State of Robotics

Investment trends 2019–2023
**State of Robotics – Key Stats & Methodology**

- **1500+ Companies** analyzed
- **~$90B** Raised Globally since 2019
- **-7%** Investment CAGR
- **20** Private Unicorns
- **6** Public Cos with Mkt Cap > $500M
- **24** Acquisitions > $250M

**Methodology**

- Analysis consisted of extracting all companies listed in Pitchbook which raised in aggregate of at least $3M from 2019-2023 and which appeared to be related to AV and robotics; those companies were then individually tagged with the use case, or those that were not relevant to the category were filtered out.

- Companies focused exclusively on space, manned flight, electric vehicles, and semiconductors were excluded from the analysis.

**Source:** PitchBook, F-Prime team analysis
Summary

- The venture capital markets experienced a significant correction in 2023, with investments returning to levels last seen in 2020 and the depths of the pandemic. Robotics was no exception, though the pullback was even more pronounced as funding in the AV sector — which had historically been a driver of robotics investment — continued the rapid decline we’ve seen over the last two years. In 2023, AV investments represented less than 30% of overall activity, compared to around 70% in 2019.

- The primary driver of investment in robotics over the last two years continues to be Vertical Robotics — that is, companies focused on vertical-specific use cases. While investments in Vertical Robotics also declined in 2023, the category has experienced net growth over the last five years, with investments growing from $2.4B in 2019 to $4.1B in 2023.

- Despite the overall decline in funding for tech startups, early-stage investing in robotics (Seed and Series A) held up better than late-stage investing over the last three years. This is reflective of investor excitement about the tailwinds creating opportunities in the sector. Advancements in AI, falling hardware costs, and labor shortages are driving more experienced and talented founders to create new robotics businesses. Startup accelerator Y Combinator, a longstanding bellwether of early stage investment activity, included robotics as one of the focus areas of its 2024 cohort.

- Consistent with the broader venture market, 2023 was a challenging year for exits. Deal volume and value in the robotics industry dropped to a five-year low, with deal value falling 90% compared to 2022. Of the 46 companies that went public via IPO or SPAC since 2019, as of the end of 2023 only eight now trade as independent companies with market caps above $250M. In the public markets, scaled high-growth businesses continue to enjoy premium trading multiples.

- Given the challenging exit market of the last 12+ months, there is still a significant amount of value locked in private robotics companies. There are currently 20 private companies which have raised at valuations north of $1B, with an aggregate last-round valuation of $118B. While much of the value is in AV companies, where valuations are likely to reset, there is still an attractive backlog of robotics startups capable of driving significant exit value going forward.

Source: PitchBook, CapIQ, F-Prime team analysis

Note: See page 5 for category definitions
Investment in Robotics fell sharply in 2023 to a 5-year low

70% of investments go to companies in the Americas, Europe and Israel

Source: PitchBook, F-Prime team analysis
Vertical Robotics remained the largest investment category, while investments in AV continued their steep decline.

**Source:** PitchBook, F-Prime team analysis
Across stages, Seed and Series A investments have been the most insulated from the funding downturn.

### Investment Dollars by Stage

<table>
<thead>
<tr>
<th>Year</th>
<th>SEED/SERIES A</th>
<th>SERIES B/C</th>
<th>CORPORATE</th>
<th>PE/BUYOUT/LBO</th>
<th>TOTALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>$1.1 (9%)</td>
<td>$4.6 (38%)</td>
<td>$3.8 (32%)</td>
<td>$1.8 (15%)</td>
<td>$11.9</td>
</tr>
<tr>
<td>2020</td>
<td>$3.0 (15%)</td>
<td>$1.1 (9%)</td>
<td>$3.9 (31%)</td>
<td>$2.9 (23%)</td>
<td>$12.5</td>
</tr>
<tr>
<td>2021</td>
<td>$2.8 (15%)</td>
<td>$1.8 (10%)</td>
<td>$6.3 (28%)</td>
<td>$4.7 (26%)</td>
<td>$18.1</td>
</tr>
<tr>
<td>2022</td>
<td>$2.3 (14%)</td>
<td>$3.4 (28%)</td>
<td>$4.2 (34%)</td>
<td>$2.3 (19%)</td>
<td>$12.4</td>
</tr>
<tr>
<td>2023</td>
<td>$0.1 (1%)</td>
<td>$0.7 (10%)</td>
<td>$1.6 (22%)</td>
<td>$1.7 (24%)</td>
<td>$7.4</td>
</tr>
</tbody>
</table>

### CAGR %

<table>
<thead>
<tr>
<th>Stage</th>
<th>2019-2023 CAGR %</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE/B</td>
<td>-11%</td>
</tr>
<tr>
<td>SERIES D/E</td>
<td>-2%</td>
</tr>
<tr>
<td>CORPORATE</td>
<td>-36%</td>
</tr>
<tr>
<td>TOTALS</td>
<td>-1%</td>
</tr>
</tbody>
</table>

### % Change vs 2021 Peak

<table>
<thead>
<tr>
<th>Stage</th>
<th>2019-2023 % CHANGE vs 2021 PEAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE/B</td>
<td>-59%</td>
</tr>
<tr>
<td>SERIES D/E</td>
<td>-64%</td>
</tr>
<tr>
<td>CORPORATE</td>
<td>-66%</td>
</tr>
<tr>
<td>TOTALS</td>
<td>-27%</td>
</tr>
</tbody>
</table>

Source: PitchBook, F-Prime team analysis
Defense and Logistics have been the major driver of investment in Vertical Robotics

**Vertical Robotics - Americas, Europe, Israel**

**INVESTMENT BY SUBCATEGORY**
- 27% Logistics
- 20% Defense/Security
- 17% Other*
- 15% Medical
- 6% Manufacturing
- 6% Agriculture
- 4% Lab/Pharma
- 3% Food
- 3% Const & Mining

**INVESTMENT BY STAGE**
- 38% Series B/C
- 30% Seed/Series A
- 29% Series D/E
- 2% PE/Buyout/LBO
- 0% Corporate

**TOTAL INVESTMENT, $B**
- 2019: $2.6B
- 2020: $3.0B
- 2021: $6.0B
- 2022: $6.9B
- 2023: $4.1B

**TOP FUNDING ROUNDS 2022-2023**
- **ANDURIL** Defense $1.5B
- **Shield AI** Defense $500M
- **Zipline** Logistics $330M
- **EXOTEC** Logistics $328
- **EPIRUS** Defense $200

*Source: PitchBook, F-Prime team analysis
*Other: Other includes inspection/survey, landscaping, recycling, retail, cleaning/maintenance and marine use cases, amongst others
Logistics and Medical Robotics saw the most activity in 2023; several emerging segments also saw sustained activity.

### ESTABLISHED SEGMENTS: > $500M INVESTED/YR

<table>
<thead>
<tr>
<th>Segment</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics</td>
<td>1653</td>
<td>1508</td>
<td>1066</td>
</tr>
<tr>
<td>Medical</td>
<td>984</td>
<td>748</td>
<td>767</td>
</tr>
<tr>
<td>Defense/Security</td>
<td>1085</td>
<td>2000</td>
<td>555</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>340</td>
<td>531</td>
<td>98</td>
</tr>
</tbody>
</table>

### HIGHEST FUNDED PRIVATE COMPANIES

- GreyOrange
- Zipline
- Exotec
- Noah Medical
- Distalmotion
- ANDURIL
- EPIRUS
- CMR Surgical
- Shield AI
- Flexiv
- Bright Machines

### EMERGING SEGMENTS: < $500M INVESTED/YR

<table>
<thead>
<tr>
<th>Segment</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction/Mining</td>
<td>164</td>
<td>264</td>
<td>156</td>
</tr>
<tr>
<td>Agriculture</td>
<td>328</td>
<td>289</td>
<td>275</td>
</tr>
<tr>
<td>Lab/Pharma</td>
<td>431</td>
<td>157</td>
<td>58</td>
</tr>
<tr>
<td>Food</td>
<td>160</td>
<td>247</td>
<td>170</td>
</tr>
</tbody>
</table>

### HIGHEST FUNDED PRIVATE COMPANIES

- DUSTY Robotics
- BUILT Robotics
- Verdant Robotics
- Iron Ox
- ecorobotix
- opentrons
- Emerald Cloud Lab
- Soft Robotics
- MISO Robotics

Source: PitchBook, F-Prime team analysis
Much of the recent focus in AV has shifted to trucking-related use cases

Autonomous Vehicles - Americas, Europe, Israel

**TOTAL INVESTMENT, $B**

- **2019**: $8.2
- **2020**: $8.2
- **2021**: $9.7
- **2022**: $4.1
- **2023**: $2.2

**INVESTMENT BY SUBCATEGORY**

- 78% PASSENGER
- 9% DELIVERY
- 12% TRUCKING
- 2% OTHER

**INVESTMENT BY STAGE**

- 80% of 2023 funding went into trucking

**TOP FUNDING ROUNDS 2022-2023**

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>SEGMENT</th>
<th>ROUND SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>cruise</td>
<td>Passenger</td>
<td>$2.1B</td>
</tr>
<tr>
<td>STACK</td>
<td>Trucking</td>
<td>$1.0B</td>
</tr>
<tr>
<td>Conigital</td>
<td>Trucking</td>
<td>$632M</td>
</tr>
<tr>
<td>Nuro</td>
<td>Delivery</td>
<td>$625M</td>
</tr>
<tr>
<td>Einride</td>
<td>Trucking</td>
<td>$500M</td>
</tr>
</tbody>
</table>

Source: PitchBook, F-Prime team analysis
News for passenger AV companies has been particularly challenging

Public sentiment lags tech advancements

Cruise says its autonomous vehicles can save thousands of lives. But Americans still don’t trust driverless cars

Cruise says its autonomous vehicles can save thousands of lives. But Americans still don’t trust driverless cars. Americans still don’t trust driverless...

Apr 21, 2023

Source: F-Prime team analysis

Legislative headwinds

Cruise told by regulators to 'immediately' reduce robotaxi fleet 50% following crash

Cruise, the self-driving car subsidiary of GM, has been asked to reduce its robotaxi fleet by 50% in...

By Kirsten Korosec | August 18, 2023

Yet still some optimism remains

Zoox headcount grows as Amazon’s self-driving unit expands testing in Vegas

Amazon.com Inc’s self-driving vehicle unit Zoox has grown its headcount by about 16% at a time when access to capital is tight and other large companies...

Jun 27, 2023

Waymo and Uber Partner to Bring Waymo’s Autonomous Driving Technology to the Uber Platform

Today, Waymo and Uber Technologies Inc. (NYSE: UBER) are excited to announce a new, multi-year strategic partnership to make the Waymo Driver available to...

May 23, 2023
Investments in Enabling Systems are a smaller niche within robotics

Enabling Systems - Americas, Europe, Israel

TOTAL INVESTMENT, $B

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment, $B</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>$1.1</td>
</tr>
<tr>
<td>2020</td>
<td>$1.3</td>
</tr>
<tr>
<td>2021</td>
<td>$2.4</td>
</tr>
<tr>
<td>2022</td>
<td>$1.4</td>
</tr>
<tr>
<td>2023</td>
<td>$1.0</td>
</tr>
</tbody>
</table>

INVESTMENT BY SUBCATEGORY

- 38% SOFTWARE SYSTEMS*
- 23% LiDAR
- 19% HARDWARE SYSTEMS*
- 20% DRONE

INVESTMENT BY STAGE

- 42% SERIES B/C
- 33% SEED/SERIES A
- 21% SERIES D/E
- 3% CORPORATE
- 1% PE/BUYOUT/LBO

Source: PitchBook, F-Prime team analysis

*Hardware systems include robot arms and other sensors; software systems include perception, location, mapping, security and navigation

TOP FUNDING ROUNDS 2022-2023

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>SEGMENT</th>
<th>ROUND SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skydio</td>
<td>Drone</td>
<td>$230M</td>
</tr>
<tr>
<td>Echodyne</td>
<td>Sensor</td>
<td>$135M</td>
</tr>
<tr>
<td>Autosens</td>
<td>Perception</td>
<td>$120M</td>
</tr>
<tr>
<td>Light</td>
<td>LiDar</td>
<td>$118M</td>
</tr>
<tr>
<td>Swift Navigation</td>
<td>Sensor</td>
<td>$100M</td>
</tr>
</tbody>
</table>
Robotics has produced numerous unicorns, with significant value in still-private companies

New Robotics Unicorns in each of the last 5 years

### 2019
- Nuro
- Uber ATG
- Aurora

### 2020
- TuSimple
- Embark
- Emerge
- Waymo
- Stack

### 2021
- Luminar
- Aurora
- Ouster
- Shield AI

### 2022
- AutoStore
- Corindus
- ANDURIL
- CMR Surgical

### 2023
- Zipline
- Anduril
- Procept
- Vincotech
- Emotio
- Exotec

### Drop*
- TuSimple
- Embark
- Berkshire Grey
- Vicarious Surgical
- Sarcos
- Aeva
- Ouster

**20 unicorns still private**

**$118B**

**last round valuation**

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**Source:** PitchBook, F-Prime team analysis

*Public market caps dropped below $1B in subsequent years

** includes Cruise and Pony.Ai

Dropped*: TuSimple, Embark, Berkshire Grey, Vicarious Surgical, Sarcos, Aeva, Ouster

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M&A IPO
Much of the private market value is in AV companies, where valuations may reset; other sectors should see value expansion as companies continue to scale.

Private market value of unicorns split by use case ($B)

Source: PitchBook, F-Prime team analysis
Exit activity has pulled back significantly as IPOs and SPACs disappeared, and M&A significantly slowed.

**Exits peaked in 2021:**
36 deals totaling ~$44B in enterprise value

SPACs came and went, dropping from 47% of activity in 2021 to 0% today

**Rapid decline in M&A and IPOs:**
- M&A down 35% from 2021
- IPOs nearly zero in 2023

*Source:* PitchBook, F-Prime team analysis

*Note:* Only includes Americas, Europe, and Israel, and M&A exits >$25M
Most M&A deals have been <$250M, with a handful of larger exits

### M&A exits above $500M since 2019

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>ACQUISITION VALUE</th>
<th>DATE</th>
<th>ACQUIRER</th>
<th>SEGMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>AURIS</td>
<td>$5.75B</td>
<td>April 2019</td>
<td>Johnson &amp; Johnson</td>
<td>Medical</td>
</tr>
<tr>
<td>Uber ATG</td>
<td>$4.0B</td>
<td>December 2020</td>
<td>Aurora</td>
<td>AV</td>
</tr>
<tr>
<td>ZOOX</td>
<td>$1.3B</td>
<td>June 2020</td>
<td>Amazon</td>
<td>AV</td>
</tr>
<tr>
<td>Isra Vision</td>
<td>$1.1B</td>
<td>June 2020</td>
<td>Atlas Capco</td>
<td>Enabling System</td>
</tr>
<tr>
<td>Corindus</td>
<td>$1.1B</td>
<td>October 2019</td>
<td>Siemens Healthineers</td>
<td>Medical</td>
</tr>
<tr>
<td>Boston Dynamics</td>
<td>$880M</td>
<td>June 2021</td>
<td>Hyundai</td>
<td>Logistics/Other</td>
</tr>
<tr>
<td>Elmo</td>
<td>$700M</td>
<td>September 2022</td>
<td>Bosch</td>
<td>Enabling System</td>
</tr>
<tr>
<td>Velodyne Lidar</td>
<td>$600M</td>
<td>February 2023</td>
<td>Ouster</td>
<td>Sensor</td>
</tr>
<tr>
<td>Lyft SELF DRIVING UNIT</td>
<td>$550M</td>
<td>July 2021</td>
<td>Woven Planet</td>
<td>AV</td>
</tr>
</tbody>
</table>

Source: PitchBook, F-Prime team analysis

Note: Only includes Americas, Europe, and Israel, and M&A exits >$25M.
Recent public listings of robotics companies have seen mixed results, with the market mostly valuing scaled, high-growth businesses.

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>MARKET CAP (12/29/2023)</th>
<th>LTM REVENUE</th>
<th>LTM REVENUE GROWTH</th>
<th>EV/LTM REVENUE</th>
<th>12 MONTH STOCK PERFORMANCE</th>
<th>SEGMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>symbotic</td>
<td>$22.0B</td>
<td>$1.2B</td>
<td>98%</td>
<td>18.3x</td>
<td>4.3x</td>
<td>Logistics</td>
</tr>
<tr>
<td>Aurora</td>
<td>$6.6B</td>
<td>$2M</td>
<td>-98%</td>
<td>N/A</td>
<td>3.5x</td>
<td>AV</td>
</tr>
<tr>
<td>AutoStore</td>
<td>$6.6B</td>
<td>$618M</td>
<td>16%</td>
<td>10.9x</td>
<td>1.1x</td>
<td>Logistics</td>
</tr>
<tr>
<td>PROCEPT BioRobotics</td>
<td>$2.1B</td>
<td>$116M</td>
<td>90%</td>
<td>16.4x</td>
<td>1.0x</td>
<td>Medical</td>
</tr>
<tr>
<td>LUMINAR</td>
<td>$1.4B</td>
<td>$59M</td>
<td>40%</td>
<td>28.9x</td>
<td>0.7x</td>
<td>LiDar</td>
</tr>
<tr>
<td>HESAI</td>
<td>$1.1B</td>
<td>$236M</td>
<td>59%</td>
<td>3.1x</td>
<td>0.4x*</td>
<td>LiDar</td>
</tr>
<tr>
<td>INNOVIZ Technologies</td>
<td>$417M</td>
<td>$8M</td>
<td>23%</td>
<td>37.8x</td>
<td>0.7x</td>
<td>LiDar</td>
</tr>
<tr>
<td>Ouster</td>
<td>$312M</td>
<td>$70M</td>
<td>66%</td>
<td>2.6x</td>
<td>0.9x</td>
<td>LiDar</td>
</tr>
</tbody>
</table>

*Performance since IPO in Feb 2023

Note: Only includes Americas, Europe, Israel with public listing in last 5 years. Excludes companies with market cap <$250M.

Source: CapIQ, F-Prime team analysis
Future Outlook

- The venture-backed robotics industry is still in its early innings, increasingly fueled by the growth of Vertical Robotics and the rapid pace of development of AI. The last few years’ robust early stage activity will drive increased later-stage investment as companies mature and achieve commercial milestones.

- The boom and bust of the AV sector has been a simultaneous boon and bane for the robotics industry. Initially, it attracted lots of investor interest and talent, ultimately helping to fuel the rise of Vertical Robotics as experienced AV founders shifted to focus on use cases with a shorter path to commercialization. However, the ongoing correction in the AV sector has caused many investors to become far more cautious about what it takes to build a successful robotics business.

- The significant exit backlog of scaled robotics companies will create a massive tailwind for the industry in the coming years. The IPO window will reopen and established businesses will seek to reinvent their product offerings through the acquisition of Vertical Robotics players, sharpening the opportunity in the eyes of many investors. Over time, the virtuous cycle of company creation and exit will accelerate.

- The past year has been a wake-up call to the entire venture ecosystem — and particularly robotics. Hype-driven investment cycles inevitably come to an end, while those focused on business fundamentals endure. Investors today are looking for differentiated solutions which transform massive addressable markets, but they must also deliver superior financial results. The industry’s tailwinds have positioned it to be one of the driving sectors for venture returns in the coming years — though plenty of work remains to deliver on the financial promise of robotics.

Source: F-Prime team analysis
About F-Prime

We create and invest in healthcare and technology companies that impact lives all over the world. We have over 200 companies in our portfolio including 23 that we started. Our global portfolio is spread across the US, Europe, and Asia.

Note: Above listing is a sample of robotics portfolio companies in the F-Prime and Eight Roads funds.
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