capitalist "inventory" (64). In one part of her work, Tsing traces the path of the matsutake mushroom as it is picked in rural landscapes and then transported to an international marketplace. Whereas the foragers have an intimate relation with forests where the mushroom grows, the warehouse workers they deliver their produce to are unconcerned with their history—they work to sort the mushrooms along their size and maturity, categorizing them along easily understandable metrics. Making the mushrooms "legible" by reducing them to quantitative data is how their indeterminacy is "translated" into a capitalist rationality based on efficiency; it is a process that produces new knowledge of this non-human life (128).

Like Tsing's warehouse workers, e-waste recyclers need to "translate" their supply's varied histories and conditions to attempt practicing efficient capitalism. Machines' indeterminacy encompasses a whole new set of qualities by virtue of e-waste's human/non-human hybridity. For recyclers, the history of machines *is* important, as human-use opens up new possibilities for how to commodify machines. If "knowing waste is rendering the indeterminate determinate," then making inventory in response to incoming supply is simply the first step in addressing used electronics' indeterminacy (Hird 2012:454).

My field visits with recyclers showed me that categories are not enough to conduct business; they are simply the pretext. Human use comprises discarded machine's commodity candidacy as "waste." That is, the shared meanings of used machines as a commodity differ when say, a secondhand iPhone is sold on an online marketplace like eBay, where the eletronic's use-value is compared and discounted from fully functional units. When machines are treated as

"waste," their commodity candidacy is not relative to a fixed use-value, but an indeterminate use-value that covers more than just their functionality. Legible inventory is a lens to machines and their possibilities of value.

Encountering Waste

Alejandro was the second R2 recycler we met in the field; unlike our first informant, Mary, Alejandro was his company's CEO and let us see his facilities in person. After dozens of interview rejections, our research team was eager to see a facility up close. We arrived at his site to find a warehouse with an adjacent building. Inside along the walls were shelves of sharpie-labeled gaylords filled with various sorted metals. A few wooden tables with smaller cardboard boxes were set up to create a small workshop space, and a tool room rested beside this work area. For how complex electronic disassembly was, I was surprised at how little was needed for the initial stage of breaking things down.

At his facility Alejandro takes in machines as they are first discarded. His workers sort through the machines and tear them apart, keeping easily sellable parts like hard drives for the company to resell. The rest is further disassembled into pieces or parts and packaged to be sent to another facility to be shredded down to fine pieces. Early in our conversation, we asked him about what types of machines he tended to deal with:

> We get all conditions. We really create an outlet here for either resident, local communities, or surrounding communities to have an outlet to properly recycle equipments they have, or in storage for ten years. We receive materials that happened three years ago with the major floods[7]. The flooded materials all came

[7] His city had severe flooding several years back, resulting in a demand for people to help distill the various waste and rubble accumulated from the damage.

> here because...they are no longer useful. But what are they gonna do? Don't throw them in the trash! They can't go to a landfill. So...we get all ranges you can think of, whether it is old, old old, to newer stuff, whether it is something that broke, or "I've got a new phone screen that didn't work, I just wanna get rid of it."

Presented with these materials, Alejandro is faced with the difficult process of assessing their conditions and deciding what methods he can take to procure value from them and who he can send the remainder of the material to. The indeterminacy expressed by these devices is not whether or not a recycler has enough waste to work with; the indeterminacy lies in the decisions they must make to get value out of them. Any industrial actor is faced with decisions regarding what materials they work with, the labor they employ, and the businesses they deal with. Alejandro, as a private industry, certainly has agency in deciding who he accepts waste from and what types of waste he accepts. On his website he has an extensive list of what he does process and what he does not, alongside what guarantees he can offer for specific methods of disassembly[8]. A key component that drives this indeterminacy is the unpredictable history of human use and the implications this has for the "affordances" it offers the recycler, that is, the uses they see in the context of a profit motivated practice (Keane 2018).

Identifying what affordances to act on requires an adequate inventory rationale. Alejandro, much like Scott's recommendation to Jason in the ballroom, set a "tech cutline"; any computer with a P3 processing board or above would be considered for repair. Alejandro checks for immediately visible damage, then removes the hard drives and runs through all of a computer's functions: "Is the RAM working? Is the memory working? Is the processor working?

[8] E-waste clients may have sensitive data on hard drives they send, such as company information or patient/student files. These clients pay to ensure that hard drives are physically destroyed rather than simply having their memory erased from the hard drive and then reselling it.

Is the …" He ran through a series of questions relating to its use that, at that time early in our research, was dizzying to hear. There are ample things that must be assessed in order to know waste and its potential. Alejandro added to his description of his supply, explaining how he reacts to his inventory, rather than controls it:

> … so in a sense yeah, we don't have control about what is coming in or what are we gonna get. For us, we don't really focus on that … But because it varies and varies and so forth then, we really just focus on the **condition** of that machine, what really dictates what's gonna happen.

Alejandro acknowledges the impossibility of ever having complete control over a determinate supply, so he structures his actions in response to the "condition of that machine" because that is what "*really* dictates" what he will do (emphasis mine). He can determine the actions he and his workers take in response to objects, so these are where he focuses his efforts to make waste determinate. Of interest to me was how much of used machines' materiality was due to its existence as a non-human/human hybrid object—it was apparent that his relationship to his supply was notably different from a relationship a factory might have to what we normally might consider raw resources, such as wood or plastic. Whereas these raw resources are acted on and transformed by labor into products, Alejandro's practice was in response to what his resources presented to him. This tension between a commodity turned into a resource and search for value reflects these waste items' status as non-human/human hybrid objects. Since each piece of waste has their own unique history of human usage, "knowing" your waste means analyzing each machine's materiality. And, if the only way to fully understand waste is through practice, that moment of deconstruction on the warehouse floor is where waste history is attempted to be made determinate.

As an entity created and utilized by human actors, electronics become indeterminate when used by human actors within different geographies and temporalities. Alejandro's computers are massed produced in identical conditions on assembly lines, and exist in a determinate state. However, machines reach indeterminate conditions when handled by unique human actors, who use these technologies for their own unique purposes. When these products are discarded and become e-waste, the way that they become e-waste is indeterminate and specific to the technological context in which it exists. To explain this, we must consider the holistic state of machines' combined heterogeneous elements as its own sort of materiality. A device, as a combination of non-human elements and human labor, has its functionality as a part of its material agency. That is, the ability for a computer to function is a facet of its materiality, just as the elements that lie within it are also its materiality. Functionality is an opportunity for a machine's materiality to become indeterminate. Since as the wear of human actions is different in each waste item, it becomes an indeterminate materiality in this specific sense. As a product, that is, before it becomes designated as "waste," a machine's functionality reflects a certain kind of indeterminate "beginning" and "end" of the machine.

To account for this indeterminacy of used machines' conditions, my mentor, Dr. Tahir Naqvi, referred to them as "snowflake" commodities, explaining how each individual machine could be the same model, but must each be approached as a unique object. Even though Alejandro has a list to filter out machines his company does not want to process, he still must confront this individuality and subsequently have a system to sort through the different types of machines. Popular computer models can be sorted into reuse or torn down "at a glance" according to him, yet they each have their own flowcharts for how his workers should approach them. If a computer is going to be torn down, then workers will still assess the quality of each

part before it is sorted out into each respective container. A computer with resale value will be tested for its key functions because, as I have mentioned, they are touched by human use and subsequently its ability to perform its expectations needs to be figured out. I argue that they have been "touched," rather than "defined by" human use because in the cases where machines are torn down, human use is irrelevant to the relative scarcity of precious metals and rare earths. Human wear imprinted on machines has no bearing on market rates of copper or platinum, at least not in a direct causal relationship way. The indeterminate encounter with waste encompasses much more than just the machine's condition.

Markets: Domestic and International, Labor and Capital

The e-waste industry is not concerned with *producing* finished products; e-waste is a practice of disassembly and scavenging. That is, whereas, for example, a fashion line may make clothing, e-waste productive practices do not revolve around a particular product. Rather, e-waste's formal productive actors are solely concerned with extracting value from discarded electronic and disposing of the materials that they cannot get value out of. Value, rather than a definite image of a finished product, guides their practice. Machines are combed through and assessed for the use-value available to the particular actor based on what services their facility decides to offer; the rest is designated as exchange value for their downstream. Indeterminacy comes out of this lack of product-oriented practice prompted by the machines' materiality and waste commodity candidacy. Recyclers, in response to this supply, must make decisions about how they want to make value out of their materials.

I have described thus far two ways that recyclers make waste determinate in how benchmarks are set to sort supplies and how each machine is treated individually. These are intimate ways of relating to waste, what we might understand as the small scale personal relation

to e-waste. Alongside this exists a far wider network that must be attended to: the marketplaces for refurbished electronics and raw commodities. These larger scale networks also contribute to machines' indeterminacy, as they inform what decisions recyclers will take to make value out of these objects.

In this section, I unpack the market dynamics recyclers contend with along with the labor that enables and constrains possibilities for value. The complexity and number of processes that must be done to fully break down waste mean that it is extremely challenging for a certified recycler to completely break down a machine from a functional unit to its base raw elements. Rendering used machines determinate means choosing and rejecting paths to value. Mary, our first R2 informant, had a prodigious history in the e-waste industry. Currently, Mary is part of a non-profit organization where she manages waste donated from the surrounding area. As a part of a larger facility than Alejandro, Mary is joined by technicians and market analysts who ascertain if there is a market for any machine, and if so, where it would be best to sell it at. Her team includes specialists who analyze aggregate data on second hand machine markets, ranging from online platforms to other stores. Finding a marketplace for waste, we learned, involves experimentation and patience. Mary explained the ongoing process of making waste determinate:

> We're constantly trying to categorize, okay yes if it's this it goes here, if it's that it goes there—and it's always changing. Always. We have to work very closely as a team. We meet every week to talk about our operations and what we do, where decisions are going to be made, and every day I'm working with the technicians on "I want you to work this product this way" or "I want you to do this this way." My inventory specialist … he works directly with the stores to talk to them about what's selling what's not selling. And he goes out—we're going out to a store this

> afternoon—to see what customers are doing, so we can come back and say "okay that makes sense, we're going to put that back in the store" or "no we're not, they're not buying that." So we're constantly evaluating, it never ends.

Categorization continues to guide e-waste production for Mary, but since her business is donation based, she primarily receives much older machines whose marketplaces are not immediately obvious to her team. She described this process further, explaining that her organization monitored wholesale channels (where products are sold in bulk) in online posting boards and in-person discussion groups, collected data on market prices for precious metals, and finally, "tested the market" themselves by putting a few of their machines out in their retail stores. These machines are ones that she assumed there might be market for, but had no data on hand for. Older machines can also have their own vintage market niche worth considering—but they also can have more recoverable resources inside of them, increasing their tear down value. These older machines also present a potentially valuable object to sell for resource recovery. Engineers have cut down on the amounts of gold and copper used in technology, making the production process more cost efficient for the manufacturing company, but older machines still hold ample amounts of gold and other precious metals. Her desire to continue testing markets for value shows how just because a machine has perfect functionality does not mean the most value can be gained from reselling it. Furthermore, if a market does exist, then it likely has to be actively searched for. Sometimes this requires some creativity and experimentation on behalf of the recycler; other times it entails searching for markets out of the United States.

Similar to Mary, Alejandro assessed market trends and found that his supply of older Kindles had a lively market in Mexico. The Kindles' use value, as e-waste, was difficult to find in the United States; his turn to Mexican markets should be understood as a way of determining

these machines' use-value by considering different social arenas. While the Kindles are fully functional, their datedness comes into contact with specific geographical contexts; with newer and newer codes for machines, such as operating systems for computers, their perceived use value of them lies in an indeterminate condition. Machines become "outdated," an effect of their human environment; but, the "datedness" of objects is relative to the environment it exists within. The combination of indeterminate human usage and purposes for discarding machines (such as accidental damage, perceived uselessness, outdatedness) render the value of this waste indeterminate.

I have shown in this section the ways used machines represent an uncertain encounter for those in the industry. Waste items' past use-value as a brand new machine is made indeterminate through human use. Its status as "waste," created by discarding it, presents a history that the recycler must assess to determine what value affordances they can act on, and what affordance they *should* act on. The condition of the machine is coupled with large scale quantitative data to render it determinate; therefore, an ethics of waste involves attention to both the intimate, particular qualities of each machine as well as global market trends.

ETHICAL COMPLIANCE

History of Regulations

Throughout my time with certified recyclers, the R2 standard was continuously invoked as a way to explain their positionality as a formal recycler with clear productive processes. Since this was a prevailing theme in my fieldwork, I now briefly delve into the history of electronics recycling regulations to unpack their prevalence in these narratives.

In the 1970s, various "developed" countries, such as the United States, created stricter

laws such as the Resource Conservation and Recovery Act (RCRA) for disposing hazardous waste. A decade later, several international issues arose where ample amounts of toxic waste was found in "developing" countries, sent over from "developed" countries[9]. Two standards emerged to address the global flows of e-waste. Pickren (2014:27) concisely describes the differences between R2 and E-Stewards:

> "While both standards seek to eliminate hazardous e-recycling practice in the global commodity network, they differ over when and where used EEE should be treated as a commodity or as a (hazardous) waste. R2, partially crafted by the scrap industry, casts the export of used EEE largely as a process of commodity circulation, 'resource recovery,' and 'bridging the digital divide' and therefore seeks to use certification to reform trade. On the other hand, e-Stewards, which is administered by BAN, uses certification to voluntarily impose a North-South export ban on what they describe unequivocally as the 'toxic trade of hazardous wastes.'

Although e-Stewards was created by the Basel Action Network, the NGO created after the Basel Convention—which first brought e-waste into the international spotlight—, my informants explained to me that R2 has been steadily increasing in popularity worldwide. When I met e-Stewards representatives at E-scrap 2018 they echoed this sentiment. When asked about why they chose R2 over e-Stewards, my informants largely drew on R2 discourse (such as the "circular economy") and asserted that e-Stewards was too costly for business. E-Stewards staff in

[9] The Basel Convention was held in 1989 to address the growing environmental and geopolitical issue. A treaty was produced from the international conference banning the export of hazardous waste from designated OECD countries to non-OECD countries. "Waste," under the Basel Convention, is defined as anything that contains toxic, flammable, or corrosive parts or is categorized as hazardous waste by either the exporting country in question or the importing country (Basel Convention: 1989).

attendance lamented their declining popularity, and conceded that R2 was likely gaining traction due to its lax standards and the ease this afforded them in making international transactions.

R2 and e-Stewards, despite their ideological origins and differences, do have some inherent things in common. Regulations exists as a formal system of values and representations that facilitate the ongoingness of e-waste. Regulations, as a shared set of meanings, are the means through which e-waste's commodity candidacy is realized (Appadurai 1986). I argue each standard puts forth its own claim to the status of e-waste and how it ought to be handled both domestically and as a part of an internationally connected network.

A driving question that emerged out of my time with recyclers is how regulations became the predominant force for these capitalist actors in processing and articulating their machines. Regulations exist in other industries, either relating to workers' bodies (OSHA), the materials themselves (FDA), or the environment (EPA). Rather than outline how different machines processed in different geopolitical contexts attain various degrees of "legitimacy" or are "normalized" along a standardized gradient (Dunn 2005), my intention is to show how regulation guides a particular form of ethics in a site of indeterminacy. Although regulations symbolically guide how objects are to be seen and assessed, this section is concerned with how these regulations are used as tools for translating materials in practice. Practice in this sense encompasses many things. It includes, but is not limited to, finding the right downstream vendor for whom to send materials to, assisting workers in figuring out how to disassemble a new machine, and the process of organizing machines into easily identifiable categories. Through attending to these practices, I show how use machines' indeterminacy affects their production processes across geopolitical contexts.

The most common regulations narrative from recyclers is how it lets clients feel assured that their concern over waste ends with discarding it at the recycling facility. This is more important for institutions with sensitive data—hospitals are legally required to erase all patient data from their discarded hard drives; businesses may want to ensure trade secrets are kept within the company. On top of this, there is also a concern for a company's waste being illegally exported and exposed by media, tarnishing the image of the company or city[10]. In this sense, becoming certified is a pragmatic business decision to attract customers. Upon further probing, recyclers never articulated compliance as constraining their processes, save for when they disclosed their payments for audit agencies. Rather, regulations provided them with a language and rationality that gave meaning to the many parts and elements in machines as well as their own industrial action. Since electronics recycling is indeterminate, that is, their industrial practice does not *produce* products, and instead produces materials and parts needed to make further commodities, compliance is able to exist as a binding force for the industry, providing a much needed rationale for grappling with their supply.

Landfill Imaginaries and Flowcharts

Recyclers would mobilize certifications as a sort of cultural capital to secure clients and construct their identity as an efficient business person. Regulations were seen as the means to avoid illicit flows of waste along with the forms of human suffering associated with them. Alejandro spoke to this narrative most clearly when articulated his business strategy as capturing all of the value he could in contrast with "the landfill," which was on one hand a real, physical place, but also a symbolic space of lost opportunities and abjection. "The landfill" acts as a foil

[10] For one example of this, see Mottola (2005).

for responsible recycling that both is efficient economically and morally right. At times Alejandro referenced it to explain the dangers electronics could have if their elements seeped into the soil. More often though, the landfill was used as an impetus for thinking critically about how to evaluate waste. Pay attention to the way the landfill is posed in opposition to him in the following remark,

> Personally as a business standpoint, our focus as a wholesome company is to test and resell every market materials that still have "life." So our goal is to keep it the furthest away from the landfill as long as we can. So seeing that we were missing out some of those opportunities was what led me to ask the question "why" or "how am I missing it," and "what do I need to do in order to gain some of that material …"

E-waste is not exclusively associated with the landfill imagery; by drawing attention to it I am not claiming that recyclers rely on domestic and foreign landfills to construct their practices. Rather, Alejandro, along with other recyclers I met at E-Scrap, invoke the landfill in articulating their practices, revealing one way the indeterminacy of e-waste is acknowledged by them. The landfill is a metaphorical space representing the limits of the recycler's ability to make their waste determinate. It is a threat that catches everything that the recycler fails to consider, leading Alejandro to question himself, "What do I need to do in order to gain some of that material?" These regulations moralize waste processed in different geopolitical contexts (Dunn 2005), associating e-waste processed in informal sites with implicit untrustworthiness. This intense moralization of e-waste practice "moulds social relations" (De Neve 63) between the compliant sectors and informal spaces, while regulations consistently are structuring—and imagining—the former as a coherent, industrial process. Regulations moralize waste, restrict

recyclers from illicit avenues, and require them to sanitize data should the client ask. What they do not offer, however, is a totalizing gaze for waste through which all materials can be rendered determinate through flowcharts and carefully articulated policy.

Despite this lack of structure regulations provide, recyclers do lean on them to describe their industrial processes. Alejandro enthusiastically pointed to the thick binders hanging on the wall behind him and explained he wrote out his company's flowcharts and strategies for compliance with his wife when he started his company. He drew on R2's language to explain the necessity of these flowcharts:

> Part of the R2 standard is testing the material for key functions. That then breaks down into detail. In our manuals, I can pull that out, show you "here is our testing process," and then all that is written down is what all he [the worker] is doing. So, there are two lines where we can in go in R2, ready for resale. R2 ready for resale can be something that is fully functional, tested, and remarket. And then there's R2 ready for repair: still functional but it may have some issues. There then, we can move that material to an approved vendor, who is gonna repair that material to get to the reuse-remarket stage. So there's lines there to disposition and sort accordingly.

Alejandro employs R2's categories for types of waste to divide his supply into broad categories, "ready for resale," "ready for repair," and "ready for recycle." In my conversation with him and other recyclers, these regulations were seen to be primary means to understanding discarded electronics. But, even he acknowledged earlier that the conditions of these materials was what "really" guided his industrial action. Neither Mary nor Alejandro's specific industrial actions are the natural conclusion of a regulation that stipulates that an "electronics recycler shall

repair and refurbish *as needed*" (SERI 2013:11), emphasis mine. Nothing within the regulations dictate that Mary should take out a 120GB hard drive out of a computer she wants to resell, and replace it with a 160GB hard drive (minimum) she extracted out of another machine. Her decision to do this is informed by the testing and data accumulated by her and the rest of her team. How are we to make sense of an productive process that, on the one hand, appears to be guided by an intimate relationship with the unique materiality of machines, and, on the other hand, is articulated as a coherent industrial process defined by regulations that seem to be readily applicable in any context?

In a conversation with my advisor, he referred to R2's effect as an "illusion of holism," wherein its industrial-like guidelines made formal e-waste recycling under it appear as a coherent industrial practice. R2, marketed as a globally applicable regulation, is seen as the means towards rendering waste determinate through making all e-waste recyclers carry out seemingly identical industrial processes[11]. In turn, practicing while certified seemed to reify this imagined holism, resulting in many of the other recyclers I spoke with to describe their practices as "by the books."

Used machines' moral qualities as a commodity speak to the practices recyclers can choose to determinate waste. Products, when discarded, take on a new form of commodity candidacy which allows them to act similar, but markedly different from, a "raw material." Likewise, these waste items are unlike the secondhand commodity that is indiscriminately traded in informal marketplaces; the e-waste machine is understood to be something else. The life of e-

[11] Drawing on Latour's concept of the "immutable mobile" (Latour 1987), Ong and Collier (2005) describe standards regimes as "a technoscientific form that can be decontextualized and recontextualized, abstracted, transported and reterritorialized, and is designed to produce functionally comparable results in disparate domains (11). At E-Scrap 2018, R2 was marketed to foreign recyclers as something readily applicable to their specific context.

waste begins with raw resources, which are transformed through labor-time (commodified) into products that consumers purchase. Once these commodities are *discarded*, their use-value is indeterminate and contextual (as a product); the act of discarding them, as opposed to trading, marks these machines as "waste." If a discarded electronic is resold—recommodified as a second hand machine—recyclers must reassess its ability to function in relation to a brand new product. However, this is not the sole way "waste" can be recommodified: it can be scavenged, valuable parts may be taken out, it can be repaired, or it can be processed and traded for someone else to find value in it. In this second model, the ways used machines are commodified cannot be easily explained in a labor-theory of value (Marx 1987), in that its material outcomes are not products but rather parts, materials, and refurbished machines. The presence of regulations exists as a binding force for making sense of their indeterminate supply.

CONCLUSIONS: AN AUTONOMY OF E-WASTE ETHICS

By nature of its social and material production e-waste can never conform to a rigid model. Nevertheless, regulations exist to produce and frame e-waste productive processes actions under the guise of an industrial process. As a centerpiece of the formal recycling sector, regulations reproduce their moral narrative of properly disposed machines through practice. However, at the individual, facility by facility level, productive processes are informed by their inventory, and as it is processed in these certified facilities, the "illusion of holism" provided by regulations is also reproduced. What I propose then, is an understanding of e-waste that does not privilege its political, regulatory definitions or profit driven rationalities. Through my ethnographic data, I have shown that handling used machines is more than just a question of human representation. Rather, I suggest that there is a material autonomy of e-waste that guides

the production of ethical meanings and economic value. I have highlighted moments and micro-practices, such as in Mary's warehouse, where the arrival of a vintage machine challenges the flowcharts she has created as part of her organization's effort to comply with the R2 regulation. What she does then is have the machine taken apart in order to assess its functionality and physical condition—its use value. Even after making it known, she still has to draw on average rates for gold, copper, and other metals along with data from consumer trends to make her e-waste determinate.

Mary's process of searching through discarded machine's qualities, comparing it with existing data, and testing unfamiliar technology's market presence in her stores is a form of ethics that is counter to traditional notions of industrial capitalism. Marxist understandings of capitalism champion "efficient" industrial processes products are able to be assembled quickly with cheap labor. Production is imagined to be infinitely scalable with increased capital—Ford's assembly line is a paragon of scalable production. Raw materials for commodity production are calculated based on cost-benefit analysis of similar materials, and are easily made determinate through quantitative data. Euroamerican formal e-waste recycling bears some resemblance to this model, in that e-waste recyclers are still concerned with the price of human labor and market trends. However, the meanings that are produced from e-waste ethics are parallel to, disruptive of these tenets of efficient industrial capitalism. Scalable assembly line production was not the meaning of "efficiency" for every recycler. Searching for value in the midst of discarded machines' materiality and past lives as brand new commodities demands the recycler slow down and treat each waste item as unique. Value must be excavated from machines in an indeterminate form, be it a 160GB hard drive or shredded metal. This positions the recycler in a manner where they are beholden to the quality of their "raw resource," and the expected relationship of a

capitalist actor who *acts on* their supply is contorted. What my research calls for in light of this analysis, is a deeper consideration of the types of rationalities that can emerge within spaces of formal capitalism, created by both practice and discourse. My hope is that I can contribute to future studies on e-waste or commodities broadly by presenting one such case where the production process *itself* is a central force in a business rationality, rather than any polemics over the definition of their supply or product. Creative, indeterminate ways of producing value are not the exclusive economic practices of the informal sector.

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