Powerful Futures: How a Big Tech Company Envisions Humans and Technologies in the Workplace of the Future

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Big tech companies have had increasing control over how we work with technologies and how technologies define the work we do. In this paper, I identify the sociotechnical futures that Amazon—one of the big tech companies—envisions and the future of work that the company is moving toward. I explore the future of fulfillment centers through an analysis of the patents on fulfillment center technologies which Amazon may turn into reality one day. In my analysis, I focus on humans by asking how they are configured in the future of fulfillment centers and, more specifically, how Amazon envisions the role of human labor within work automation and AI systems. The analysis reveals where and how humans are expected to "step in" to operate the future of fulfillment centers. I discuss my findings within and beyond CSCW, highlighting the importance of studying tech companies' imaginaries. I argue that by understanding tech companies' imaginaries, it becomes possible for us to launch effective sociotechnical interventions to negotiate or even resist their specific imaginaries and/or design ways for a more democratic uptake of companies' future technologies. Finally, I articulate practical ways in which patents can be utilized in CSCW research.

CCS Concepts: • **Human-centered computing → Collaborative and social computing**.

Additional Key Words and Phrases: patents; the future of work; automation; big tech; sociotechnical futures; human labor; human worker

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1 INTRODUCTION

Emerging technologies such as AI and robotics have been successfully implemented in a variety of workplaces [62], and their prevalence is rapidly increasing, particularly in labor-intensive locations such as factories [147, 184, 236], construction sites [149], warehouses, and delivery centers [58]. These technologies have changed the nature of work [15] and transformed the roles of humans in the workplace, requiring us to rethink the relationship between these technologies and human workers [44]. In relation to the changes, researchers, tech workers, and activists both from academia and the industry [17, 67, 79, 103, 128, 171, 205, 227] have posed a fundamental question: Who has the real power to shape our relationship with new technologies? More specifically, is it acceptable for big tech companies to determine "the actual designs we get to live with" [211, p.2]? Similar concerns have also been raised by the CSCW community [187] in regard to tech companies' increasing control over how we work with technologies and how technologies define the work we do. For example, tech companies have leveraged their political powers to determine labor rights, workplace surveillance, and justice [3, 78, 97, 228].

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In this paper, I introduce Amazon as a case study of understanding the sociotechnical futures that big tech companies envision and the future of work that these companies are moving toward. Specifically, my research focuses on how Amazon envisions humans and technologies in future fulfillment centers. I argue that by understanding tech companies' imaginaries, it becomes possible for us to launch effective sociotechnical interventions to negotiate or even resist their specific imaginaries and/or design ways for a more democratic uptake of companies' future technologies. My hope is that the findings of this study will allow us to develop more equitable future work arrangements with technologies.

Amazon, the United States' second-largest private employer, has hired millions of workers, approximately 270,000 just in the latter half of 2021 [235]. Amazon warehouses are frequently cited in the media as "one of the most high-tech buildings" [20] and sites where advanced technologies like robots, computer vision, machine learning and ergonomic design are developed, tested, and deployed. Amazon has been a leader in workplace automation by robotizing their warehouses over the past decade, mobilizing over 200,000 robots. Amazon recently announced that they will invest one billion dollars in developing warehouse technologies [57]. Amazon was operating over 110 active fulfillment centers in the United States and over 185 centers worldwide as of 2021. According to the About Amazon website, fulfillment centers' names reflect their function, expanding beyond the fulfillment of customers' orders to the fulfillment of workers' careers and visions of work innovation. Robotics, scanning machines, and computer systems in Amazon's fulfillment centers reflect "the vision of engineers and developers who innovate every day to make fulfillment centers more efficient and constantly improve the way Amazon gets products to customers" [235].

As Amazon's hiring slogan "Come Build the Future with Us" suggests, they intend to realize the future in their fulfillment centers. While the fulfillment centers' advanced technologies and strenuous working conditions have been well-reported, little is known or discussed about exactly what kind of future Amazon intends to realize and in what directions they plan to advance. Given that other retailers and logistics companies have begun to emulate Amazon's fulfillment systems and operations, and that Amazon has been setting precedents for other industries to achieve "Amazonification" [114], the specifics of the future that Amazon intends to shape should be the focus of considerable attention.

In this paper, I explore the future of fulfillment centers through an analysis of the patents on fulfillment center technologies which Amazon might one day turn into reality. Following the work of technofeminism scholar Judy Wajcman [225] in critically examining Silicon Valley's futurist discourse, which often masks the integration of human labor with automation, AI, and robotics, I center on the human dimension in my analysis. Wajcman argues that the input which human labor provides to machines and the value it creates must remain central to analyses of automation. Similarly, Mateescu and Elish [143] use the term "human infrastructure" to describe human workers in their report on human labor, AI systems and automation, bringing attention to the tendency to obscure human labor in the planning and discussion of AI. Aligned with these works, I focus on humans in the analysis of Amazon fulfillment center patents by asking how humans and humans' roles are configured in the future of fulfillment centers, specifically, how Amazon envisions the role of human labor within work automation and AI systems.

This paper makes empirical, methodological, and conceptual contributions to CSCW. First, by analyzing patents from Amazon fulfillment centers, I provide new empirical evidence of human integration into the future of automated workplaces. Although issues like future automation, human replacement as well as deskilled and invisible labor have all been discussed by the media and the public, this debate has often taken place on a conceptual level and been predictive on the basis of past and current trends. Amazon's fulfillment center patents—public documents explicitly describing the company's technological visions on automated work configurations—that I analyze in this study reveal exactly where and how humans are expected to “step in” to operate the future of fulfillment centers. I show that the role of human labor cannot be completely automated away, but rather that machines are integrated with humans to mobilize human bodies and extend the functionality of machines. Other CSCW scholars have come to similar findings in their empirical studies on emerging workplace configurations with robots (e.g.,[39, 40]). Thus, my study continues to support these findings in light of the sociotechnical futures that big tech hopes to realize in the future. Furthermore, my findings illustrate that human activities and presences are captured and abstracted as data to fuel machines; human labor is devalued by being regarded as replaceable and interchangeable, although there is no elaboration on how such replacement will be accomplished. Ironically, the patents also describe the indispensable aspects of human labor; human workers are often alienated by the obfuscation of the machines with which they work, whereas individuals “with ordinary skills” are able to comprehend the machines. All of the findings presented here have societal implications: they signal the increasing prevalence of using human (even biometrical) data for workplace automation and the growing possibility of human labor being commodified. The justification for mandating specific physical abilities, such as excellent visual acuity, may also be warranted for the deployment of patents. Moreover, the sociotechnical futures of a big tech company, presented in my findings, are in stark contrast to the vision of humans flourishing in the workplace alongside AI and robots [77]. Considering the growing concerns about big tech and the fact that big tech’s strategies have inspired imitation by companies in other industries, my findings suggest that civil society, policymakers, and researchers should pay close attention to big tech’s future practices.

Second, I show how patents, unconventional types of data in CSCW research, can serve as core empirical data providing critical insight into tech companies’ “future-making” [237] to the CSCW community. I see a high potential for patents as a new methodological venue to be leveraged in CSCW research for data collection. My uses of patents extend recent CSCW works that have expanded the scope of methodological possibilities. For example, CSCW researchers have offered diverse insights from historical documents [14, 117, 203], policy developments and debates [231], and court records and labor disputes [60, 215]. I shift our conceptualization of patents by considering them as a collection of “goals and values that guide and frame technology” [49] rather than mere legal and technological repositories. Findings presented in this paper describe Amazon’s imagined futures—“the powerful futures” in Urry’s words [220]—and where humans are situated within the futures. I discuss the significance of paying attention to tech companies’ imaginaries by joining a growing body of CSCW technopolitics research that centers on “larger and external forces within which technology design unfolds” [134]. To draw more attention to patents as a source for design and inquiry, I articulate several potential practical ways in which patents can be utilized in HCI and CSCW research.

Finally, as a conceptual contribution, to broaden our perspectives on how human labor and human bodies will be integrated into the automated workplaces of the future, I introduce and contextualize conceptual tools such as “people as infrastructure,” “alienated skills,” and “surveillance assemblage” in the discussion.

I begin the following sections by reviewing CSCW literature on the human perspectives on emerging workplace technologies, workplace automation and surveillance, and science and technology studies (STS) literature on patents as future-making. I then describe my research approach and methodology before introducing empirical findings from this research which illustrate how human labor and human bodies are envisioned in Amazon’s powerful futures. I discuss my findings within and beyond the perspectives of CSCW by drawing from geography, the sociology of science, and STS, highlighting the importance of studying tech companies’ imaginaries. Finally, I offer practical ways of using patents in CSCW design research.

2 RELATED WORK

2.1 Human's Perspectives on Emerging Technologies in the Workplace

Workplaces are increasingly becoming the sites of emerging technology adoption, such as robots and AI applications. Recent HCI and CSCW scholarships have focused on how workers perceive those new technologies in the workplace. The studies have focused on enhancing human-robot collaboration in the future workplaces: what to consider in the design of collaborative robots [40], social and power dynamics in the workplaces with robots [39, 40], and strategies for working with robots effectively [113, 238]. Those studies are in relation to workers' perceptions of robots in workplace settings like that of a manufacturing plant [39, 40, 184, 185]. The studies by Sauppe et al [184, 185], for example, examined how human workers interpret the social behaviors of robots. Instead of the preconceived notion of a machine, they demonstrate the significance of sociality in a robot playing the role of a coworker.

Another line of research examined how workers across a variety of industries, including IT architects [229], data scientists [226], software developers [146], healthcare workers [105, 158, 219], knowledge workers [83], and gig workers [229, 234], perceive AI and ML-powered technologies and algorithms in the workplace [119]. For instance, the study by Wolf and Blomberg [229] examined how skilled IT architects interact with tools and systems that integrate algorithmic outputs and make sense of the algorithmic activities of ML applications in the workplace.

In other studies, researchers looked at how workers would view AI tools that assisted them in their work as well as the advantages and drawbacks of using them. For instance, Okolo et al. [158]'s study examined the perspectives of health workers on the application of AI for automated disease diagnosis, specifically how data science practices might change as a result of AI tools automating specific tasks. Some studies concentrated on the AI tools currently in use at work. For instance, the research by Kim et al. [119] investigated how gig workers' perceptions of the quality of platforms like Uber affect their perceptions of the autonomy and satisfaction of their jobs. Similar to this, examples of how an AI assistant interferes with a knowledge worker's work [83] were looked at.

As we've shown, earlier research examined how workers feel about using robots and AI in the workplace, with an emphasis on the types of technological work arrangements they would prefer to see in the future. These studies commonly make the assumption that future work arrangements will be created solely based on the preferences of the workers, which ironically serves as a reminder that there haven't been many workplaces where worker-centered technologies have been implemented. Instead, they are typically business- or employer-centered. Few empirical studies have been conducted on what future technologies are envisioned by tech corporation [232] and how they might alter worker roles and responsibilities in the workplaces of the future.

2.2 Workplace Automation and Surveillance

Specific cases of "workplace automation experiences" [13] have been collected in HCI and CSCW as emerging technologies have been incorporated into everyday workplaces. When it comes to the three fundamental components of "everyday automation," namely intelligibility, experienced control, and recording automation experience, the recent studies are mostly in line with the aspect of experienced control, which could be workplace surveillance in the context of the workplace. For instance, the study by Holten Møller et al. [105] examined how hospital employees interpret movement and interaction data from sensor tracking [90]. The researchers created a set of strategies for group sensemaking among the workers so that they could challenge the sensor tracking data. Similarly, Marquis et al. [141] investigated how gig economy workers perceive behavior control by the platform's rating system on work performances, as well as its impact on workers' job satisfaction. Given the increasing use of technological controls and potential workplace surveillance, researchers have looked into ways to empower workers through technology. Uhde et al. [219], for example, gave healthcare employees more control over shift planning by developing worker-centered self-scheduling systems. Meyer [146] investigated how software developers perceive workplace self-monitoring using a technology probe called WorkAnalytics. They used the probe to allow workers to self-monitor their work productivity. Some studies focused on ways to improve workplace environments, which emphasize human-centered values (e.g., care, worker well-being) rather than work productivity or efficiency. Peer-based cooperative fitness tracking to improve workplace fitness [173], computer-mediated peer-support system for home care workers [165], and telepresence robot system for teleworkers to trigger informal communication are just a few examples [126].

Previous HCI and CSCW work has pushed the direction toward ways to center workers (i.e. prospective users) in the design of future work technologies. On the other hand, little is known about the future of work that big tech and major corporations hope to realize. While our CSCW community acknowledges the anticipated reduction of human labor through the implementation of AI, there is a paucity of research on how to address the potential replacement of human workers by AI systems. With the exception of Sriraman et al. [206]'s suggestion of paying these workers long-term royalties from a tool that replaces their labor, there is a lack of laid-out solutions or strategies in this regard. In order to comprehend holistic visions of future technologies in the workplace, we must look into what kinds of future work configurations and technologies major tech companies imagine. This paper offers a critical analysis of the future workplaces envisioned by one of the big tech companies. Specifically, I examine Amazon's fulfillment centers—one of the workplaces with the most advanced AI and robotics deployment to date—by studying patents underlying future fulfillment centers.

2.3 Patents as Future-making

A patent is made up of the specification, claims, and bibliographic information such as the application number, filing date, inventors, and assignee. The specification is a thorough technical explanation that includes the relevant prior art (i.e. previously published patents and other publications), a description of the invention and its drawings, how the invention addresses a particular technical issue, and the invention's preferred embodiment. In these specifications, the necessary information about the invention must be presented in clear, non-technical terms. In addition, patent data is openly accessible to everyone. In existing legal literature, patents are regarded as "legal assets" devoid of moral considerations [49]. This view has long been challenged by STS scholars, particularly by actor-network theory (ANT) scholars who proposed investigating the interconnectedness of patents based on some underlying subjects [34, 35]. Scholars have showed that patents are more than just technical descriptions of inventions; patents are data indicating technological relationships and future technology opportunities [70, 151, 152]—such as technological strengths, weaknesses, "corporate R&D efforts, technology trends, prediction of emerging technologies, and technological capabilities at the individual, firm, sector, and national levels" [153, p.957]. Patents, according to Callon, are "a unique source of information about the mechanism of innovations and the dynamics of technological development" [34, p.187]. Following in the footsteps of previous STS works, I consider patents to be a collection of "the goals and values that guide and frame technology" [49, p.1344], rather than just legal assets.

In line with this, patents are an excellent resource for examining how companies envision their technological futures by "materializing the company's desire" [59]. By making the technological future tangible through written documents [24], companies can publicly "colonize" [183] not only related future technologies markets but also related technological futures. Ugo Pagano, a political economist, coined the term "intellectual monopoly capitalism" [161] to describe the relationship between intellectual property rights and a company's future prospects and value. The efforts to privatize knowledge, which have been anchored in patenting activity, continue to be a significant source of profits for large tech companies. In the case of Amazon, its annual reports [5, 6] explain how such intellectual assets (i.e., patents) are critical to shaping the company's future: "We want to be a large company that's also an invention machine" [5, p.5]. Amazon's inventory and warehouse-related patents—as entrepreneurial efforts to realize this vision—not only demonstrate what technological developments contribute to their envisioned future but also legitimize the company's commitment to actualizing these technological ideas. Patents also showcase the technologies that the company may one day develop and introduce to the world [59]. Media outlets have been paying attention to new patents filed by major tech companies to see "where its technology is going" [45]. In fact, these companies' patents were quickly put into practice, such as Airbnb's new booking system [25] and Facebook's new algorithms and products (e.g., identifying faces and other elements based on photographs, advertising products targeting family) [32].

While there have been few studies that use patent analysis to examine technological futures that tech companies may envision, there have been some works that are aligned with my focus on big tech companies' strategies for the future of work [59, 223]. Delfanti and Frey [59], for example, conducted a systematic analysis of Amazon's inventory management patents to examine Amazon's future automation and replacement of human labor. Similarly, Vertesi et al. [223] examined Amazon delivery patents to investigate companies' strategic orientation toward automation for worker replacement. While both works are interested in how Amazon, as a large tech company, approaches future workplace automation, the study presented in this paper intends to focus on Amazon's technological futures but with a greater emphasis on human labor: what future work configuration Amazon envisions in the future of warehouses? How are human workers and labor portrayed in their visions? In other words, this study reveals exactly where and how humans are expected to step in to operate the future of fulfillment centers.

Drawing on STS works on imaginaries [9, 87, 112, 188], I also see patents as a social practice of "future-making" [237], since patents involve a conceptualization of futures to guide futures in a certain direction and make a world. Such an "imagined future" [21, 112] influences current decision-making and resources, labor, and technology coordination [26, 31, 61, 223]. Fujimura [87], for example, demonstrates how scientists use their future imaginaries in the production of science and technology. "Imaginaries" have been conceptualized and widely used in STS, such as sociotechnical imaginaries [112], future imaginaries [87], technoscientific imaginaries [140], and social imaginaries. These imaginaries commonly emphasize "collective visions" of society through scientific or technological practices based on a shared understanding of what is desirable to society. Scholars, on the other hand, have shown that public discourses on the future are increasingly "corporatized" [220] by tech companies' strong discursive and technological clout, which directly shapes the design of their products (e.g., [82, 159]). Given the corporatized sociotechnical imaginaries, we must understand what kinds of imaginaries tech companies are spinning and how they might overlap or diverge from those of the general public. The futures that are "'owned' by private interests rather than shared across members of a society" are referred to as "powerful futures" by Urry [220, p.189]. My research aims to increase the transparency of "powerful futures" and close the gap between them and sociotechnical imaginaries.

3 STUDY APPROACH

I analyzed Amazon's patents for fulfillment center technologies to comprehend how humans and their work configuration are envisioned for future fulfillment centers. This paper only analyzes patents demonstrating human involvement or interaction with the technologies patented for fulfillment centers. This section describes my data collection method for identifying relevant patents, the exclusion criteria for filtering an initial set of patents into a corpus for analysis, and my data analysis approach.

3.1 Data Collection

I chose Google Patents over other patent databases because it contains more than 120 million patent publications (as of July 2022) from over 100 patent offices worldwide [162]. Due to its extensive coverage and number of patent publications, this database has been chosen by numerous prior studies (e.g., [36, 120, 139, 150, 160, 202, 204]) that analyzed a subset of patents. As the database offers a high-performance search engine and allows to use standard search methods such as Boolean and keyword searches [155], I could rigorously navigate this comprehensive database.

To identify relevant patents, I started using a keyword search combining these terms such as "fulfillment center," "Amazon," "human," and "worker." During multiple rounds of searches with different keywords and logic, I manually looked through each retrieved patent to see how the database works depending on the search terms. I learned that using the keyword "employee" automatically retrieves other related terms such as "staff" or "worker." Considering my focus on patented technologies aimed at deploying in Amazon fulfillment centers, I finalize my Boolean and keyword search like this: "fulfillment center" AND "Amazon" AND [employee OR human] from Google Patent with limiting the Assignee to "Amazon Technologies Inc." This search yielded 148 patents as of January 2022.

Going through all 148 patents, I excluded all patents that did not mention humans or did not indicate human involvement. To eliminate these patents, I searched various words that can refer to a human, such as the words "human," "worker," "person," "staff," "personnel," "agent," "employee," "driver," "entity," "user," "operator," and "vehicle" (since a driver operates it). When "human" referred to a "customer" (e.g., [179]), "merchant" (e.g., [197], [182]) or "suppliers" ([38]), I excluded those patents. System-oriented patents (e.g., cloud computing) [122, 136, 217] or patents for backend technologies (e.g., [23]) were also excluded since humans are not mentioned in the patents. After this filtering process for relevance, I retained 66 patents for full-text analysis and coding. The corpus of patents represents various types of systems ranging from inventory management to task assignment (see Table 1). Their application filing dates ranged from 2005 to 2021, and their publication dates from 2008 to 2021. Thirty-one unique inventors were involved in the 66 patents. The sample size of the patents is adequate for a qualitative analysis of their content, given that it is comparable to that of previous research analyzing a subset of patents [120, 174, 201, 210]. The Appendix includes a list of the 66 patents in the corpus[1].

Among the limitations of my data collection method is the inability to examine other patents on similar topics if they do not include the keywords I employed. Because this study of patents is based on a sample related to envisioned human configurations in potential future fulfillment centers, the data corpus does not represent Amazon's imaginaries in their entirety. Understanding their technological visions may always be limited without access to their internal documents. Not all systems and methods are patentable, and some machines and systems that have been patented may never be implemented. In a similar vein, the implementation of a patented machine or system may differ from the patent's technical description [120]. Consequently, my research may only inform the intended purpose of each patented technology and not its ultimate form of implementation. Despite these limitations, patents reveal the issues companies are concerned with and attempting to resolve. For instance, Spotify's patent for an automatic parking finder [213], regardless of whether

[1]After the search, I listed and numbered 148 patents in Excel. P1 was the patent assigned to the first spreadsheet row. After filtering, the final 66 patents were not renumbered, thus, the patents referred to in this study may be labeled anything from 1 to 148.

Classifications	The Number of Patents
Inventory or stock management, e.g. order filling, procurement or balancing against orders	12
Logistics, e.g. warehousing, loading or distribution	9
Storage devices mechanical with arrangements or automatic control means	9
Detection, identification, selection, recognition system	7
Picking, packing and stacking	6
Control system directing robotic devices, teleoperation	4
Transferring, shipping, conveyor-based	4
Head mounted characterised by optical features	3
Monitoring and recording carriers and activities	3
Mixed reality	2
Aerial vehicles	2
Certifying business or products, verification	2
Electrically-operated educational appliances	1
Total factory control	1
Scheduling, planning or task assignment for a person or group	1

Table 1. An overview of the types of systems outlined in the patents

it is implemented, is a clear indication that the company seeks to eliminate potential interruptions to their users' music listening.

3.2 Data Analysis

I analyzed the patent data through reflexive thematic analysis [29]. I conducted interpretive analysis of the data at the intersection of the dataset, the theoretical assumptions of the analysis, and analytical skills/resources. Braun and Clarke [28–30] suggested that the theoretical assumptions should be addressed before implementing any form of thematic analysis. I briefly explain what theoretical assumptions I have. To answer my research question, I adopt constructionist epistemologies (by assuming that meanings are socially produced), a critical orientation (by examining the constitution of social reality), and an inductive approach to produce codes (by open-coding). I remind my reader that my analysis followed prior STS works on patents and imaginaries: I view patents as a collection of "the goals and values that guide and frame technology" [49] instead of legal assets.

I initiated the process by thoroughly reading all patents. I re-read and open-coded all patent documents with a particular focus on human agency. The codes were produced at both a semantic (e.g., human as a packer) and latent level (e.g., devalued human input). Both levels were meaningful and relevant to addressing my research question [163]. I then collated the initial codes and generated themes by iteratively reviewing them and combining them into themes/sub-themes. Following each review, I reflected on the generated codes and themes [29]. Finally, I organized and defined the themes according to the interactions between humans and the patented machines. The themes encompass the roles of humans and human bodies as components of the machines, how they interact and connect with the machines they work for and with, and how human workers are conceptualized in relation to other humans who may be minimally impacted by the patented machines.

4 FINDINGS

My findings are divided into five sections to reflect how humans are positioned within future fulfillment centers, that is, how they are integrated or excluded by the machines and devices claimed by Amazon. I show that humans and human bodies are effectively becoming part of machines, systems, and fulfillment centers, which revolve around roles of humans—both workers and non-workers—and their bodies, as well as surveillance mechanisms, human replacement, and skills. The patents, taken together, reveal the potential relationships that humans have with automated fulfillment centers, which reflects Amazon's sociotechnical futures.

4.1 Humans Embedded in Fulfillment Center Machines

This section describes how humans have been absorbed by Amazon fulfillment centers, which are among some of the most technologically advanced installations, and have thus effectively become a part of the building-sized machines. At the FCs, humans are integrated into the work of machines by 1) offering their manual labor and 2) their bodies being closely connected to the machines to keep the system running. In the patents, human labor serves as one of the machine components.

Picking, packing, and stowing are specific human labor types that are frequently mentioned in patents. For example, regarding a picking task, human workers often are described as "picking agents" or "pickers[2]":

> "Agents, or pickers, may receive instructions from a control system on a device such as an RF-connected wireless terminal or handheld scanner, to go to locations in inventory to pick a list of items from those locations...at any time, one or more agents of the distributor may each be picking items from inventory to fulfill portions or all of one or more orders. ...When picking items from inventory, the picking agent generally must examine any co-located items in order to determine the specific item to pick" (P144 [190]).

Instead of receiving instructions from managers or other humans, as P144 shows, control system-connected devices, such as scanners, assign specific picking tasks to workers. Specifically, a RF-connected wireless terminal or a handheld scanner (P144) transfer power from local floor managers to the control system. The control system ensures that the human workers are at the correct picking location and inform them of the number of units to be picked. An unidentified site now has control after authority is given to the system, shifting it away from human administrators.

Furthermore, as P144 illustrates, with workloads and locations to complete tasks constantly changing, the types of human tasks performed become sporadic and uncertain. The number of orders a human worker is expected to handle during their shift is unpredictable. Their tasks go beyond merely physically placing designated items somewhere because the picking tasks are closely integrated with the control system monitoring the items' locations. The human workers, acting as though a vision sensor for the system, are expected to scan each item with their eyes to determine whether the item is the correct one to pick as directed by the system.

4.1.1 Integrated Nature of Fulfillment Centers Settings. I discovered that manual human input and tasks, which function as machine components, are tightly integrated into the patented machines and allow these apparatuses to continue operating. For instance, P133 demonstrates how the work performed by machines and humans is interconnected. When the task of placing an item has been completed, once the human labor input is registered on a machine, it is transmitted to the sensor of the control systems, which then in turn sends signals to the workers as a feedback mechanism of their input: *"In one embodiment, when the agent places the picked item in a receptacle, the sensor on the receptacle may detect placement of the item, the mote may relay this information to the control system, and the control system may then indicate to the agent if the item was placed in the correct receptacle or in an incorrect"* (P133 [191]). Systems and machines are unable to translate their commands into physical reality. As P133 shows, a system can find items and decide where they should go, but it is unable to carry out the time-consuming, repeated activity of selecting items in the first place

[2]Given the legacy of slavery and colonialism, I acknowledge that Amazon's use of the term "picker" for certain FC workers is problematic but analyzing this issue goes beyond the scope of this paper.

and moving them to the required locations. Instead, humans are required to perform these tasks. The system's reliance on human physical labor contrasts with how the future is predominantly portrayed in the media and public discourses, which is that machines will perform physically demanding and monotonous tasks, while humans will only provide guidance and critical judgment.

In line with this observation, I learned that human workers participate in a number of the sequential tasks that are processed by machines, a finding that manifests that the fulfillment center space is integrated by design and that human workers are bound to the demands of the machines. For instance, P134 (the patent for the feedback systems in the workstations) demonstrates that the sequentially connected work from pulling items, identifying specific items and receptacles, and then ensuring the items' correct placement in receptacles requires constant manual labor from humans to make this system functional: *"The above describes aspects of an induction station in which a human operator performs at least a portion of the pulling of units of items from groups of picked items, scanning/reading the items and receptacles to associate single units of items to particular conveyance receptacles, and placing the units into the conveyance receptacles"* (P134 [53]).

4.1.2 Machines Requiring Human Assistance. Similarly, P12, the patent regarding the tele-operated inventory management system, provides an example of a situation in which human workers frequently need to be on hand in case the system is unable to complete a task. Robots are programmed to request human labor when necessary. The human worker becomes legible as a physical "component" of the system, which is programmed to identify for the robots which human workers are available or not: *"In this scenario, the robotic units of the described system may submit a request for manual operation to a queue of operators to complete the task. When the request reaches the top of the queue, and when an operator is available to handle the request, the operator is able to take control of the robotic unit to complete the task manually. . . "* [94].

In other instances, such as setting up and adjusting the placement of item information to aid the system with processing the items properly and quickly, the human assistance in operating the robots is evident: *"In some embodiments, an operator may augment image information to assist the robotic unit. For example, an operator may highlight a representation of an item within an image in order to help the robotic unit locate the item. Based on this analysis, the system may learn that the actions recorded with respect to the manual operation used to manipulate the item are inappropriate"* (P12). The fact that such manual human labor input is not just an extra is especially noteworthy, as P12 indicates. During the time that human workers assist the system, their body movements and activities are captured as new data for the system's training, with the goal of gradually improving its functionality to the point where it can assess the quality of human work.

I found that the human worker is also evolving into an organic extension of the system that controls the environment but lacks the ability to act in it. P19, for instance, introduces a foot switch for human workers, providing additional manual input for the system. Currently, Amazon FC workers–pickers, stowers, and packers–are isolated at a workstation for 10 hours per day, standing while lifting, pulling, and gripping up to 100 items per hour [92]. These repetitive uses of the upper halves of the workers' bodies put them at a high risk for shoulder, neck, and wrist injuries [175], prompting the Department of Labor to issue yet another citation against Amazon [186]. This recent additional citation demonstrates that these upper-body-intensive forms of work have persisted in the FCs for a long time without correction. However, here, humans are expected to use body parts other than their upper bodies.

> "Alternatively, as discussed above, manual triggers may also be used by processing agents to trigger image capture of order processes. For example, a processing agent may use a foot switch to trigger an image capture device to take a picture...For example, processing agent may step on a pressure mat at a processing station whenever an order

> is being processed and may step off the pressure mat whenever he is not processing an order. The pressure mat may in turn control the capturing of images" (P19 [192]).

By providing their manual input to operate the system and often being expected to use all possible body parts, human workers in this situation also function as one of the system's components.

4.1.3 Humans Acting as a Sensor for a Vision. In addition to their main tasks—for example, picking and packing—human workers are expected to look for machine errors (P145, P98, P7, P18). Human workers identify and fix any discrepancies between how the system ought to operate and how it operates in actuality. P145 demonstrates the flexibility required of human workers to deal with such mismatches: *"For example, during packing, an agent may directly identify the recommended container as too small by providing input into the system via user interface or indirectly by only packing a portion (or none) of the items in the recommended container and the remainder of the items in one or more separate containers"* (P145 [129]).

As stated, human workers are asked to report errors, modify their work processes accordingly or devise solutions, such as tackling only the appropriate containers (P145) or manually resolving errors (P98). By indicating whether an item is included in the tote or not, operators in P98 are expected to manually resolve the discrepancy. P7, a patent for item detection and transitions, also delegates the responsibility of identifying any discrepancy between the data and the items to the workers: *"Any differences between the tote identifier list and a scan of the tote at the transition area may be resolved by a user (e.g., picking agent, packer, customer, carrier) at the transition area. For example, any differences may be presented on a display at the transition area and the user can confirm whether the item is actually included in the tote"* (P7 [89]). Humans are expected to these navigate information-rich environments as if they were visual scanners integrated into a larger information network and inventory control system.

In this situation, a human is any individual that is capable of noticing as well as reporting an error while working with the system. Even the patent for visual task feedback for workstations (P18), where employees are supposed to receive visual cue feedback on their task handling, acknowledges that humans must manually address any errors and missing tasks: *"This type of visual cue may convey one or more indications to agent. For instance, the item may not be recognized by visual feedback system and require manual entry, or the item may be the wrong item to pack"* (P18 [54]).

4.1.4 Human as a Sporadic Intervention. Some patents depict specific mechanisms that require sporadic human intervention as an extension of the human roles in addressing system/machine errors. For instance, numerous sensors and devices that are integrated with the control system but distributed discretely across the work environments alert workers to perform maintenance (P17, P45) or repairs (P141):*"the stacker may include one or more sensors (e.g., optical sensors) or other mechanisms that may operate to detect problems with the stacker (e.g., a jam, misstack, or misalignment of the receptacles in the stacking component or lift component) and, in response to detecting a problem, raise an alarm so that an agent can clear the problem"* (P141 [37]). Humans are also often specifically asked to act as a backup for a system's limitations, for example, when the system fails to access and collect essential information. As P123 shows, for the system to "increase its confidence," humans are asked to manually identify specific users in the crowd or verify their personal identification information (e.g., their age): *"the automated techniques may be unable to generate output data with a confidence level above a threshold result. For example, the automated techniques may be unable to distinguish which user in a crowd of users has picked up the item from the inventory location. In other situations, it may be desirable to provide human confirmation of the event or of the accuracy of the output data. For example, some items may be deemed age restricted"* [46].

The sporadic interventions of humans also demonstrate how they are made up of humans doing small odd jobs: one individual reports the condition of a machine, and other individuals deal with the problem. Extended communication tools are used to quickly relay any need for system maintenance or repair. For instance, in the case of P45 on the kiosk, which is designed to run without the assistance of human workers, humans are needed to report when this autonomous machine requires cleaning due to unexpected events: *"… the distribution agent may report to the kiosk management system if there is graffiti on the kiosks that needs to be cleaned off. The report may be transmitted via communications network in the form of an electronic mail, instant message, text message, SMS, or any other suitable communication or message to the kiosk management system"* (P45 [2]).

4.2 Carrying Devices on the Human Body

Humans are primarily referred to as users of the devices that make up the patented machines and devices in these patents. To expand the functionality of the devices, the bodies of human workers are meant to act as carriers of these devices (P91, P122, P34, P12, P117). For instance, P91, a patent on dynamic rfid-based input devices, illustrates how RFID signals can acquire mobility by being affixed to the bodies of human workers: *"The worker may be any designated personnel tasked with performing one or more tasks within the fulfillment center, and may wear, carry or otherwise be associated with or adorned with an RFID tag that may emit a unique RFID signal"* (P91 [221]). According to P117, for an "autonomous vehicle" to function, humans must carry the "autonomous vehicle" and their own sets of sensors (see Figure 1): *"As is shown in FIG. 14A, the autonomous vehicle (e.g., an aerial vehicle or drone) is outfitted with a plurality of sensors and is held within a hand of a human actor … As is shown in FIG. 14B, the autonomous vehicle is transported or carried by the actor throughout a facility… [and] captures data using the one or more onboard sensors or any other sensors, while tracking its position within the facility"* [145].

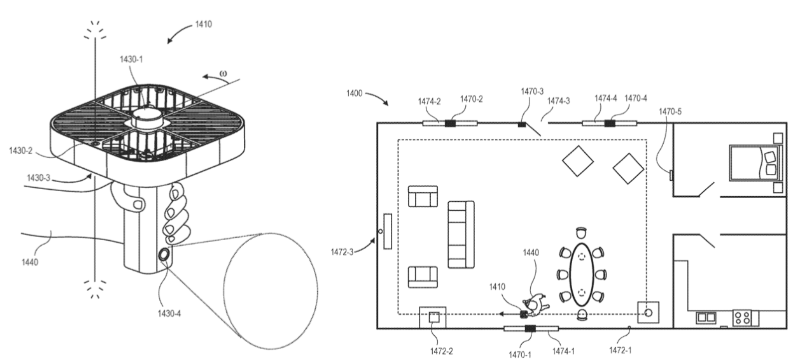

Fig. 1. Patent drawings of P117 (left:14A and right: 14B)

Human workers often are asked to 'wear' the devices because the machine is thought to possess the mobility of moving between workstations thanks to the "human body": *"The imaging device may be mounted to any structure or frame, e.g., a tripod, and may even be worn about the human body, e.g., on an eyeglasses-type frame or like apparatus"* (P122 [116]). Various body parts, including the legs and head, are mentioned as possible parts to be used (this is partially illustrated in the right drawing in Fig2):

> "the systems and methods disclosed herein are directed to providing an apparatus, e.g., an article of clothing, which includes one or more manually activated RFID tags (e.g.,

transmitters or other transmitting devices) and may be worn by a user. Some of the devices disclosed herein may be worn about a hand, a wrist, an arm, a leg, a head or another body part or extension of a user, and may include one or more manually activated RFID devices that may cause RFID signals to be transmitted to an RFID reader upon contact" (P34 [178]).

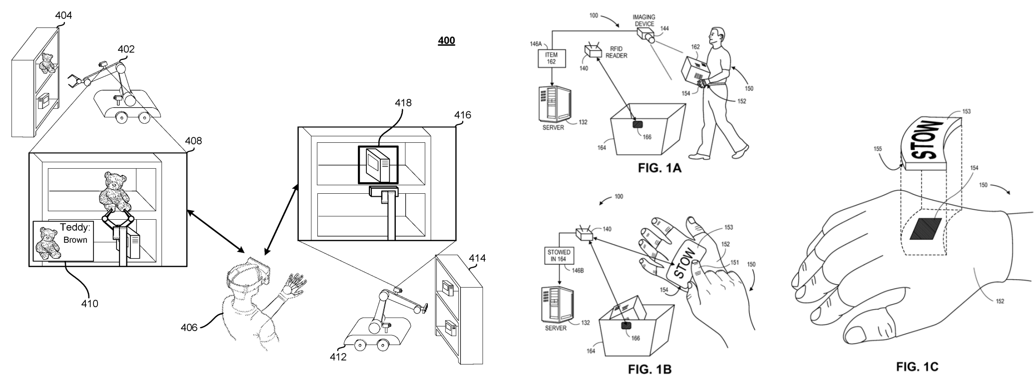

Fig. 2. Patent drawings of P12 (left) and P34 (right)

As another example, the human body is viewed as an additional system for expanding the functionality of the fulfillment center machines. For example, by outfitting human workers' hands and heads with cameras and sensors, the workers augment the system's visions (see the patent drawing in Fig 2 (left)): *"In another example, a remote manipulation device may include a combination of a VR headset and one or more gloves that are tracked by a system in communication with the VR headset (e.g., using machine vision via a camera system or using sensors on the one or more gloves). In this example, the operator may be provided the ability to guide the robot by moving his or her hand in a projected virtual space"* (P12 [94]). The VR headsets and gloves featured in P12 allow human workers to see through otherwise unreadable surfaces in inventory environments and supply their gestures to direct the robot's activities. The human body serves as a bridge between the technologies and the fulfillment center settings. I argue that this function serves to further erode the boundaries of the human body.

4.2.1 The Relationship between Work Productivity and Human Body Data. Worker-worn devices are also used to gather crucial data for the system. In the case of P2, the workers wore the gadget like glasses or as a headset. Their gaze direction, bodily movements, and locations are converted into data, combining this information with other data-like order information, which then yields a meaningful mechanism, such as the act of assigning tasks to workers: *... the user interface displays structured information that can be rendered upon the display of a wearable computing device worn by a user or worker in a fulfillment center in order to facilitate fulfillment of orders or other tasks in the fulfillment center by providing the worker with information about a particular task, such as the retrieving or stowing of items that are stocked in the fulfillment center* (P2 [218]).

Such information, which is based on the wearers' body activity data, leave some expectation for workers to quickly identify and complete their tasks:*"Items at item locations within the sorting/packing area may be located such that workers may be able to quickly and efficiently retrieve items for fulfillment or shipments"* (P2). Other wearable gadgets are often suggested, such as headsets or heads-up displays (P18 [54]), *"[a]s the process evolves to increase efficiency, agents may have less* *time to view or read information from multiple sources"*. In these cases, the system would deliver information without the wearers having to turn their heads and would do so without any delay—not even of a few seconds. In addition to allowing workers to be "hands-free," these wearable devices expect workers to be more productive.

I found that, as a follow-up to raising expectations of worker productivity, the data provided by the workers' bodily movements and work processes is further directly used to predict and control the degree of their mobility. For instance, rather than receiving work instructions from human managers, the workers are directed by the wearable devices based on the data collected in real-time from their workstation.

> "....the fulfillment application and/or client applications executed by multiple instances of wearable computing devices can generate turn-by-turn instructions to optimize the flow of workers through the fulfillment center. In other words, the fulfillment application can direct workers via turn-by-turn instructions according to a route that minimizes collisions with other workers wearing wearable computing devices in the fulfillment center" (P2 [218]).

This example demonstrates how wearable technology and associated systems record and carefully observe the activities of workers in the fulfillment center. I outline several of the identified surveillance mechanisms for the technologies from the patents to track human workers in the section that follows.

4.3 Surveillance Mechanisms

As the prior illustrations have revealed, the majority of patented machines and technologies collect information on workers who perform tasks in fulfillment centers. For instance, in the patent for methods to locate a mobile object (P125), the mobile object even includes "a human worker": *"embodiments of the present disclosure may be used to locate a person (e.g., among a plurality of people) that is walking in a floor on a building (e.g., carrying a mobile device with them), a drone (e.g., among a plurality of drones) moving through mid-air, etc"* (P125 [239]). Similarly, humans are often mentioned as being a part of the monitored environments in which technologies gather data. P117, a patent on autonomous security devices, reads: *"upon arriving at the door, the autonomous vehicle captures one or more images of a person that entered the facility via the door using one or more visual cameras."* P117 elucidates that this patented system could be installed in warehouse facilities, where people would be subjected to its system and being monitored.

As other patents show (e.g., P138), workplace surveillance is justified by pointing to increased productivity. P12 describes how the system functions as a manager who monitors employees' work output, while also looking for ways to streamline the entire work process: *"...each operator's approach to retrieving or otherwise manipulating the item may be recorded by the system. The system may then determine which approach used by the operators was most effective"* [94]. The system needs to rely on the workers' bodies carrying wearable devices and sensors to determine how to optimize the workflow, so recording workers' activities, whether they are active or inactive, is described as essential: *"The user interface can also be updated in response to the changing orientation of the wearable computing device.... it may be the case that the visual indicator requires updating as the user moves his or her head while moving through the fulfillment center as well as when the user is standing still within the fulfillment center"* (P2 [218]). Because the system is designed to run based on data from the worker, attaching sensors and devices to workers' bodies is justified so that they *"can detect movement, acceleration, orientation, and other aspects of the position of the device"* (P2) worn by workers.

Another method of tracking workers' whereabouts and movements is by tracking the mobile and communication devices carried around by them. P1 indicates that the location of a worker can be determined by looking at their communication tools and carts: *"In one embodiment, each cart may have a mote coupled to the cart, and the control system may be able to track the location of each cart via the mote on the cart, and thus the agent, in the materials handling facility . . . .Alternatively, location of an agent in the materials handling facility may be tracked using the agent's communication device"* (P1). The statistical implications of workers' work performance are computed using the collected data, such as the workers' location and movements over time. These results are then used to evaluate each worker and decide on future work assignments and hiring:

> "In some embodiments, the control unit may obtain statistical information with respect to the operators, upon which it may base future assignment decisions. For example, the control unit may obtain metrics related to a number of manual operations that a particular operator performs within a specified timeframe (e.g., operations per hour). In another example, the control unit may obtain metrics on how many manual operations for an operator are not completed or result in a broken item. These metrics may be used to disqualify the operator from further manual operations or to limit that operator to only non-fragile items" (P12 [94]).

P12 illustrates how labor data on tracked workers can be used as a tool to control individuals by punishing workers for mistakes or subpar work. Additionally, some patents (e.g., P23, P26) describe the capture and collection of workers' unique body appearance data, such as facial images and skin tones. It is possible to further distinguish inventory items from other objects by analyzing the stored data of each worker's hand shapes and skin tone in P23 and P26. For example,

> ". . . when the user's hand is removed from the inventory location, one or more images may be captured of the user's hand as it exits the inventory location. Those images may be compared to determine whether a user has removed an object from the inventory location or placed an object in the inventory location. . . . For example, image analysis may be performed on the first image to determine a skin tone color of the user's hand and pixels including that color, or a range of colors similar to the identified skin tone color may be identified to represent the user's hand" (P26 [167]).

Without obtaining workers' consent, a key component of this intelligent inventory system—collecting and using images of human bodies and their skin color—is legitimated. This type of system could be an extension of Amazon's current way of coercing their workers' "biometric consent" [95]. Humans are easily recognized by the system's radar and the information is stored as data, with personal identification information being used to improve detection precision: *"Upon entering the materials handling facility, the inventory management system may identify the user (e.g., facial recognition, user ID cart, user provided information). Upon identifying the user, information (e.g., item retrieval history, view history, purchase history) may be retrieved from a data store"* (P23 [125]).

4.4 Humans' Replaceability by Automation and Machines

The patents I studied describe current human labor operating the patented machines as being easily replaceable by machine labor. Machine labor is considered as a feasible option to replace human labor, despite the fact that few details or explanations are available in terms of how this replacing would work in practice (e.g., P137, P119, P122, P127, P134, P148).

Several patents, including P122 and P148, clearly acknowledge the possibility that human tasks could be performed by an automated agent or automation: *"Moreover, process steps described as being performed by a "marketplace," a "vendor," a "fulfillment center," a "worker," or a "customer" may be typically performed by a human operator, but could, alternatively, be performed by an automated* *agent"* (P122, [116]); similarly, P148 illustrates, *"... some or all of the activities described as being performed by a human operator may be performed by automated mechanisms, which may be coupled to and under control of the materials handling facility control system"* (P148 [98]).

It is not uncommon for patents to state that a given task can be completed either by a human or a machine, rather than making a clear distinction. This failure to specify who can perform the task means that the differences between the caliber of human work and that of machine work are not recognized: *"In operation, a person or automated system stacks multiple totes or cuboid containers one on top of another free from any alignment mechanism or within an alignment or stabilization mechanism, such as frame"* (P119, [177]).

Other possible work configurations have been proposed, such as those described in P127 and P134, which state that humans and machines may share the same task: *"The workstations may be controlled, entirely or in part, by human operators or may be fully automated"* (P127 [11]). P134 also implies that both people and machines can use some of the other's labor to achieve a shared objective:

> "In alternative embodiments, some or all of the activities described as being performed by a human operator may be performed by automated mechanisms, which may be coupled to and under control of the materials handling facility control system. This may be performed manually (e.g., by an operator or agent using a hand-held scanner), via an automated scanning/reading process using fixed scanners/readers, or by a combination of manual and automatic scanning/reading" (P134 [53]).

4.4.1 The Erasibility of Humans. Although the patents acknowledge the need for human workers in at least some capacity, they eventually envision an autonomous system that is devoid of human workers. P58 expresses this goal in a direct manner, for example: *"While it has been described that one or more workers are present at one or more workstations in various embodiments, in other embodiments the workstations may be fully automated or semi-automated to eliminate a need for the presence of a worker"* (P58 [157]). According to yet another patent for the Kiosk Network, *"they [Kiosks] can operate autonomously without constant human supervision"* (P60 [1]).

Similarly, I found that the patents often highlight unfavorable views of human labor. These views are due to the possibility that human "intervention" could prevent developed automation or technology from being applied effectively. P18 details several ways in which human workers could potentially obstruct the work of the machine, such as inconsistency in the work performed by humans: *"As the capabilities of different human agents may vary widely, processes with manually performed or assisted tasks can be subject to inconsistent performance. When combined with processes operating with improved performance characteristics, like the aforementioned automation techniques, processes with manually performed or assisted tasks may reduce the overall effectiveness of such techniques"* (P18 [54]).

Another patent (P66) for the automatic detection of missing, obstructed, or damaged labels clearly references the inefficiency of the manual processes carried out by human workers: *"...manual inspection of every label on outgoing shipments can be a time-consuming, tedious, and error prone process."* Furthermore, the patent highlights the significance of the patented technology that automates label examination: *"Accordingly, embodiments of the disclosure can facilitate automated inspection of labels that are required to be affixed to certain packages being shipped from the fulfillment center* (P66 [71]). In a similar vein, robots are considered to be more suited to operating the patented machines than human workers in terms of work efficiency. Robotic arms are one example that P54 (a patent on dynamically reconfigurable inventory recipient) suggests: *"Further, the ability to transport inventory items to and from an inventory holder with robotic arms rather than human workers may vastly increase efficiency and productivity within the inventory system"* (P54 [156]).

4.4.2 References to "Human Errors" in the Patents. I found that the frequent use of the term "human errors" in Amazon's patents is also indicative of the company's perspective on human labor. For example, P71, a patent on implicitly confirming item movement, explicates that a failing system is the result of human errors: *"an agent directed to store item X in bin Y may accidentally store item X in bin Z due to human error. When another agent is later directed by the computing system to pick item X from bin Y, the other agent may be unable to find the item because it is not in the assigned bin"* (P71 [19]).

Just like the term "machine error" indicates a mistake made by a machine, "human error" refers to the mistake of a human worker here. In the case of the P71, human errors refer to situations in which human workers fail to follow the system's instructions. This failure is similar to a machine error, which typically describes situations in which a programmed action is not carried out. P71, interestingly, takes the stressful working conditions of fulfillment centers into account, acknowledging that it may be reasonable to expect human errors given that the human work pace is expected to match that of machines: *"Agents are required to work with great speed, so it is unsurprising that occasionally items may be placed in or picked from the wrong locations. Thus, the computer-based data representation of the materials handling facility may be consistent with reality"* (P71 [19]). To back up the system claimed by the patent, human errors are once again brought to light here. Rather than attempting to improve the difficult, labor-intensive working conditions, the patent proposes changing the primary agent of work.

4.5 The Skills of Humans: Fictional Characters and Actual People

Besides human workers, there is another category of human actors that can be found in all patents. These are people with ordinary skills, who are referred to as "those of ordinary skill in the pertinent art" or "a person of (ordinary) skill in the art" in the patents. As this category of individuals is not directly involved in interacting with the patented fulfillment center technologies nor bound to the demands of the technologies, their position is "beyond" the scope of the patents and is therefore decontextualized in all situations that are covered by the patents. This hypothetical group of people with ordinary skills is a legal construct that can be found in many patent laws around the globe. Without being a genius or layperson, this essentially fictional character is thought to possess the typical knowledge and skills of a given technical field. He or she primarily acts as a patent examiner or jury to determine whether a claimed technology is patentable, for example, or if it is too simple to be protected by a patent. Although the term "ordinary skill" is not strictly defined here, the specifics of (or even a certain part of) claimed technologies that would presumably be understandable based on the "ordinary skill" are not described in any detail or not provided at all: *"Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the described embodiments"* (P116 [12]).

The patents assert the invention's extensibility and applicability based on the speculative knowledge of this legal fiction. To illustrate, further potential uses and applications of the technology that the patents allude to rely on the legal fiction's knowledge without disclosing what these uses and applications are: *"Various methods and techniques for sorting items into item-size categories may be implemented which are well-known to those of ordinary skill in the art in addition to the examples above. Therefore, none of the above examples are intended to be limiting"* (P57 [93]). As another example, the patent also offers the possibility to apply the devices to any part of the workers' body by relying on the imagination and common sense of these legal fictions: *"Those of ordinary skill in the pertinent art will recognize that the applications of the wearable RFID devices of the present disclosure, and the aspects or extensions of a human body about which the wearable RFID devices may be worn, are not limited"* (P34 [178]).

As the preceding examples demonstrate, it is anticipated that the claimed technologies will ultimately result in the automation of what currently are tasks performed by humans. This legal fiction is described as someone who would embrace the automation trend, thus supporting the perspective and future that the patent envisions: *"Those of ordinary skill in the pertinent arts will understand that process steps described herein as being performed by a "worker," by "glasses," by a "fulfillment center," or by an "external user" may be automated steps performed by their respective computer systems, or implemented within software modules (or computer programs) executed by one or more general purpose computers"* (P33 [168]).

While not commonly articulated throughout the patents, some specific expertise is needed by human workers or future users of the proposed technologies in the patents, just as "ordinary skills" are needed for anyone to appreciate and evaluate the patents. For instance, to fulfill specific responsibilities as a human worker, a person must possess the necessary training or experience. Workers dealing with certain items are required to possess essential knowledge to distinguish between similar items as well: *"In some embodiments, assignment of a manual operation to an operator may be made based on an expertise of that operator. For example, manual operation of a robotic forklift may be assigned to an operator certified to operate a forklift. In another example, manual retrieval of a particular item may be assigned to an operator that is familiar with that particular item"* (P12 [94]). Instead of creating sophisticated sensors, it may be simpler to boost job precision or efficiency by requiring specific expertise or experience for workers to complete certain activities.

Even physical labor involving the system requires specific qualifications for employment: *"a particular operator may be selected to perform a manual operation based on time zone information, language, experience, labor costs, experience on similar issues, or any other suitable factor...In another example, an operator may be compensated based on the manual operations performed. In this example, the operator may be a member of a crowdsourcing website in which users are able to select and perform various manual operations"* (P12). It is interesting to note that—similar to platform workers or gig workers—remote workers are also seen as a potential source of "physical labor." The patent shows the possibility that future fulfillment centers could outsource their labor through crowdsourcing websites, allowing them to hire manual laborers from anywhere in the world.

5 DISCUSSION

In this section, I return to the question of the ways in which humans are involved in the future of fulfillment centers. As I have shown in the findings from the patents, the major themes revolve around the workers' bodies, workplace surveillance under datafication, and the different skills required for approving patent technology versus operating it. I first discuss each theme in turn. Then I discuss how patents, unconventional types of data in CSCW research, can serve as core empirical data providing critical insight into tech companies' "future-making" to the CSCW community. To draw more attention to patents as a new methodological venue to be leveraged, I outline practical ways in which patents can be utilized in CSCW research.

5.1 Visible Human Body, Invisible Human Output

My analysis of the patents surfaced many instances in which the technologies of future fulfillment centers (FCs) rely heavily on living labor. Operating these technologies requires extensive human labor; it is not something that is phased out.

One recurrent agenda across the patents has been that of exclusively using the human body and its physical capabilities. Workers' bodies and their bodily practices become essential as the patents tend to claim that they are noble and widely applicable, despite having limited technological functionality. For example, for patent technologies to be able to have free mobility and for their sensors or usages to reach different locations in the FCs, workers are expected to carry them around (Section 4.2). The technologies often have a wearable form and need to be embedded in the human body, something which post-phenomenologists [106, 176, 222] refer to as 'embodiment' or 'embodiment relations' with technology. Well-known examples of embodiment are reading glasses and walking sticks, which form a partially symbiotic relationship with the user, extending the individual's body and supporting the human bodily experience. However, interestingly, in the case of this study, it is the technology or the machine that expands into the human body in order for it to work effectively and benefit, whereas humans themselves gain no (bodily) benefit.

Furthermore, instead of using advanced vision sensors or monitors, the human workers referred to in the patents are expected to discern a particular item and/or recognize errors (e.g., mismatched records or items; Section 4.1). Good physical strength, eyesight, and sensitivity are essential for performing common human tasks, such as picking or packing the right items or stowing them in the correct place. What is taken for granted in regard to these patents is that workers are able-bodied enough to have a good level of physical ability to work with and around the patented technologies. Ekbia and Nardi [73] note that online gig workers, like crowdworkers [119, 234], become legible as computational components as they make up for the shortcomings of machines [180, 194]. Similarly, as my study of the patents has shown, a human body becomes a component by mobilizing its body parts to run machines. Humans are left with physical tasks, such as picking, packing, and stowing, as machines increasingly take over cognitive tasks, such as computing and decision-making.

Almost all the patents mention that current human interventions could or will be replaceable or exchangeable with the work performed by machines (Section 4.4). It seems that full automation is the goal here, although there are no specifics with regard to how such an objective might be achieved. To justify this goal the inconsistency of human labor and the potentiality of human errors are frequently mentioned. The implication of perceiving human labor as something replaceable or exchangeable is particularly noteworthy in that current, integral roles of human labor are not counted or acknowledged at all. What this perspective disregards is the indispensability of human labor in operating patented technologies. In HCI, CSCW, and other relevant fields, the dominant view has been that humans cannot be completely replaced by automation [55, 56, 76, 91, 131, 148], but that they will take on different tasks instead [193], such as filling in for what machines are unable to do [195]. Considering this position, while machines would do more computational work, the different tasks humans are likely to take on would be work that is not prone to errors, an expectation which is well represented in the patents as well. The work of a machine is designated and defined, whereas human work could become contingent upon a machine's performance and its shortcomings.

Finally, I reflect upon the general illustrations of human figures in the patents. Human figures are minimally outlined or often just in silhouette. As Bell and Dourish noted, "homogeneity and an erasure of differentiation is a common feature of future envisionments" [22, p.134]. Patents have absences or limited expressions of gender, race, ability, age, and more. Considering prior works of invisible labor (e.g., [154, 166]), the invisibility of workers' heterogeneity is in effect when labor is devalued. This view might reflect how human labor is valued in the future of fulfillment centers. As HCI and CSCW continue to contribute to diversity, equity, and inclusion in computing, understanding and accounting for the heterogeneity in human beings included in the patents will be essential.

5.1.1 People as Infrastructure. Following the line of work in CSCW, STS, and infrastructure studies [111]—revealing the operations of technology and people that are otherwise obfuscated by black boxed technologies and systems [81] is central to their inquiry—we were able to see when and what kind of human labor and human roles are revealed or concealed in Amazon's envisioned future fulfillment centers. As HCI and CSCW scholars have noted in research examining other work contexts, humans are explicitly visible [91, 169]. While the patents also visibly illustrate human figures rather than making them invisible or hidden [27, 154, 166], the representation of humans in work configurations proposed in the patents is somewhat less recognizable. For example, the roles and contributions of humans are changing and not clearly definable, a factor which makes the immediate effect of these work configurations on humans less visible [208, 212]. By highlighting the human body and its physical capabilities rather than humans' cognitive abilities and work, and by revealing humans' unstable roles and less visible representations in the system, the patents proceed to mold humans into the patented machines and system.

How, then, can we "unfreeze" the way the company envisions future FCs, where the idea of humans as components of machines is prevalent? How can the human body and human labor become the focal point of our analysis? The concepts of "the body as infrastructure" [8] or "people as infrastructure" [199]—both drawn from geography studies—can provide a useful lens when analyzing workplace automation. In his seminal work, urban researcher AbdouMaliq Simone proposes the concept of people as infrastructure. In line with his suggestion that the notion of infrastructure must be directly extended to people's activities [199, p.407], other scholars argue that "the movements and circulations of people" are also considered forms of infrastructure themselves [198, p.791]. In more recent work, Simone reflects on "people as infrastructure" to underline the concept's renewed importance given the "vulnerabilities" that human life faces today. He writes, "'people as infrastructure' was intended to resituate urban human existence in a way that acknowledged the constellation of accompaniments to the eventfulness of urban life" [200, p.1343]. As humans' roles and contributions are less represented and often not acknowledged, the vulnerability of humans working and being underserved in future—and arguably also current—fulfillment centers is apparent. Considering this factor, "people as infrastructure" reminds us to foreground humans as they are infrastructure and also to "sustain" them [8, p.800]. The roles of HCI and CSCW scholars would be to deliberate and negotiate questions on how we might want humans to function in relation to the large technological infrastructure of fulfillment centers.

5.1.2 Surveillant Assemblage. The patents reveal that human workers are constantly captured as data in various ways—from their work activities to their biometric data—analyzed, and integrated into the machines (Section 4.3). According to Reid and Gibert's broad classes of human-machine interactions [172], human workers' interactions with machines can be classified as "passive and nonconsenting" in that an individual is subjected to a machine without a consent process. One example of a passive, nonconsenting interaction is facial recognition for law enforcement purposes. Similarly, human workers in patents unwittingly become a source of data for the machines while interacting with them, while how the tracked data will be used is not known. This systemic datafication is referred to as dataveillance by computer scientist Roger Clarke [47].

Recently, CSCW and HCI scholars have been looking at how workers, particularly low-wage workers [65], become data workers [48, 118, 149, 194] as they are expected to capture data either manually (e.g., hours spent on a certain task) or automatically via their mobile devices (e.g., location-based data [90]). For example, Kristiansen et al [123] show that the manual labor of electricians—the subjects of their study—has become data-driven due to the management system allowing them to track their work. While the electricians were engaged in producing, monitoring, and accessing their work data, the human workers illustrated in the patents are not: their manual labor work is automatically tracked as data, which is then processed and utilized by the machines without the involvement of any human worker. Media studies scholar Mark Andrejevic observes that it is nearly impossible for an increasingly automated system to be manipulated by something that is not similarly automated [7], something which he refers to as the "cascading logics of automation." My findings also demonstrate that humans cannot recognize or access their work data tracked by the systems and machines of fulfillment centers. Crooks describes how subjects of datafication can elude dataveillance by manipulating the ambiguity of the representational relationship between digital data and behavior, a strategy termed "interpretive resistance" [52] Under the patented systems, humans would not be able to engage in interpretative resistance due to little opportunity to grasp how the data are used and what forms of control they attain.

In addition to work activities and performance of human workers being tracked, the patents reveal that workers' body and biometric information, such as skin tone and hand shape, is also data that is collected, analyzed, and integrated into functioning machines. All distributed technologies—cameras, sensors, scanners, carts—in the patents are mobilized together to record and gather data on the human workers in the fulfillment centers. Haggerty and Ericson [96] call this convergence of discrete surveillance systems "surveillant assemblage." They write, "the surveillant assemblage standardizes the capture of flesh/information flows of the human body. It is not so much immediately concerned with the direct physical relocation of the human body. . . , but with transforming the body into pure information, such that it can be rendered more mobile and comparable" [96, p.613]. The systems shown in the patents—resembling surveillant assemblage closely—rely on a variety of machines monitoring and abstracting human bodies from their work settings, and circulating the data obtained to fuel the automated systems. Given the multiplicity of surveillance systems—such as surveillance assemblage—it is nearly impossible for humans surrounding the systems to respond or resist dataveillance regimes by decoupling their behavior from the data that represented that behavior [52].

5.1.3 Alienated Skills. As demonstrated in the patents, these patents differentiate humans "of ordinary skill" from those who directly or indirectly interact with the patented technologies in the fulfillment centers. While ordinary skills are required to understand and appreciate the technologies claimed by the patents, the patents rarely talk about how understandable the technologies are to the human workers affected by them. Unlike humans of ordinary skill, other humans (mostly workers) are isolated from the ways in which the patented technologies work. They are seen as merely a part of the building-size machines that are black boxed by design [80, 81, 107, 108]: the machines obfuscate how they work and the human workers may know nothing with regard to the machines' operation. This characteristic of concealing conjures up Marx's concept of "alienated labor" [142], which can occur in four dimensions: the worker being alienated from the product of their labor, from the process of labor, from others, and from the self. In the case presented in this paper, the human workers or users are "alienated" from the knowledge to recognize and understand the technologies they work for and within, as they do not have to even possess the ordinary skills necessary to understand what these technologies are, and what they can or cannot do.

The alienation of knowledge or skills can also emerge in other sociotechnical contexts. If CSCW and HCI are to pursue the ethos of participatory design [16, 72, 102, 124] or worker-centered design [66, 85], then research on workplace technology must expand and decentralize knowledge about technology and applications. Such research should seek ways in which human workers can be more committed to their sociotechnical practices through increased social and political agency (e.g., being informed about what a particular machine is able to do and in fact does when used by workers).

5.2 Collective Imaginaries Versus Tech Company's Imaginaries

Throughout the paper, I have articulated the preferable futures of Amazon on the basis of an analysis of their patents for future fulfillment centers technologies, to broaden our scope of inquiries in HCI and CSCW. My observations both contribute to and critique the sociotechnical imaginaries that we are moving toward.

Obtaining patents could be seen as “anticipation work” [209], given that this practice “cultivates and channels expectations of the future” [209, p.443], and builds as well as maintains the envisioned future through “mobilizing resources, aligning political and scientific interests, and evangelizing imagined worlds” [209, p.449]. The patents claimed and obtained by big tech, therefore, embed a particular vision and expectation of the future that they seek to move toward and maintain.

We argue here for paying more attention to the specific ways in which tech companies actively arrange their sociotechnical visions and narratives. CSCW and HCI researchers have shared diverse interests in the relationships between employers and workers [216]. Central interests involve, among other things, the workers’ uneven social, political, and economic relationships [85, 99, 144] with employers and organizations, including insecure employment [63, 64, 84, 170] and poor working conditions [101, 109, 110, 121, 181]. Another line of research focuses on exploring values and perspectives of developers and designers [4, 42, 137, 196, 230], as these professionals are also “workers” who often have to align their work with the vision of companies or organizations, rather than realizing their own ideas [214]. The prior work has shown that corporations can powerfully shape the direction of what happens in the future in a way that is difficult to disregard. Very few studies have tried to unravel companies’ technological visions by using corporate concept videos [233] and media articles [100], due to access to companies’ internal documents being limited. I call for further examinations on what sociotechnical imaginaries tech companies—particularly big tech—actively engage in, something which could expand the body of critical CSCW and HCI scholarship.

We as HCI and CSCW researchers must be aware of the imaginaries of big tech companies for several reasons. When research and innovation are largely left to companies, technological developments will be shaped by their specific future visions and economic rationales, which may clash with society’s collective imaginaries and stifle democratic deliberations in the design and implementation of new technologies [86]. By being aware of a particular vision or narrative woven by tech companies, we will be able to avoid being swayed by them and uncritically reproduce the power that big tech and other companies wield over the present.

This awareness would furthermore allow us to launch effective sociotechnical interventions—what Kazansky and Milan call “counter-imaginaries” [115]—to negotiate or even resist their specific imaginaries and/or design ways for a more democratic uptake of companies’ future technologies. Kazansky and Milan [115], for instance, demonstrate how technological and speculative interventions performed by civil society through open-source software projects can contest the dominant imaginaries of datafication and generate alternative futures (e.g., configuring users as the ones with increasing agency rather than as helpless victims of pervasive datafication). Through sociotechnical interventions like Turkopticon [109], We Are Dynamo [181], and the Shipt Calculator [33], CSCW researchers have also engaged in the creation of counter-imaginaries. Other potential interventions could include continuing support for grassroots initiatives, experimenting with civic technologies, and cultivating critical questions in the public discourse, all of which would contribute to the proliferation and maintenance of counter-imaginaries.

Lastly, this effort to understand companies’ imagined, aspirational futures could also become part of the endeavor of scholarship focusing on “larger or external forces”—e.g., infrastructure, policy making, social and economic system, the political economy [10, 74, 75, 127, 133, 207]. Building on prior work, Lindtner and Avle broadened what studying technopolitics means in CSCW, defining it as “to make what is typically construed as “larger” or “external” forces within which technology design unfolds. . . the very focus of analysis” [134, p.3]. For example, adopting this view of technopolitics, they looked at the political economy of tech entrepreneurship redefining the relationship between the state and citizens. Companies’ imaginaries—their visions of specific technological futures—are the very sites that HCI and CSCW scholars can explore further through the lens of technopolitics. The acts of speculating about worlds beyond individual artifacts [50, 135, 189] have been implemented as critical design strategies (e.g., worldbuilding [51], worldmaking [88, 224], and infrastructure speculation [104, 232]). Drawing on this body of work, scholars can leverage their empirical and critical accounts of alternative futures so as to then mobilize to confront the companies' "powerful futures" [220].

5.3 Patents as Speculative Design Materials

Patents have some similarities with speculative design in that they often eliminate practical challenges of execution and economic viability [68, 69]. As some speculative designs look to more plausible futures [132], patents vary in terms of their economically feasibility in regard to being implemented in reality. For example, a delivery service via hot-air balloons [164] is not likely to happen in the near future. Patents also differ from speculative design in several ways, something which could complement the development of such design. Speculative design occasionally aims for a different social and cultural milieu, whereas patents examine alternative technologies within a comparable social milieu (e.g., social and economic system, cultural contexts) [68]. As opposed to speculative design, which concentrates on the connections between people, objects, practices, and structures in an imagined world [41], patents are more concerned with the mechanisms or artifacts of technology. Furthermore, patents also tend to dominate and colonize a certain future that they delineate and serve in the patents [183].

By capitalizing on these different yet complementary aspects, patents, I argue, could be used to craft a new mode of speculative design. For example, analyzing patents with a certain focus in mind to identify what kind of futures are envisioned with and through their patented technologies, as well as which expectations are built into the patents, and, furthermore, to reflect on social and political questions that the patents might raise—like this study does—could constitute a good start. Simply, the approach could be to speculate about alternative sociotechnical worlds [130] by centering on how the world might adopt certain patented technologies and what the ramification of using them might be. Design fictions could be created as a form of fictional patents, with inventors' motivations, patented technologies, and their implementations being weaved together through speculation [43, 104]. Moreover, developing speculative artifacts based on the ways in which designers are reading current patents could constitute another way. Patents as speculative design materials could creatively contribute to currently ongoing practices and developments of speculative design. I call on the CSCW and HCI design communities to consider engaging in this kind of approach in developing speculation.

5.3.1 Methodological Reflections and Future Research. As part of my methodological reflections, I suggest several future works for CSCW researchers. In addition to patents, other forms of intellectual property, such as copyright and trademarks, as well as discursive resources (e.g., CEO statements, corporate communications, R&D networks) can be utilized to examine how companies use future imaginaries to expand their "technological zones" [18]. Given that there are always multiple imaginaries [138], examining other actors—such as influential research institutes or grassroots activists—to track the trajectories and interrelationships of imaginaries of various types and scales would be worthwhile. Second, based on long-term observations, a new focus could be the process by which a tech company's imaginaries are enriched by their current practices of governing new technologies. For instance, researchers could ask how a technology company might propel a new socioeconomic order in accordance with their imaginaries. Lastly, I acknowledge the limitations of my research. As I am unable to discover the "true" future vision of tech companies and their true goals, my work should be viewed as a subset of larger conversations about the role a big tech company may play in our technological future. In light of this, future work could consist of observing how big tech companies' "powerful futures" may disrupt the present civil society's imaginaries or other alternative futures, rendering them less meaningful or even impossible.

6 CONCLUSION

In this study, I explore how Amazon envisions future configurations of humans and technologies in future fulfillment centers. Throughout the paper, I have articulated the preferable futures of Amazon on the basis of an analysis of their patents for future fulfillment centers technologies, to broaden the scope of inquiries in HCI and CSCW. My observations both contribute to and critique the sociotechnical imaginaries that we are moving toward. By being aware of a particular vision or narrative woven by tech companies, we will be able to avoid being swayed by them and uncritically reproduce the power that tech companies wield over the present. My hope is that the findings of this study will allow us to develop more equitable future work arrangements with technologies.

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APPENDIX

A LIST OF 66 PATENTS

P	ID	Title
1	US-2014257553-A1	Method and apparatus for multi-destination item selection using motes
2	US-2018218218-A1	Augmented reality user interface facilitating fulfillment
3	US-2015073587-A1	Modular material handling system for order fulfillment
4	US-2015151913-A1	Method and apparatus for managing the allocation of items to processing stations in an order fulfillment process
7	US-2021241216-A1	Item detection and transitions
9	US-2018155142-A1	Automated loading system
10	US-2016264357-A1	Item retrieval using a robotic drive unit
11	US-2017175413-A1	Multi-level fulfillment center for unmanned aerial vehicles
12	US-2018284760-A1	Method and system for tele-operated inventory management system
17	US-2018053141-A1	Agv traffic management system
18	US-2019258853-A1	Visual task feedback for workstations in materials handling facilities
19	US-2015221021-A1	System and method for visual verification of order processing
21	US-2014343714-A1	Robotic induction in materials handling facilities with batch singulation
23	US-2019251499-A1	Detecting inventory changes
26	US-2019138986-A1	Transitioning items from a materials handling facility
27	JP-2017222517-A	System and method of process control in material handling facility
28	US-2018150787-A1	Tracking transactions by confluences and sequences of rfid signals
29	US-2008294536-A1	System and method for providing export services to merchants
30	US-2016176637-A1	Consolidated pick and pack for outbound fulfillment
33	EP-3084684-A1	Pointer tracking for eye-level scanners and displays
34	EP-3161750-A1	Wearable rfid devices with manually activated rfid tags
37	JP-2013256392-A	Method and system for inventory placement according to expected item picking rate
38	JP-2013224222-A	Method and apparatus for processing receptacle of item in material handling facility
39	EP-2584500-A1	Method and system for anticipatory package shipping
45	US-2015088731-A1	Kiosk management system
48	US-2015088307-A1	Inventory distribution method and system
54	WO-2016064719-A1	Dynamically reconfigurable inventory recipient
57	US-2014364995-A1	Determining stowability based on item-size categories
58	US-2015291356-A1	Bin-module based automated storage and retrieval system and method
60	US-2015088694-A1	Kiosk network in a kiosk management system
63	US-2020398441-A1	Optimization-based spring lattice deformation model for soft materials
64	EP-2443603-A1	Processing shipment status events

65	US-2018058739-A1	Transportable climate-controlled units for fulfillment of perishable goods
66	EP-3469543-A1	Automated detection of missing, obstructed, or damaged labels
68	US-2017283185-A1	Multiple speed conveyor storage system
71	US-2018060619-A1	Implicitly confirming item movement
74	US-2017036866-A1	Singulators with ports for diverting items
77	US-2015332216-A1	Optimization of packaging sizes
81	EP-3050009-A1	Mobile transactions with a kiosk management system
84	EP-3510537-A1	Bundled unit identification and tracking
85	EP-3161739-A1	Performing automated tasks based on visual cues
87	US-2012072011-A1	Generating Customized Packaging
91	WO-2016069352-A1	Dynamic rfid-based input devices
107	US-2018129992-A1	Planning labor shifts
111	WO-2018187166-A1	Using proximity sensors for bin association and detection
116	US-2019147710-A1	Color blind friendly pick to light system for identifying storage locations
117	US-2021094686-A1	Autonomous home security devices
119	US20190241364A1	Container palletizing system
121	GB-2587449-A	Automated modular system for sorting items
122	WO-2015200393-A1	Tracking transactions by confluences or sequences of rfid signals
123	US-2021182921-A1	Customized retail environments
125	US-2021181331-A1	Techniques for determining a location of a mobile object
126	US-2021209543-A1	Directing secondary delivery vehicles using primary delivery vehicles
127	US-2020265733-A1	Live adaptive training in a production system
129	US-2019071250-A1	Item retrieval using a robotic drive unit
133	US-2016347546-A1	Method and apparatus for multi-destination item selection using motes
134	US-2016210738-A1	Visual task feedback for workstations in materials handling facilities
137	US-2015168727-A1	Pointer tracking for eye-level scanners and displays
138	US-2009000912-A1	Method and Apparatus for Non-Linear Unit-Level Sortation in Order Fulfillment Processes
141	US-2013166062-A1	Methods And Apparatus For Stacking Receptacles In Materials Handling Facilities
143	US-2009081008-A1	Stow and sortation system
144	US-2007150383-A1	Method and apparatus for processing receptacles of items in a materials handling facility
145	US-2013218799-A1	Container Selection in a Materials Handling Facility
147	CN-104995656-A	Unauthorized product detection techniques
148	US-2011295412-A1	System And Method For Managing Shipment Release From A Storage Area Of A Material Handling Facility

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