JUST TECH

Behind the Curtain: How Human Labor Disappears in the Making of Autonomous Machines

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Late on a Tuesday night in a robotics lab, a small team of engineers gathered in silence around a humanoid robot. For months, it had failed at the same deceptively simple task: reaching for a bottle and removing its cap. That night, after countless failed attempts, the robot's arm moved slowly toward the bottle, grasped it, and opened the cap in a jittering, hesitant motion. The team erupted. "This is the future!" the team lead shouted, and everyone cheered as if this small, halting victory were a glimpse of a world already arriving, one where robots move seamlessly through human environments, autonomous and capable. That successful moment became one short second in the demo video.[1]

What the demo video would show was a robot completing a task on its own. What it would not show was the months of failed attempts, the engineers who had manually guided each movement, staged the space to accommodate the robot's limits, or simply did the work for it, and the room full of people whose labor, judgment, and care had produced that single successful second.

When ChatGPT and other large language models entered public life, they intensified a much older obsession: How autonomous, really, is the machine? Public conversation has grown saturated with what we might call the "realness" question: Does AI possess genuine intelligence, genuine independence? At the center of this discourse are so-called autonomous systems, machines widely portrayed as able to act on their own, without human help.

But the machine autonomy we see in headlines is not a real feature. It is a *performance*, supported by a

huge, mostly hidden group of human workers who must stay out of sight to not break the illusion. Asking if machines are really autonomous misses a more important question: whose work is making them seem that way, and what does that work cost those people?

This isn't a philosophical question. It shapes who gets credit, who gets harmed, and who evades accountability entirely. To answer these questions, we need to look at what's performed in front of the public, what happens backstage, and who pays the cost in between. What follows is an account of these dynamics based on my one-year research embedded inside a robotics development lab. Through following the team, I will parse the carefully sustained masquerade of the autonomous robot and its implications.

On Stage: The Public Performance

The hype around "autonomous" machines depends on public demonstration. Building a sense of inevitability requires not just capital and infrastructures—venture funding, government grants, data centers—but public buy-in. At technology conferences I've attended, speakers routinely marketed these robots as empowering technologies that liberate humans from dangerous jobs. Crucially, they framed robotics as an urgent answer to pressing social problems: labor shortages or the elder-care crisis. These complex human challenges got recast as engineering problems with technological fixes. This framing did more than make the machines look useful; it made them look necessary, reinforcing a sense that "the robots are coming" and nothing can stop them.

Live demos made the performance more concrete. In one widely applauded moment, a speaker asked his humanoid robot to "give me a hug." The robot embraced him, while, just out of the audience's view, a VR operator controlled its every movement through a headset and a remote. Keeping operators behind demo stages, out of the crowd's line of sight, was what let the performance read as autonomous. It's also worth noting that successfully operating these robots required intensive training, yet none of this expertise was, or ever is, acknowledged. The labor was essential to the performance, and it had to disappear for the performance to work.

The same dynamic played out in the hallway, at a robot racing competition. One team's humanoid navigated an obstacle course with four engineers actively working around it: two physically supporting a gantry structure holding the robot in case of falling, two more steering its movements by keyboard and remote. When it crossed the finish line still standing, the project lead announced, "This is our latest robot being implemented for the first time!" The crowd applauded. The camera operator stayed close to the team, but only the robot ever entered the frame.

What audiences celebrated as autonomous achievement was, in both cases, carefully coordinated human effort, rendered invisible by narrative framing and spatial staging. These weren't accurate glimpses of what the technology can do; they were performances_ones that made an imagined robotic future look like a matter of time, rather than a fundamental uncertainty.

So, what does the invisible labor behind that performance look like?

Backstage: The Reality in the Lab

In my second week visiting the lab, a senior roboticist nonchalantly mentioned at lunch that their humanoid was broken. They would need to pause physical experiments till repair was done. I asked how long repair would take. “Ten hours continuously, but could take longer,” he said. When I asked how he knew so precisely, he shrugged: “We’ve done this many times.”

After lunch, I joined the team at repair. They disassembled parts of the humanoid, exposing its interior: a dense tangle of electronic and mechanical components that needed to fit together simultaneously for the robot to function. Even seasoned repairers often made a wrong move midprocess and had to take everything apart again to fix the errors they had accidentally introduced.

This repair process was slow and tedious, as I would come to encounter repeatedly; these repairs often lasted several days to two weeks and required collaborative efforts from multiple people. Mundane operations like repair are part of roboticists’ daily reality, yet this often-overlooked labor is fundamental to the capability the robot would eventually display.

What struck me more than the repair itself was how little the team thought of it. “We’re just tinkering, playing around with the robot to see what it can do,” one engineer told me. “It’s not that impressive at all.” Most attempts failed. Success felt like finding a needle in a haystack, and the team had made peace with the rareness of success, treating constant failure as ordinary and not worth mentioning to outsiders. I began to understand the production of this form of invisible labor: The labor disappears from the demos not just due to institutional demands of technological progress, but because the people doing it have learned to see it as insignificant.

That normalization extends beyond invisibility to precarity. Funding pressures, unpredictable machine behavior, and institutional demands leave roboticists with far less control over their work than the public narrative assumes. A junior researcher told me he felt no control over whether his work would ever produce results. What surprised me was that even veteran engineers said almost the same thing—they were “hoping something would work,” “playing around to try to make it work.” Improvisational tinkering was far less empowering than the media’s portrayal of empowering technology. At another time, when a quadruped robot broke down due to its loss of connection with its control system, I asked what went wrong; two engineers just laughed: “There are thirty possibilities.” No clear diagnosis, just routine uncertainty; they learn to absorb it and move on quickly.

The engineers building technologies marketed as empowering and liberating are themselves often disempowered by the precarity and uncertainty built into the work of making those technologies capable.

Why It Matters Beyond the Lab

If autonomy is a performance sustained by invisible labor, the consequences reach well past any single lab. They reshape who is held responsible, who bears the cost, and where resources flow.

Accountability. When we treat autonomous systems as independent agents, we mislocate responsibility when they cause harm. Earlier this year, Waymo's chief safety officer testified before the US Senate that its self-driving vehicles rely on remote human operators who reside in the Philippines to step in whenever a car encounters a situation it can't resolve alone. That testimony came weeks after a Waymo vehicle struck a child near a school, and it prompted sharp questions from lawmakers about safety and labor implications[2] and who bears the responsibility when these machines cause harm to people.

The pattern is broader than any one company: Research has repeatedly documented tech firms relying on armies of low-paid workers to perform the repetitive labor that makes machines look intelligent and autonomous.[3] The labor that produces "autonomous" behavior doesn't disappear. It just becomes harder to trace, and harder to hold companies accountable.

Distribution of labor cost. This labor is not evenly shared. Some people, often junior, often precarious, disproportionately absorb the invisible work and the emotional toll of keeping the performance running. They bear the most burden but are the least credited. Credit, meanwhile, flows upward, to the institution or company that gets to claim the "autonomous" achievement. This isn't only imposed from above by power structures or demo culture. It's also willingly reproduced by the very individuals building these technologies, because many engineers' own professional identities are tied to a vision of technological progress that promises to be transformative, regardless of who is actually sustaining it. Institutions profit, in part, by enrolling individuals in a vision the institutions themselves created.

Resource allocation. Perhaps the most consequential effect is where money and attention go. When "autonomous" machines gain visibility, funding tends to chase more machines—more infrastructure, more data centers—rather than support the human labor that made the appearance of autonomy possible in the first place. For anyone making funding decisions, this is a direct distortion: Capital keeps flowing toward the myth rather than toward the people producing results. It also reinforces a public narrative in which robots are "taking over" jobs, which devalues human labor and strips workers of any sense of agency over a future they helped build.

Ripping Down the Curtain

None of this is inevitable. What looks like an unstoppable technological trajectory is actually the result of specific choices about how people, resources, institutions, and narratives get arranged. As media scholar Annette Markham has put it, a row of falling dominoes looks like an inevitable chain reaction—but it only falls that way because someone deliberately set it up that way.[4] Change the arrangement, and you get a different outcome. Different choices about funding, credit, and what counts as success would produce a different technology story, and perhaps a more accountable one. The robot is still performing. The audience is still watching. But now we can see what was always there: the months of preparation, the hands that calibrated the environment, the workers holding their breath offstage, the junior researchers who debugged until 2 a.m., the labor of everyone in the room invested in the machine looking capable.

The robot didn't do that. We did. And until we start asking who "we" includes, and what it costs them, we

will keep building technology systems that hide the humans who make them work.

Footnotes

1 Yifan Xu Miller and Elliott Hauser, "Accomplishing Robotic Autonomy: The Complexities of Sociotechnical Care and Agency in the Laboratory," *Human-Machine Communication* 9 (2024): 143–166, https://doi.org/10.30658/hmc.9.9.

2 Daniel Sims, "Waymo Admits That Its Autopilot Is Often Just Guys from the Philippines," *TechSpot*, February 7, 2026, https://www.techspot.com/news/111233-waymo-admits-autopilot-often-guys-philippines.html.

3 Mary L. Gray and Siddharth Suri, *Ghost Work: How to Stop Silicon Valley from Building a New Global Underclass* (New York: Harper Business, 2019).

4 Annette Markham, "The Limits of the Imaginary: Challenges to Intervening in Future Speculations of Memory, Data, and Algorithms," *New Media & Society* 23, no. 2 (2021): 382–405, https://doi.org/10.1177/1461444820929322.