sifted Reports

Construction robots

Here come the builder bots

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Construction robots

Here come the builder bots

Robots are rolling onto job sites to help lay bricks, lift heavy objects, paint, cut, reinforce, insulate, retrofit, secure, sort, transport, inspect and more. These machines — which display varying degrees of aptitude and speed — could eventually make construction safer and more efficient. Still: adoption in the industry is patchy. There are still many things robots are not good at and contractors seek further proof that they can handle tasks well, quickly and affordably.

This report lifts the lid on an industry slowly warming to robots, while sometimes struggling to find a place for them. Founders and investors tell us about their successes and failures in automating a tricky industry.

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FOREWORD

Robots will breathe new life into construction

Robotics has seen impressive progress in recent years. It boasts many promises for the construction industry, including improved productivity, enhanced safety and reducing workers' participation in dangerous, repetitive tasks. But there's still a lot that needs to be done.

Robots are an attractive solution for assisting workers, especially for carrying out repetitive tasks on large-scale construction projects. Several companies have already positioned themselves in this niche market, often with a focus on taking over dangerous tasks to better guarantee the safety of workers. These include Raise Robotics, whose machines can carry out high-precision operations on facades to limit the risk of falls for human workers, and Robots for Site, a VINCI collaboration, whose machines can sand, drill and handle materials to reduce accidents.

But unlike other industries, such as the automotive sector, the construction industry is made up of unique worksites, which often means that the robots used need to be adapted, limiting the use of an off-the-shelf solution. Another obstacle is cost: robotic technologies are still expensive to purchase, implement and maintain, limiting access to them to the big players in the market. As this report explains, though, entrepreneurs are finding new ways for robots to overcome the complexity of building sites, as well as experimenting with new business models that fit with established processes in the construction industry.

While the market for construction robots is currently modest, it could grow rapidly in the years to come. The global market is expected to experience average growth of 15.5% per year between now and 2029, going from €360m today to €750m. This figure certainly remains modest compared to the construction market as a whole, which is expected to be worth more than €17,000bn at that point.

Still, robotics provides a unique opportunity for the construction industry to become more efficient on many levels, from increasing productivity to optimising the use of materials. It's perhaps not surprising, then, that investors are increasingly backing the companies trying to build construction sites of the future.

In this report, Sifted shines a spotlight on the opportunities and challenges faced by startups and investors looking to deploy robots into the construction sector. From robots that can be rented by construction firms to build brick walls, to wheeled devices that can print blueprints directly on the ground, to legged robots that can perform site inspections, the technologies described in the following pages promise to breathe new life into the construction sector. We hope you find it useful and inspiring.

Julien Villalongue
Director, Leonard

INTRODUCTION

Yes, construction robots are a thing — and they're just getting started

Hoisting heavy stuff, getting things from A to B, assembling lots of pieces together: many construction tasks seem ideal to hand over to machines.

Letting robots loose on job sites feels like a no-brainer. Construction is the largest industry in the world, in terms of dollars spent. It's also among the most expensive and, often, dangerous jobs out there. The industry ticks the three Ds of automation — dull, dirty, dangerous — with ease.

But then when you really think about this, it gets harder to imagine robots being able to do what builders can do.

Anyone attempting to automate construction will tell you: the contrast between what you can do in a factory or warehouse and on a site is glaring. The big issue here is that robots thrive in environments where things are smooth and predictable. Out on the site, things are varied and changeable. No two developments are the same. Bots are forced to withstand rain, dust and dirt while dealing with varying topography and other surprises.

So why even attempt to put a hard hat on a bot? Well first of all, robot makers are patient problem solvers; they have to be, otherwise they wouldn't be designing robots. And they feel passionate about transforming industries. "A lot of my personal drive comes from growing up in a manufacturing town where they made cars and jeans, and for the cars you would just see automation everywhere [whereas] in factories it was women hunched over sewing machines. Some industries really have it much better when it comes to tools," says Maria Telleria, cofounder of San Francisco company Canvas, which has developed a robot that can do drywall finishing (you'll meet Telleria again in chapters 2 and 3).

CANVAS

No one can argue construction doesn't need a shot to its productivity, which is not just low but declining in some countries — in the US, productivity has halved since the late 1960s, according to McKinsey. The industry is facing a huge labour strain. The global population is growing, many countries have large housing deficits and there is a shortage of skilled manpower. In Japan, one of the world's fastest-ageing nations, the number of people employed in construction has declined 30% from its peak in 1997.

Another benefit of robots: they aren't afraid or claustrophobic. Flyability, a Switzerland-based startup is using specialised drones for visual inspections of dark, tight, dangerous and hard to reach spaces, saving humans the trauma of squeezing into such places. Another big motivation to automate is safety. From muscle tears and dust exposure to fatalities, this is a high-risk industry: so why not give robots the dangerous jobs and keep humans out of harm's way? This was an underlying motivation behind two Japanese companies (Jinki Ittai Co and Nippon Signal Co) that recently unveiled a giant, 12-metre high robot mounted on a truck that helps repair rail lines and save workers from potential electric shocks.

TECH STACKS ARE HERALDING A NEW GENERATION OF ROBOTS

A core reason why robotics in the construction sector is picking up pace is due to the recent progress and growing maturity of a fuller tech stack — IoT, LiDAR, satellites, AI and machine learning — that makes robots more adaptable to a real-time changing environment.

In Japan, one company, Kajima, is doing more than just building helpful robotic gadgets. It built a dam with 22 fully automated excavators, bulldozers and rollers — essentially turning a construction site into a factory, and giving the world a taste of what the future can hold for construction bots.

"We're seeing this convergence: simulation, mapping software and machine learning tools are all getting better, so the power for robots to compute and do quick calculations is absolutely new," says Gabriele Tinelli, an investor at Berlin-based VC firm Foundamental. The robot world is also benefitting from cheaper sensors and more sensitive gripping tools.


BUILT ROBOTICS

Still, this isn't an industry that's seeing a lot of private investor capital. By Crunchbase's count, just 17 robot construction companies in the world have raised funding from investors since 2022. More than three-quarters of financing rounds have been completed by seed-stage or Series A startups. San Francisco-based Built Robotics, Japan's Linkwiz and Vienna-based Gropyus are among the exceptions, each raising growth and late-stage capital in recent years.

"The fact that tech penetration for construction is one of the lowest of any industry is a clear opportunity," says Firat Ileri, partner at Belgian VC firm Hummingbird Ventures. "It's an unsexy area that's not going to attract tens of companies — so if you're a founder you can take your time and build real tech."

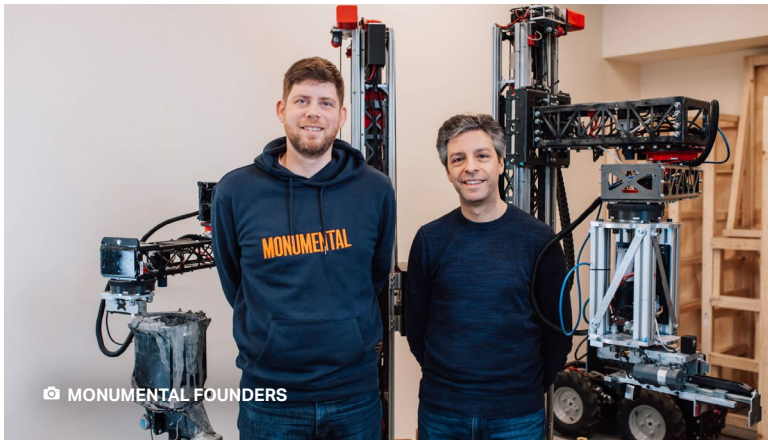
In the following pages, you'll discover robots that lay bricks, lift heavy objects and transport them. There are bots that help find problems on site and others that are becoming the source of truth for building blueprints. Some are helping with maintenance, some are finishing off interior walls with surprising finesse. We'll find out who's on the cutting edge in Europe and around the world, and dive into the nitty-gritty of how robot construction companies can succeed or how they can fail.

CHAPTER I

Trends to build on

The builder bots rolling onto European sites

One day, entire construction sites may resemble a factory — full of equipment that is connected, autonomous and controlled remotely. But for now, baby steps. It is hard enough, founders say, for robots to lay a few bricks with precision.



MONUMENTAL FOUNDERS

BRICKING IT

You expect investors to hype the companies they've backed — but rarely do VCs talk so enthusiastically about a founder as they do with Salar al Khafaji.

"We met Salar after he sold his first company [data-visualisation firm Silk] to Palantir. We had no idea what he was going to come up with next — we just knew we were going to back him no matter what," says Ileri from Hummingbird Ventures.

"He's probably the best European founder in our portfolio," says Patric Hellermann, founding partner of Berlin-based VC firm Foundamental.

Al Khafaji is the man behind Monumental, a Dutch company that raised $25m in February 2024 — a large sum for a robot construction company — to develop bricklaying bots. Despite the company only existing for three years, it already has wheels on the ground. Right now, these bots are helping to build 14 houses in a Rotterdam suburb.

> **If you can do something big in construction, you're doing something big for global GDP."**
>
> ***Salar al Khafaji,*** *cofounder and CEO, Monumental*

"After I sold my startup, I realised I wanted to do something meaningful," says al Khafaji. "A software company is fine but I think the problem with SaaS is you get stuck in an optimisation loop. If you can do something big in construction, you're doing something big for global GDP."

The Dutchman had no background in construction — much less robotics — but a plan that investors loved and an appreciation for beautiful buildings. "How were we able to build such great things in the past when we had no advanced tools? It's mind-boggling. We have more technology than ever and somehow we can't seem to build the way we used to."

Bricklaying is a line of work that seems perfectly suited to robots. "It's extremely repetitive — constructing a masonry building requires setting tens or hundreds of thousands of bricks or blocks, each one (nearly) identical, each one set in the same way," reads a blog post by structural engineer Brian Potter, which al Khafaji credits with helping him to understand the trade.

"There are no physically complex movements — each brick gets a layer of mortar applied, and is simply laid in place next to the previous one," Potter adds.

And yet, this has proved difficult to do well with mechanical systems.

It's not like people haven't been here before. "They've been trying to mechanise bricklaying since the early 20th century," says al Khafaji. The first attempts at machine-laid masonry date back to the turn of the century: Potter finds patents issued for mechanical bricklayers in 1899, 1904 and 1924.

So what sounded like it could be relatively straightforward has turned out to be anything but. "We underestimated mortar, that's one thing — it's really, really hard to work with for robots," says al Khafaji.

"And as we began increasing the number of robots we had, I've also come to appreciate how important calibration is — everything needs to be calibrated, every camera, every sensor, everything. If one robot arm is 1 millimetre longer than the other, it has this big knock-on effect on the work that gets done.

"So there have been painful moments." Getting the robot to a site safely is another challenge. "Making sure the driver doesn't hit any bumps and knock off the calibration has been a thing."

THE TIKTOK STAR

Meanwhile, in Germany, a company called Kewazo is targeting a different onsite problem with another deceptively straightforward solution.

The company's creation — called Liftbot — is effectively an automated hoist system that goes up and down scaffolding systems — a lot like the lift used by moving companies to transport furniture to a high-level apartment floor. The battery-powered bot has been used at sites including the US Capitol, as well as at refineries like the ExxonMobil Baytown Refinery. The company raised a $10m Series A in 2023, bringing its total fundraising to around $20m.

The founder, Artem Kuchukov, took time after his studies to figure out what would be useful for construction. He broke the problem down very simply. "There are two things that happen on job sites: you have stuff being added to other stuff and you have stuff being taken from point to another.

"We understood that we had to get material to where it needed to be, so if we could figure out how to transfer one type of material, we could then figure out how to transfer other types," he says.

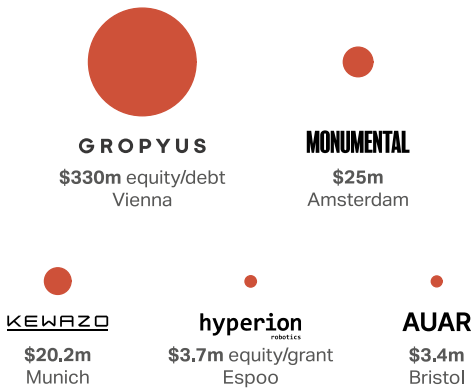
Kewazo — the name comes from the Greek word "to build" — has one unusual way of promoting itself: a lively presence on TikTok. The company has one video of its lift going up and down in the background, while a dog vigorously nods his head in approval.

"Every time a worker takes a break on the site, they're scrolling on their phones. This was an opportunity for us to keep our name in the conversation," Kuchukov says.

Engaging with (what Kuchukov says is) a very active "online scaffolding community" is one thing — navigating your company through a tangled network of general contractors, subcontractors, unions and the multi-billion-dollar management firms that run sites is another. And Kuchukov has notes, which we'll get to in chapter 2.

Top construction robot deals in Europe

Private investment in robot construction companies



Source: *Dealroom*

ONSITE V OFFSITE BOTS

Monumental and Kewazo are just two names in the still-small pool of construction robots plying their trade in Europe.

Germany's BauMotor resells autonomous vehicles — made by Japanese firm Ken Robotec — that help with the strenuous task of tying rods of reinforcement steel together. Belgium's Bimprinter is printing blueprints onto floors. Finland's Hyperion Robotics uses robot arms manufactured by Bavarian company Kuka to create 3D printed concrete structures (like water tanks).

"The most interesting robot companies will come from Europe," predicts Foundamental's Hellermann. "It's because of the cost structure. You can get three to four times more for your money than what you could hope to build in the US."

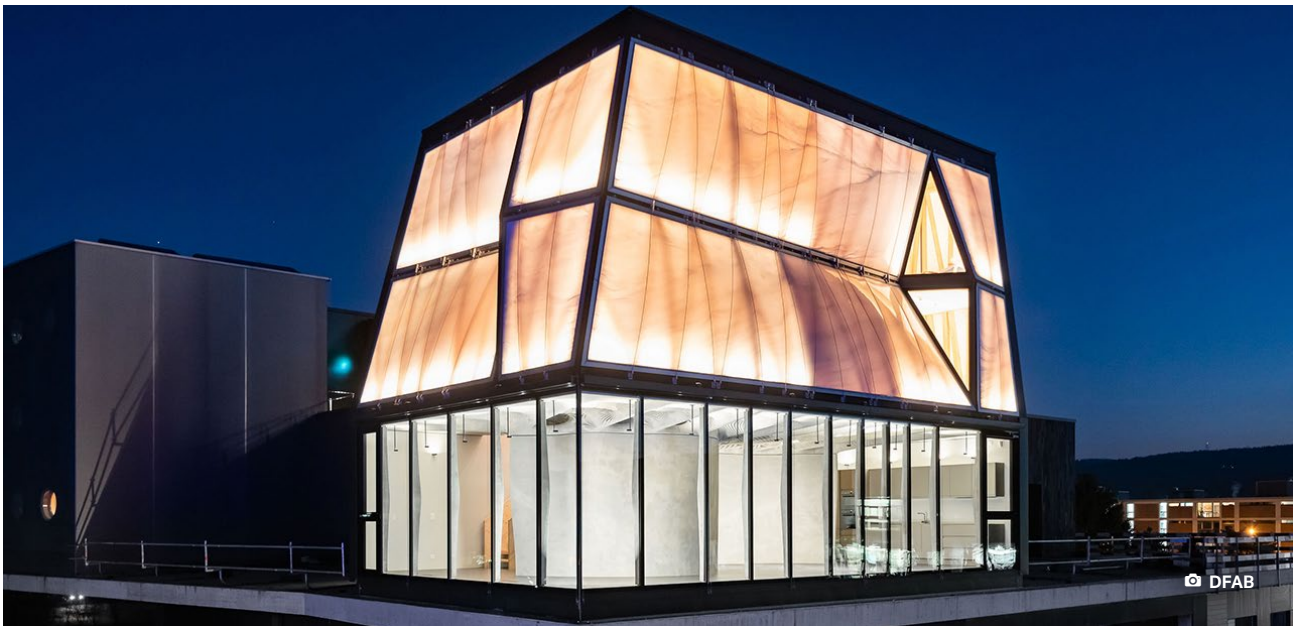
Travel to Dübendorf, a city roughly 10km north east of Zurich, Switzerland, and you'll discover an unusual and groovy-looking house called DFAB. It was developed by researchers from ETH Zurich, who chucked every leading edge technology they could think of into its construction — including robots. One of these robot companies is Mesh, which uses giant arms to weld together complex reinforcement cages that help keep houses upright.

This is just one example of a robot assisting in prefabrication — constructing large parts of buildings in factories and then assembling them onsite.

Vienna-based Gropyus — which has pulled in €140m from investors including the European Investment Bank this year — is a name to watch. Its new robot-stuffed factory for prefabricating units is targeting output of 250k square metres a year, equivalent to around 4,000 one-bed apartments. A pilot project in 2022 saw the company build 54 homes within 11 weeks of finishing the concrete foundation. Perhaps inevitably, one investor has crowned the company "the Tesla of construction".

There's a lively debate about the merits of offsite construction. A detracting feature is the logistical manoeuvring required to put the various pieces together at the end. "I'm not convinced," says Sten Tamkivi, cofounder and partner of VC firm Plural, which is a backer of Monumental. "It feels very localised. Like, it doesn't feel like these companies can shift the whole industry any time soon."

There's also the risk that offsite construction won't match with onsite work. "The offsite team might be accurate to the millimetre on something but then get onsite and discover the builders are working to within an inch accuracy. That's a problem," says Hellermann.



Logistically speaking, it's not a problem, argues Yogesh Patel, quality, improvement and innovation director at VINCI Construction Management. "If we can build an aircraft across six different countries and bring these pieces together, I don't see why we can't build a building in the same country." Rather, it's about incentives. "Consultants, architects and designers are paid by the hour — so it's not necessarily in their interest to use an off-the-shelf product," he says.

RACING TO MARKET

Whatever type of robot you're developing, the main goal should be to get out onsite ASAP and build up a track record, says Monumental's al Khafaji.

He says the reception he got from contractors has been "a pleasant surprise. Everyone warned me that it's all going to be conservative and tech adverse. And yes, we met contractors who had been hearing now for a decade that robots will come and to no avail. But when we started giving them demos in our office, they were surprised that we could do more than they expected."

Monumental started small — completing one wall on one building. "And it was the back end, it wasn't a high-end villa. We also did some brick sheds too to build confidence. That's how we got the ball rolling and then we could show proof points."

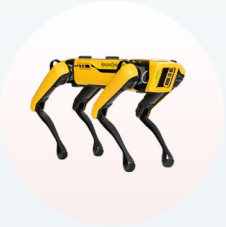
In common with 99% of founders in this business, there has been little attention to making these robots look cool. Function beats aesthetics.

"I think our robots are actually kind of shit robots from a hardware perspective — I don't think anyone's going to be like, 'wow these guys really know how to make robots'. I've just personally been obsessed with getting to market as soon as possible, using parts that are 10 times cheaper than other companies use."

Al Khafaji was wearing a Monumental-branded hoodie when he talked with Sifted. "But we have ignored branding the robots — they're on sites right now and they don't even have our names on them; it's a bit embarrassing actually, we should fix that. But I don't feel we can afford to spend time on aesthetics — yet."

The many faces of bot the builder

Wheeled bots
Civ Robotics



Four-legged bots
Boston Dynamics

Drones
3D Robotics

Exoskeletons
Boston Dynamics

Giant robot arms
Gropyus

Collaborative bots
(they work in tandem with humans)
Universal Robots

Humanoid robots
(don't expect to see these on sites any time soon)
1X Technologies

CHAPTER II

Bothersome bots — a tricky business model

Robot companies need to be very careful not to roll into the valley of death

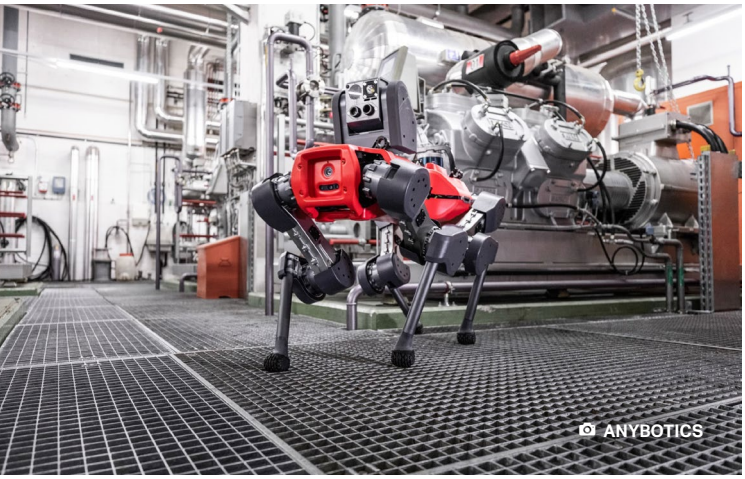
A dwindling stock of skilled workers and productivity black spots are giving contractors a new fearlessness in embracing technology. They want AI and perhaps even robots too: the debate is all about output and price.

But if the industry's warming to new technology, there are no guarantees that the founders selling it will succeed. In fact, there's still many reasons why they might fail.

Profit margins in construction are often razor thin, so when it's cheaper to hire a human, contractors will do just that. Specialist subcontractors — who are making good money because there's a scarcity of their talents — may not be sufficiently incentivised to deploy robots either.

"It's a really hard market to sell into, anyone who says otherwise is surely lying," says Kewazo founder Kuchukov. "A lot of different dynamics; a lot of stakeholders. If you enter this market, you can only hope to get 5-8% of it, at best. You can't imagine you'll get 80%, it's not going to happen."

Getting a toe in the industry is tricky so it's understandable to see some robot companies hanging back. "At the moment, we're observing [construction] from a distance," says Péter Fankhauser, founder of Swiss robotics company ANYbotics, which makes four-legged robots for inspection work. He cites "the added complexities that arise from its evolving environment, which can be more challenging compared to traditional industries".


ANYBOTICS

And because companies are attempting something that's so new, so untested, it's inevitable a few will crash and burn. For example, UK-based HyperTunnel, which pioneered a way of building tunnels entirely with robots, went into administration this year after failing to attract new investment. Company financial data for the year to April 30 2023 reveals it was £9.6m in debt.

> **The added complexities that arise from [construction's] evolving environment can be more challenging compared to traditional industries."**
>
> ***Péter Fankhauser,*** *founder and CEO, ANYbotics*

NO ONE WILL BUY YOUR ROBOT

The cost of a robot will depend mainly on the materials it has to work with. Blocks are quite heavy, which means the machines to manipulate them will likely always be more expensive than the machines for manipulating a lighter building system. Prices can exclude smaller construction firms with smaller tech budgets — a fact robotics makers acknowledge.

Something everyone will advise against is basing your company's business model around selling. Leasing or offering your robot as part of a subcontractor service are surer paths.

"Trying to sell a really expensive robot doesn't make any sense, it'll take too long to pay back the cost," says Hummingbird VC's Ileri. "If companies try it this way, I could imagine a big graveyard."

In 2015, New York firm Construction Robotics created SAM, calling it the world's first commercially available bricklaying robot. It was yours to own for $500k. It's unlikely many could afford this. A surprisingly candid

video from the company — which is available on YouTube — goes into detail about how difficult it was to convince a particular client to use its system.

"We don't fall in love with companies that aim to sell the robot," says Foundamental's Hellermann. "If you come to a contractor with a robot promising whole new kinds of workflows, and leave all the risk with them, nobody's buying; you will end up in the valley of death. Contractors' willingness to take on untested tech is close to zero."

> **Contractors' willingness to take on untested tech is close to zero."**
>
> ***Patric Hellermann,*** *founding partner, Foundamental*

Veterans of the industry will suggest you sell them outcomes — you can hire Monumental, say, to perform brickwork rather than purchase or operate the robots yourself. "I'm confident with this approach, it feels like the winner. I think we've nailed a business model that works," says al Khafaji.

The company, though still very young, can already see its future. "To succeed, we will have to be an operationally heavy company, like Uber, like Amazon. Ironically for a robot company, we are going to be hiring loads of people," al Khafaji adds.

GET DIRT ON YOUR BOOTS

A company could alternatively do a mix of subcontracting and leasing. San Francisco-based Civ Robotics, which has developed a little wheeled bot that marks sites with the coordinates set out in blueprints, charges $6,000-$8,250 to rent its bot per month. Alternatively, the company offers itself as a subcontractor service with an operator on site.

Canvas cofounder and CTO Maria Telleria says that the way for her company to initially earn trust — and also to figure out this sprawling industry, where some job sites can involve 100 different companies — was to physically get on sites and do drywall work alongside their robot.


MONUMENTAL

"I went and got our drywall finishing licence; I did my test and all of that, and that was just the way to really understand things. We just kind of lived it," she says. "The people on the site knew we had manual labour to help if anything went wrong with the robot. And so it was easy for them to de-risk." This is sage advice: have some humans ready to come off the bench in case, for whatever reason, it goes pear-shaped with the robot.

Onsite, you'll quickly find new robot problems to fix, says Telleria. "We work in a pretty dusty environment. If your sensors are blind, what can you do?" You also can't assume there will be somewhere to plug your robot in if it needs juice.. "Everyone on site is fighting for power."

But now that enough customers have worked with the Canvas bot, the company can simply lease it. "It feels like we've got over that hump of 'what the heck is this thing'," Telleria adds.

HAMMERING OUT A DEAL

Construction company VINCI Construction is exploring robots for cleaning, drilling, drywalling, excavating and cutting things. “We need to have the maintenance and the service capability behind [these] robots, so if there is a breakdown we know what to do and how to repair them quickly — and that's not going to happen overnight,” says VINCI’s Patel. “This robot maintenance need will spawn its own sub-industry in time.”

Some construction tasks are more highly skilled than others — mixing cement is not as difficult as finishing drywall — so if you can train a robot to do the latter job, you’re looking at savings over time.

“Drywalling is a four-year apprenticeship in the US so it’s actually a very high [level] skill,” says Telleria. “Speaking as somebody who’s also been trying to get good at it for seven years and I’m still not great.”

Kewazo’s pitch to contractors also emphasises the potential savings — specifically, we’ll cut 80% of the cost of hiring cranes (which Kuchukov estimates is around $50-100k a month). “Or to say it another way, we can save you $5,000 a day.”

But even with this promise, it’s not easy to land customers. “We think in quarters but the customer might not. It’s quite normal to talk to someone in September and they’ll say ‘hey, let’s talk about this next spring. I’m busy right now’,” says Kuchukov.

“The commercial construction guys count every penny and many simply don’t have time or budget to think about how to improve things. We basically can’t sell to the guys who are doing too badly in the market (they have no money) or guys who are doing too well (they have no need for us). So you need to find customers somewhere in the middle.”

In fact, Kewazo sees more selling potential from industrial clients — industrial plants in the oil, gas, energy and chemical industries. “These are constant construction sites. And the market is much bigger with a lot of capital in it,” says Kuchukov.

DON’T BE TOO TECH

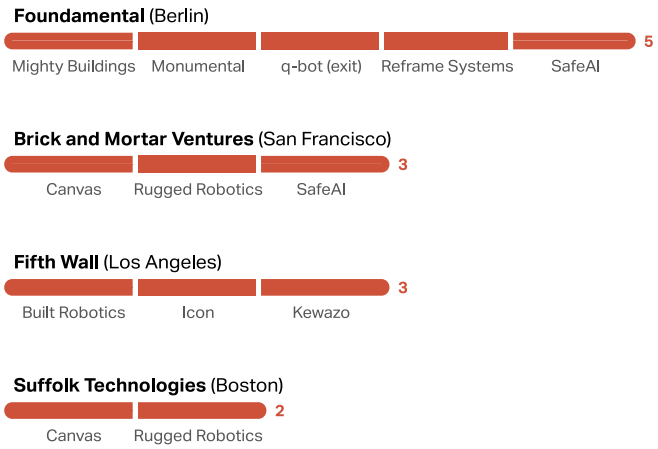
Founders have to earn the trust of the construction industry but they also need to be wary of bad advice from investors, says Alice Leung, vice president of platform and product strategy at Brick & Mortar Ventures, a San Francisco VC firm that has invested in Canvas.

“The biggest challenge is not necessarily anyone in the construction industry, it’s the investors,” Leung explains. “They’re often pushing companies into business models that don’t make sense for this world. There’s a reckoning that needs to happen here — it’s not always a recurring revenue model, which typically VCs love, that makes most sense in this business.”

Tech people shouldn’t bring too many assumptions with them, agrees Plural’s Tamkivi. “The startups that have stumbled are the ones that thought they could change the industry. But the more you can mimic what the industry expects — charging contractors on the price per brick instead of a SaaS model, for example — the better.” His advice boiled down: tech people should overdo the techie-ness.

Top robot construction VCs

By no. of announced deals in robot construction companies



Source: *Sifted Intelligence*

Beep-boop: meet the builder bots

Selection of key global players

BRICK/BLOCKLAYERS/AUTOMATED LIFTS/RE-BAR TYING

FBR · MONUMENTAL · CONSTRUCTION ROBOTICS · KEWAZO · KEN • ROBOTECH

BOT PAINTERS, CUTTERS & DRYWALLERS

CANVAS · PAINTJET · Les Companions · okibo · NOVA SPRAYTEC · KOBOTS · Legend Robot

PREFAB/3D BUILDERS

ICON · GROPYUS · Mighty Buildings · hyperion · XtreeE · MEEH · COBOD · Reframe SYSTEMS · CyBe · ToggleRobotics · BAUBOT

RETROFITTERS/INSULATION EXPERTS

BUILT ROBOTICS · SafeAI · GRAVIS ROBOTICS · q-bot

SITE INSPECTION/MAINTENANCE [INCLUDING DRONES]

Boston Dynamics · DOXEL · propeller · vHive · ABJ DRONES · dji · 3DR · haus bots · Acuity Robotics · CAPRA ROBOTICS · Robotiz3d · AMVbotics

LAYOUT EXPERTS

DUSTY ROBOTICS · RUGGED ROBOTICS · clvROBOTICS · BIM PRINTER · RAISE ROBOTICS

CHAPTER III

Builder bots go global

The biggest plays are happening outside of Europe

After remodelling her home in 2017, Tessa Lau concluded that construction desperately needed some robots. "My phone is built by a robot, so is my car, but my house is still being made by humans. I'd never seen construction up close before and I discovered how low tech it was," Lau says.

At the time, Lau was working in a company called Savioke, which made delivery robots for hotels (her then title, which surely ranks among the best out there: chief robot whisperer).

But it would take her a while to come up with an idea for a builder robot. First, she would have to put on her steel-toed boots and hardhat and spend six months roaming around job sites to find inspiration.

For a long time, nothing much occurred to her. Building a robotic hoover seemed vaguely interesting. "You get a lot of guys sweeping on sites," she says. Lau took up a broom to get a feel for the task firsthand. That's when the Eureka moment came.

"As I was sweeping, I saw these markings on the ground and there was a guy on his hands and knees snapping chalk lines. I saw them doing this layout for the building and inquired, 'if this work could be done by a robot, would it be valuable?' He said, 'yes, we really want that'."

And so Dusty Robotics was born. Lau's robots print building layouts on the floor of construction sites, so workers know where — and where not — to build. This task was traditionally done with a set of plans, tape measure and chalk line by various trades, including architects, plumbers, structural engineers and electricians.

The company, which has only been around since 2018, is already one of the most successful in its field globally, pulling in $69m from investors.

> **My phone is built by a robot, so is my car, but my house is still being made by humans."**
>
> ***Tessa Lau,*** *cofounder and CEO, Dusty Robotics*

MAKING SOMETHING 'ADORABLE'

The robot itself — and not to be all pronoun police but the bot's a "she"; "I've looked under the skirt," says Lau — seems to be the only one in the construction world that has any kind of aesthetic quality. The 23-pound robot is orange and grey and sports a big pair of friendly eyes.

This was a deliberate choice, of course. "I wanted to make her adorable to give her a shot at acceptance. Sites can be dangerous, nasty places and construction workers are very pragmatic and have a low tolerance for things that don't work.

DUSTY ROBOTICS

"But they care about their tools. A lot of people name them: carpenters name their hammers for example; builders name their trucks. These things take on such importance."

She tells a story about soldiers who watched their robot dog get blown up and afterwards went to the manufacturer to get it put back together. "I wanted to evoke a similar feeling of protectiveness, and make a tool that's beloved and one that people will want to be successful."

Opinions differ on robot aesthetics. Monumental's al Khafaji, as we learned in chapter 1, doesn't have time to think about beautifying bots. Leung, from Brick & Mortar Ventures, has a similar utilitarian outlook.

"Contractors don't care about how a robot looks — it's not like the hand tools they use are pretty, they're all functional. As long as it does its job and looks like something more than just a high school project, then that's fine," she says.

THE BLUEPRINT EXPERTS

In January 2020, Dusty landed its first paying job, laying out a wellness centre for Facebook. Says Lau, "they said 'send me an invoice'. I said 'what's that? How much should I charge you?'"

> **The bigger your robot is, the more expensive to build. We've been capital efficient."**
>
> ***Tessa Lau,*** *cofounder and CEO, Dusty Robotics*

Adoption has been swift since — today more than 150 Dusty bots are trundling around sites across the US and Canada. Data centres — which are flying up to keep pace with AI — are becoming a speciality.

The robot's small size is an advantage, Lau says. "The bigger your robot is, the more expensive to build. We've been capital efficient. And because there's so much that needs to be hauled onto a site, it's advantageous to come with something in a small box." The robot can be controlled via iPad and doesn't require a team of people to operate it. "We will train them at our online academy or send a trainer out for a day," Lau says.

Dusty is one of a small handful of robot-layouts specialists to pop up in the US in recent years; its two main competitors are Rugged Robotics ("based in Houston, Texas, not Silicon Valley", the company's website makes a point of saying) and Civ Robotics (San Francisco). The emergence of similar companies "validates the pain point", says Leung (her VC firm has invested in Rugged Robotics).

"We operate in harsh conditions — anywhere from 120 degrees in the middle of a desert to snowy upstate New York and muddy Texas," Civ Robotics founder Tom Yeshurun told the Automating Success podcast earlier this year.

Yeshurun used to pave highways back in Israel, his home country. "I used to pay surveyors a lot of money to mark roads — it's chaotic, you have to close roads down and then every minute, every second counts. What I could do in 30 minutes, the robot can do in 10."

CIV ROBOTICS

US WINS THE FUNDING WARS

After the layout robots have done their bit, you can then turn to robots that will actually do the building. In general, the construction-robot funding scene is far more advanced in the US than elsewhere. The fundraising has been more extensive; the robots more varied. One of the biggest investment magnets is Austin-based ICON, known for 3D-printed homes, which has raised over $500m.

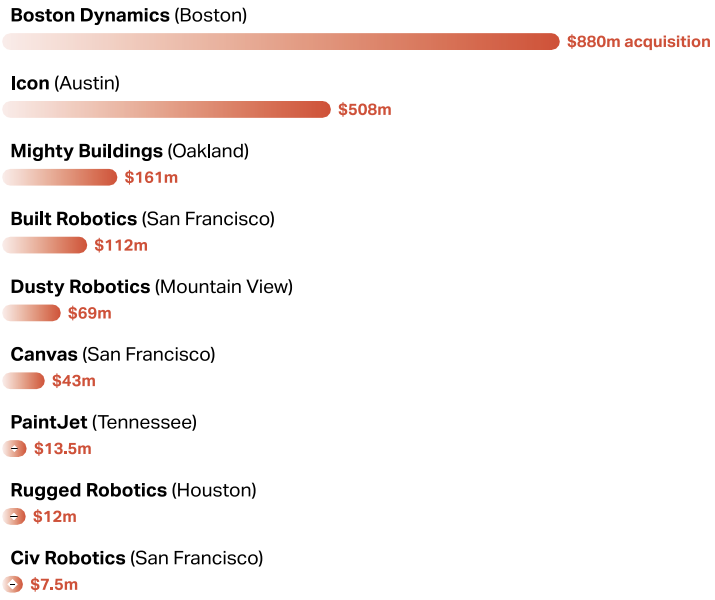
There are other companies dotted around the world that are picking up cheques. Singapore-based Fabrica AI, inventor of a tile grouting robot, has raised roughly $2.3m. Toronto-based Promise Robotics, which prefabricates units using long robot arms, landed $16m in October 2023. Perth-based FBR, which lays blocks with a telescopic boom arm, has recently brought its invention to the US market. China's Nanjing Zhuling Technology — which says it can lay tiles in half the time it takes a human — raised a seed round for an undisclosed sum in November 2023. Israeli company Verobotics — referred to in the local press as a robotic Spiderman — will climb up your building and help monitor it (the company has raised some $5m, according to PitchBook).

Meanwhile, back on US shores, Canvas — which we've already met — has another cofounder, CEO Kevin Albert, who previously worked at Boston Dynamics, which is famous for its vaguely terrifying military robots. But the company also has life-like walking robots like four-legged Spot, which doesn't bark or bite, but does document progress on sites and free up workers (a base model costs a princely $100k).

San Francisco-based Built Robotics retrofits existing construction units with robotic capabilities, while Tennessee startup PaintJet has a bot that will paint your walls.

Top US construction robot deals

Private investment in robot construction companies



Source: *Dealroom / Sifted data*

ROBOTS IN THE TRENCHES

Built Robotics outfits those big yellow CAT diggers with GPS, radar, cameras, gyroscopes and other goodies, which makes the machines autonomous and capable of digging trenches for solar farms. All that's required is someone with a laptop to upload the layout file and the robot takes it from there.

The company says it can save contractors 20-30% on hiring. Teams that do this kind of excavation cost in the region of $300-400k a year in an expensive state like California, founder and CEO Noah Ready-Campbell explained during an online chat with Ark Invest last year (it's available on YouTube). And this labour is getting harder to find too. "The average age of one of these operators is 50," says Ready-Campbell.

In time the company hopes to automate other construction tasks. Ready-Campbell predicts that most — if not all — the hydraulic-powered equipment on sites will gradually be controlled by computers in the next 10-20 years. "The tech works — the challenge now is getting folks to embrace [it]," he says.

CONCLUSION

A ‘leapfrog effect’?

The age of the proverbial hard hat-sporting robot is drawing closer — although timelines for mass adoption will surely vary from one country to another due to staff shortages and the agility of some players to change their process.

So what does the future have in store? Will there be completely automated robot building sites in 10 years? No. In 30 years? Maybe??

Monumental’s al Khafaji is certainly bullish. “In five years, I’d like us to be doing other tasks. If we can build the interior and exterior walls, plus the window frames and the lintels, we’ve [mastered] almost 90% of the facade. Eventually I’d hope our robots will number in the tens of thousands,” he adds, while estimating that there will be 10-15 adjacent tasks his robot can do beyond bricklaying.

Robots may also someday take a bigger role in deconstruction, helping to salvage usable elements from buildings being taken down. This technology basically exists already. London’s Recycleye, for example, has developed computer vision software for robots arms that can “see” waste and retrieve materials such as plastics, aluminium, paper and cardboard (though as robot developers remind us, what works in a factory isn’t guaranteed to work on a site).

A GIANT LEAP FOR ROBOT-KIND?

Why stop there: what about bots on the moon? Since 2016, Kajima has been working with the Japan Aerospace Exploration Agency (JAXA), a national research and development agency, to study the application of its dam and tunnel building bots to the construction of lunar facilities. The days when remotely operated and semi-autonomous robots are active in space “may not be far off,” says Kajima’s website.

Meanwhile, in the here and now, robots’ “equipment utilisation” potential is a wonkish concept that investors argue makes an irresistible case for more bot adoption. What it means, basically, is that bots should be able to get more done than humans because they won’t take tea breaks and they could work all hours. Built Robotics hasn't pulled a 24 hour shift but its machines have gone 14 hours; in general, there’s “a minimum 10% speed-up in a 10 hour shift,” says Ready-Campbell.

Should site crews be nervous about robots encroaching on their work? Some might see bots as a threat, while others would probably see them as liberating. “Do you want to kill your knees to lay the first round of bricks, or do you want a robot to do this?” asks Plural’s Tamkivi. More robots taking on dangerous jobs means fewer muscle injuries and less dust inhalation and exposure to vibrations and noise. Perhaps humans wouldn’t even have to be on site, instead operating these machines remotely, which opens up new possibilities for an inclusive workforce and better work-life balance.

The robots featured in this report can perform certain tasks really well, but there is plenty of information processing and precise placement work that still require the human touch. ”Stacking bricks is something to make quick progress on, but you’ll need plumbers and carpenters to hunt down old electric wires and pipes; the variance here is too high for robots,” says Tamkivi. What’s more, a robot cannot, on its own, decide where a new building should go. Taking humans out of the loop “is not even on our radar,” says Ready-Campbell. “Human collaboration is always going to be there.” Canvas’ Telleria agrees: “our approach has always been augmentation over replacement.”

In an industry desperate to attract talent, offering young workers the opportunity to use robots would surely help a lot with recruitment and retention. “Look at how the auto workforce changed,” says Foundamental’s Hellermann. “There was this leapfrog effect — and we’ll see this in construction too.”

Six hot bot takes

Some final thoughts from founders and investors...

This is doable — it's not asteroid mining

"I'm confident we'll see a lot more robots in construction: in 10 years, sites will be anywhere between 10-50% automated. I don't think it's a challenging market if you have the right business model. This isn't asteroid mining, where you need 50 assumptions to make something work."

***Firat Ileri**, partner, Hummingbird Ventures*

Construction-as-a-Service

"Robots in construction goes far beyond a few animated gadgets on site. We are going from a construction process with a lot of uncertainties to a lean process where every step from design to delivery is orchestrated together through advanced generative AI tools, some executed by robots, and others by skilled operators powered by AI."

***Kevin Cardona**, head of entrepreneurial innovation, Leonard*

Founders, talk more about quality

"Robots can move atoms, not just bits. They can actually change the world. But I think a lot of founders are approaching things in the wrong way; they're talking about productivity and how to do stuff cheaper and faster. But they should talk about quality and doing things better than we do already. They need to talk about solving problems."

***Tessa Lau**, cofounder and CEO, Dusty Robotics*

We need more investors

"The big bottleneck for robots will continue to be funding — we need more investors in the space. And we need more hardware focus."

***Alice Leung**, vice president, platform and product strategy, Brick & Mortar Ventures*

Post-tech-boom robot startups are better

"The golden generation has only begun. I'm an offsite robotics bear, onsite robotics bull. A lot of robot companies were totally over-funded in the 2020-2021 bubble; they're over-engineered Ferraris not fit for the quirks of the construction industry. The post-2022 companies are much more promising."

***Patric Hellermann**, general partner, Foundamental*

Robots will save lives

"In all countries, every year, there are construction fatalities and it remains one of the industries in which people are most likely to die at work. The introduction of robots is hopefully the thing that will remove people from harm's way and help us to bring deaths down."

***Philip Reid**, UK head of innovation and transformation, VINCI Construction*

Acknowledgements

NOAH READY-CAMPBELL
Cofounder and CEO,
Built Robotics

PÉTER FANKHAUSER
Founder and CEO,
ANYbotics

PATRIC HELLERMANN
Founding partner,
Foundamental

FIRAT ILERI
Partner,
Hummingbird Ventures

ARTEM KUCHUKOV
Cofounder and CEO,
Kewazo

TESSA LAU
Cofounder and CEO,
Dusty Robotics

ALICE LEUNG
Vice president,
platform and product strategy,
Brick & Mortar Ventures

SALAR AL KHAFAJI
Cofounder and CEO,
Monumental

YOGESH PATEL
Quality, improvement and
innovation director,
VINCI Construction Management

PHILIP REID
UK head of innovation and
transformation,
VINCI Construction

STEN TAMKIVI
Cofounder and partner,
Plural

MARIA TELLERIA
Cofounder and CTO,
Canvas

GABRIELE TINELLI
Investor,
Foundamental

JULIEN VILLALONGUE
Director,
Leonard

TOM YESHURUN
Founder and CEO,
Civ Robotics

This report was written by **ÉANNA KELLY**, charted by **ÉANNA KELLY**, edited by **BECCA LIPMAN**, sub-edited by **GEMMA TAYLOR**, designed by **GAÉTAN NIVON** and illustrated by **GEORGE CLAYTON**. It was produced by **JONATHAN SINCLAIR** and **TANYA MAHESHWARI**.

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