



Building a Robotics Company on Open Source

With ROS and MoveIt

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picknik.ai



About Me

Education



PhD Thesis

*Methods for Using Motion
Planning Using Experience*

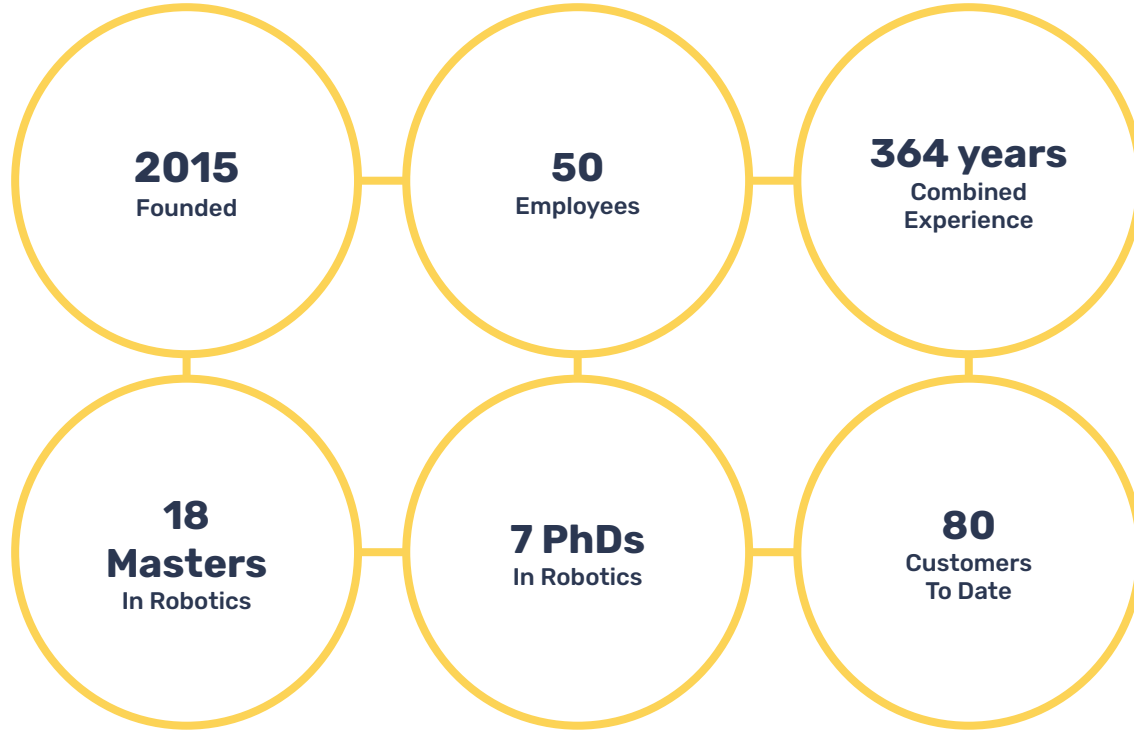
Past Industry Experience



Today



About PickNik

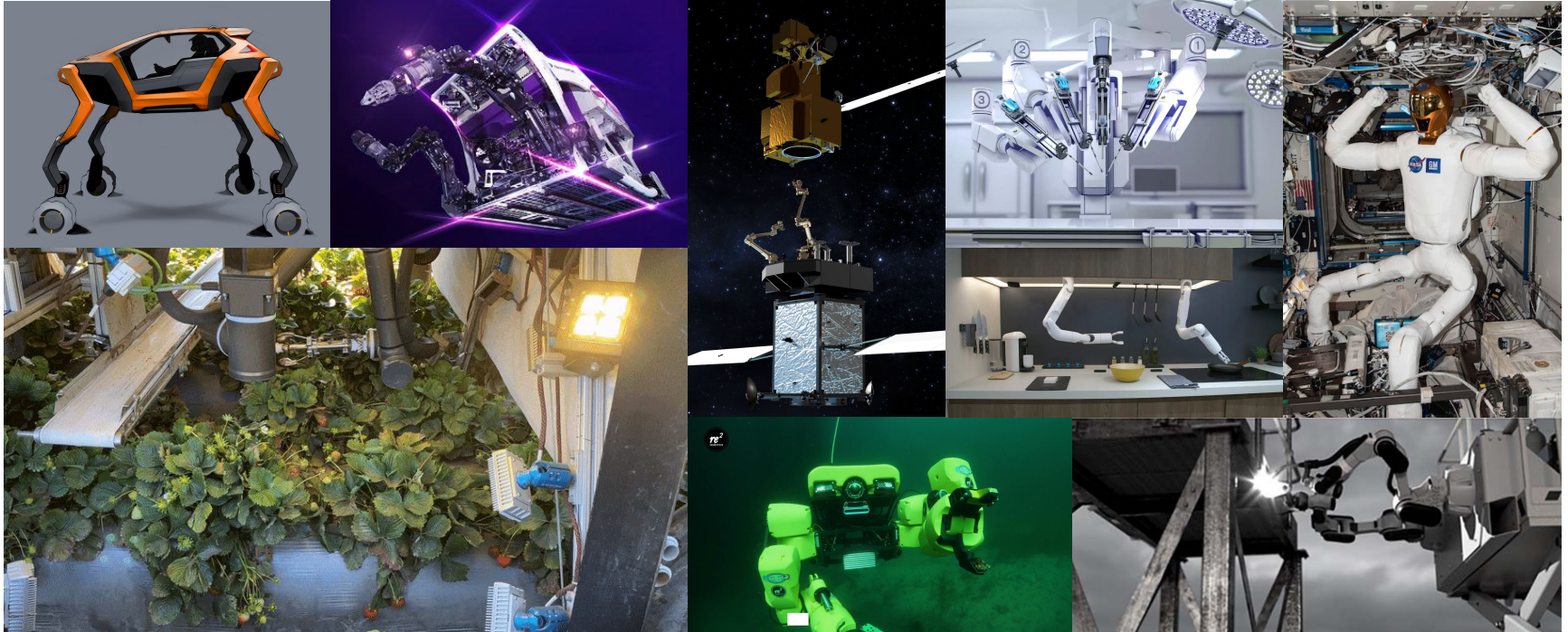


Headquartered in
Boulder, Colorado



The Unstructured Robotics Company

Companies of all sizes, both on Earth and in space, rely on PickNik for bringing the most advanced solutions to life for both structured and unstructured environments.

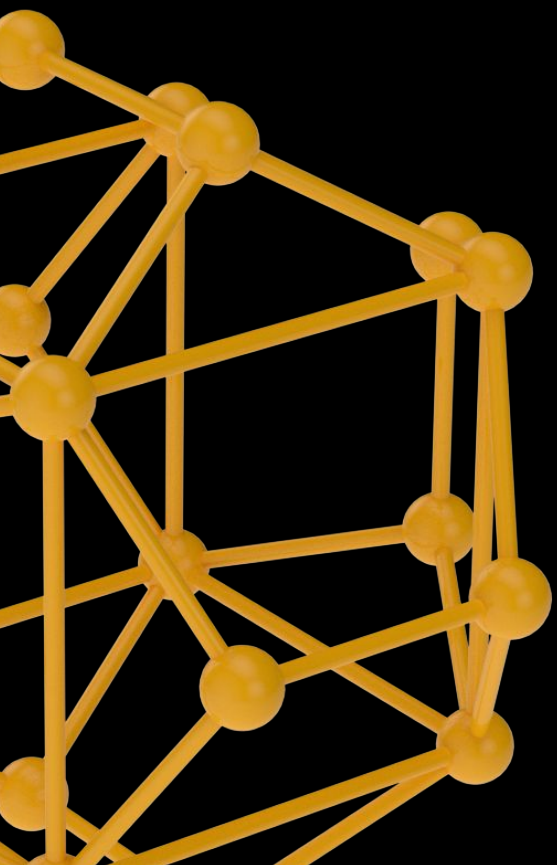




In the past 8 years,
 PickNik has become
 one of the **top providers**
 of robotic arm software
 in the world.

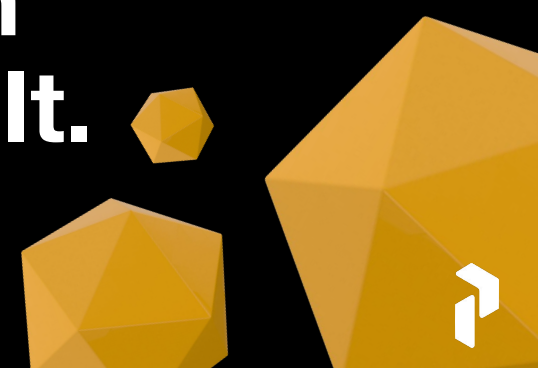
Our open source product MoveIt has been used by
 1,000s of companies.





**We've partnered
with companies in
every industry to
build advanced
applications on
ROS and MoveIt.**

We would love to work with you!



History





Willow
Garage

The logo for Willow Garage features the company name in a bold, sans-serif font. Below the text is a stylized green graphic consisting of a horizontal bar that tapers into a curved shape, resembling a path or a stylized 'G'.



We think of you interns as viruses. We want to infect you with ROS and have you take it back to your research labs to teach everyone else ROS.

- Steve Cousins (Paraphrased)



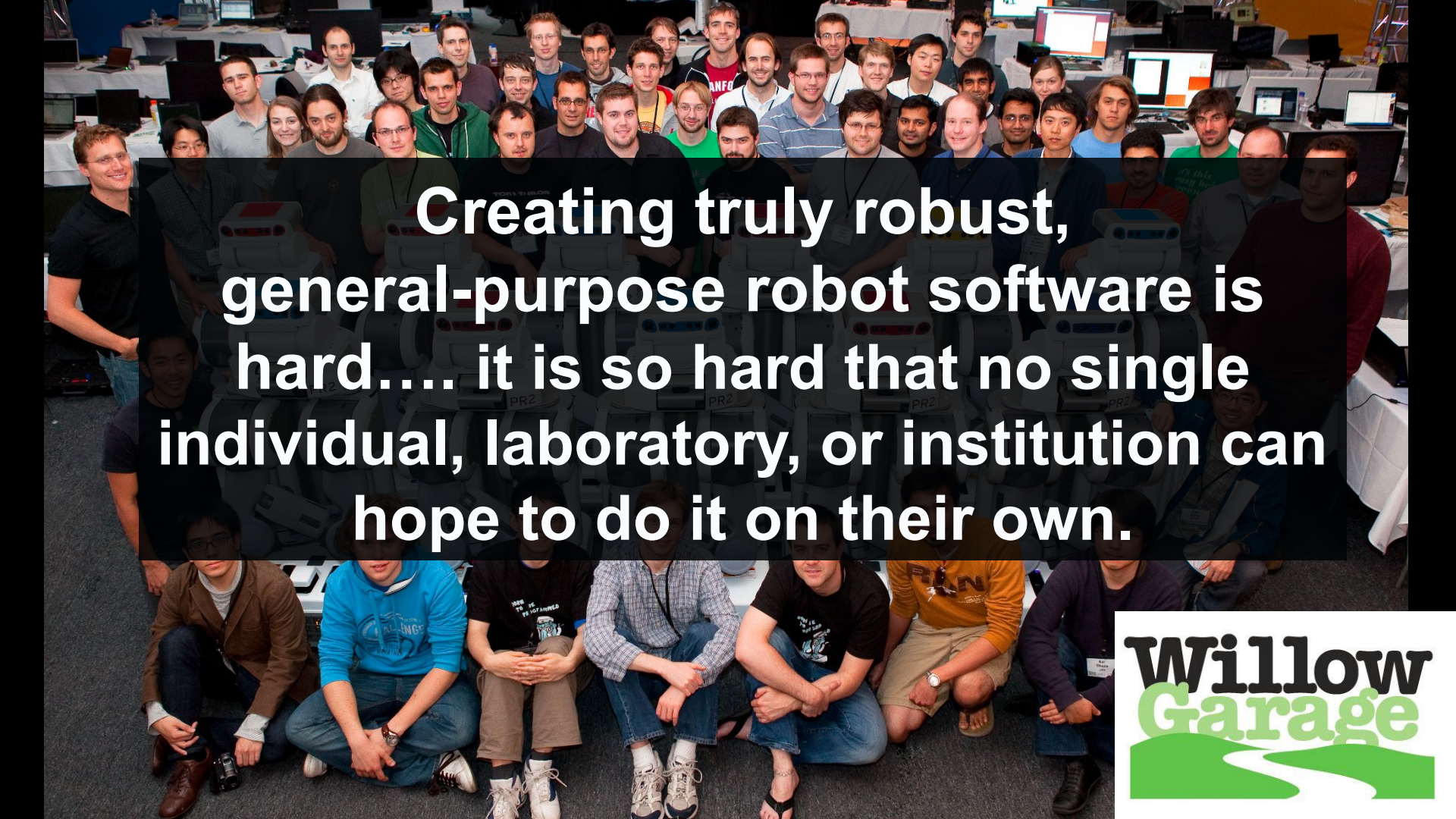
Research from the University of Tokyo in 2011!



Movelt! Setup Assistant & OMPL RViz Viewer



Young, intern me in 2012 with shaggy hair!



**Creating truly robust,
general-purpose robot software is
hard.... it is so hard that no single
individual, laboratory, or institution can
hope to do it on their own.**

**Willow
Garage**



Willow Garage's Vision

"We see personal robots as the next paradigm-shifting personal productivity tool. By investing in open source and open platform adoption models, we aim to lay the groundwork for the use of personal robotics applications in everyday life."



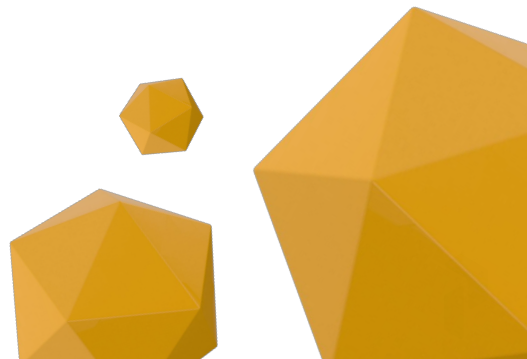
The Secret Sauce

Of Willow Garage

- Highly talented, well paid engineers
- Located next to Stanford University in Silicon Valley
- Seemingly endless funding
- No real business plan, just “make cool robots”
- Young team, mostly freshly graduated PhD, who worked long hours

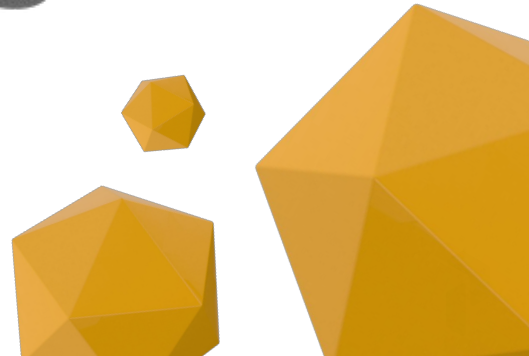
The downside:

The wealthy patron who funded Willow Garage got impatient because there was no real business model, and closed Willow Garage in 2013.



Thank you OSRF!

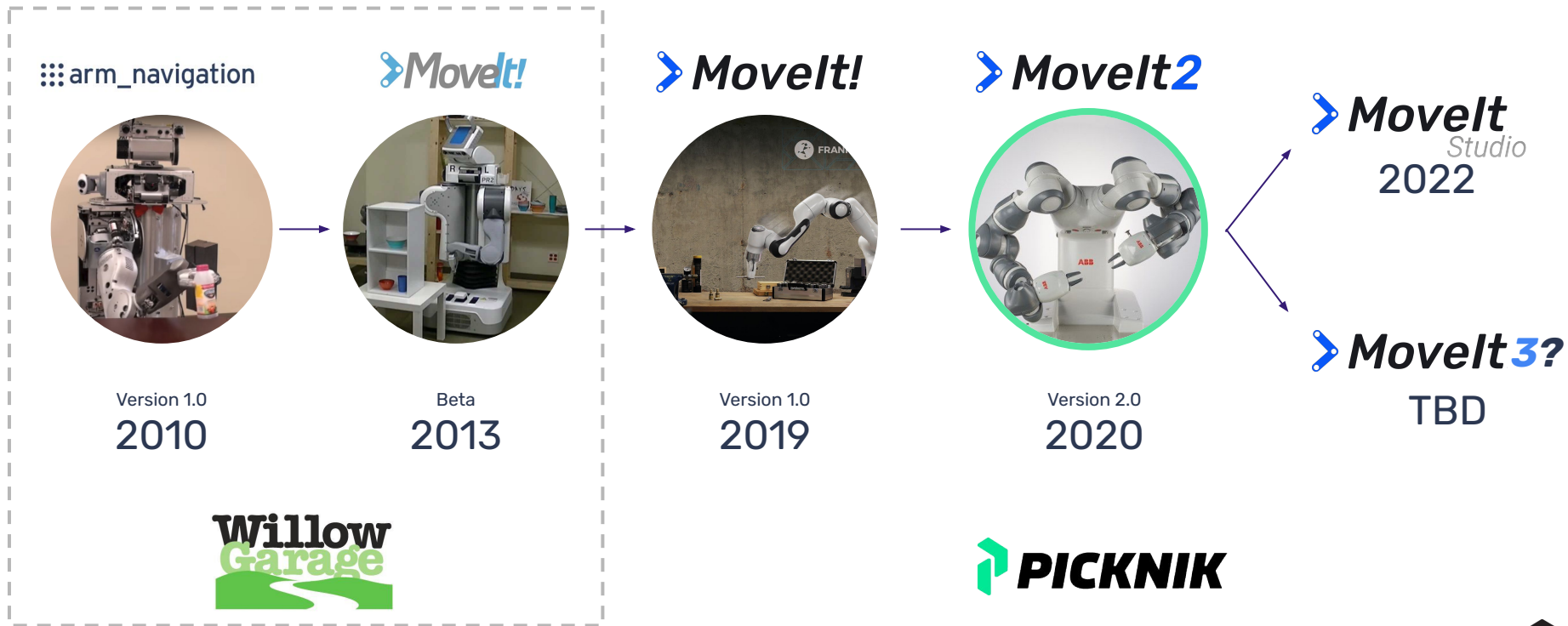
For carrying on the torch of ROS with a more sustainable business model.



About Movelt

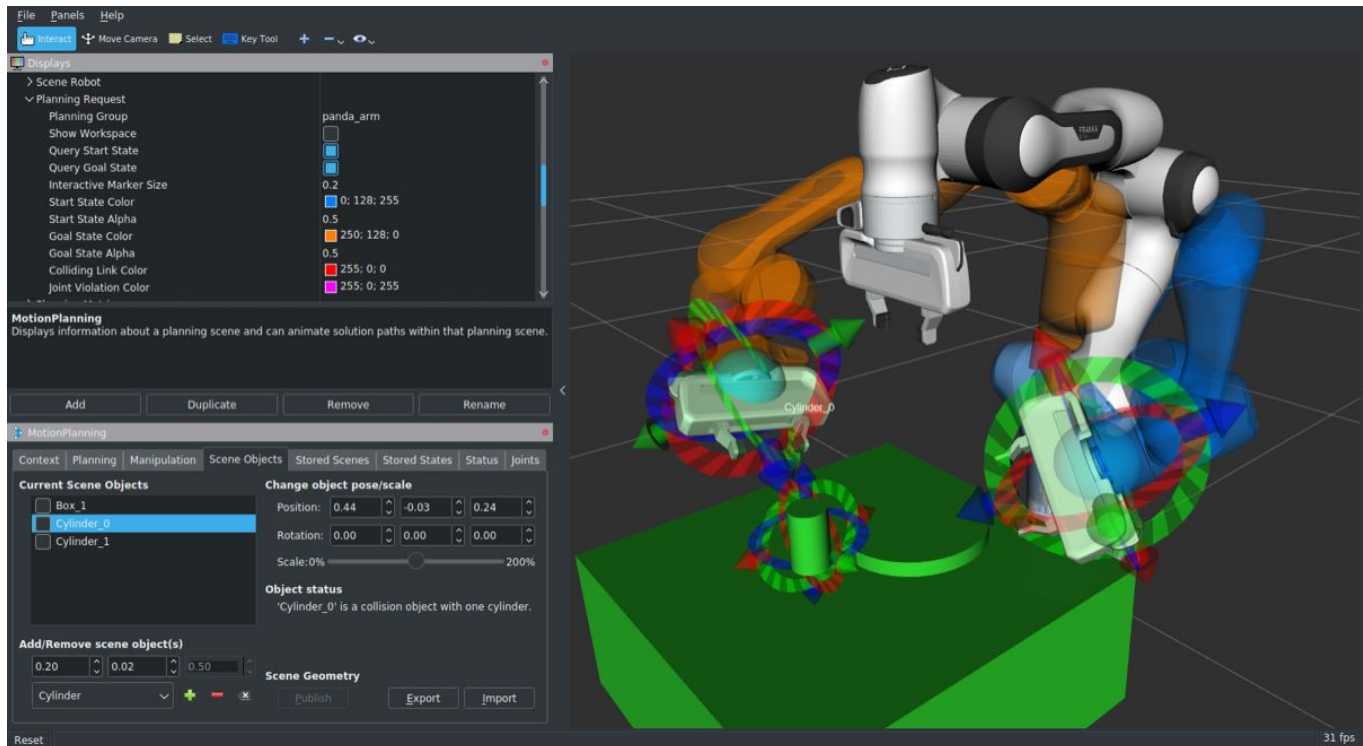


History of MoveIt



The ROS Motion Planning Framework

One of the top applications in ROS



- Motion Planning
- Kinematics
- Arm Manipulation
- Grasping
- 3D Perception
- Controls
- Mobile Manipulation

What is the MoveIt Motion Planning Framework?

An Ecosystem of Advanced Algorithms



Global Planners

- OMPL
- SBPL
- TrajOpt
- STOMP
- CHOMP

Cartesian Planners

- RobotState
- Descartes
- JogArm
- PilzMotion

Inverse Kinematics

- KDL
- IKFast
- TraclK
- LMA
- PickIK

Grasping Libraries

- MoveIt Grasps
- Grasp Pose Detection (GPD)
- Intel OpenVino GPD

Collision Checking

- Fast Collision Library (FCL)
- Bullet

Perception / Octomap

- Depth Images
- Point Clouds



Robot Agnostic



Panda

Franka Emika

[View package](#)



UR3

Universal Robots

[View package](#)



UR5

Universal Robots

[View package](#)



UR10

Universal Robots

[View package](#)



PRBT 6

Pilz GmbH & Co. KG

[View package](#)



Robonaut

NASA Johnson Space Center



Robonaut 2

NASA Johnson Space Center

[View package](#)



Valkyrie

NASA Johnson Space Center



Leading the way of ROS 2 Adoption

Some of the robot arms we've onboarded



Universal



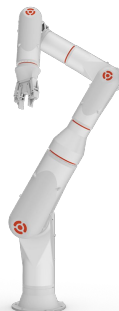
Kinova



ABB



HDT



Motiv



Ally



TechnipFMC



Announcement Movelt Studio 2.0 and Movelt 2.7 [released!](#)

Moving robots into the future

Incorporating the latest advances in motion planning,
manipulation, 3D perception, kinematics, control and navigation

[▶ WATCH OVERVIEW](#)

[GET STARTED](#)



Latest: **Movelt 2 Iron**

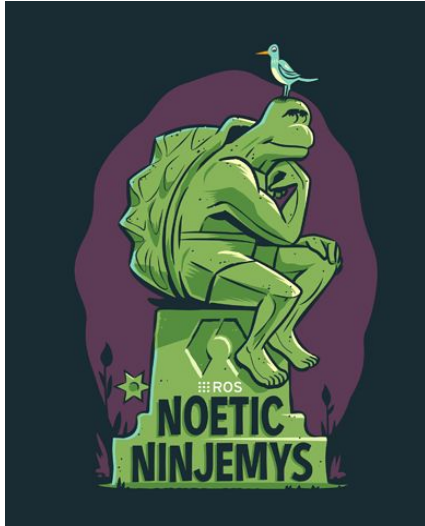
[BUILD MOVEIT 2 FROM SOURCE](#)

Ubuntu 22.04

[Install Movelt 1.0](#) | [View on Github](#)

⌵ ROS

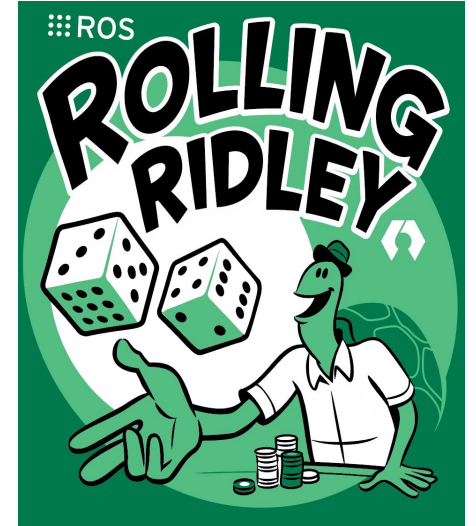
Movelt is supported on 4 distributions of ROS



Last version of ROS 1.0!



ROS 2



An Active Community



MoveltCon @ ROSCon New Orleans
Next month!

World Movelt Day
Annual Hackathon

Movelt Manipulation Working Group
Weekly Meetings





152 Robot types integrated to work with Movelt

29,843 Downloads per month of moveit_core

899 Academic citations of Movelt

197,579 Unique users to moveit.ros.org in 2021

7,600 Members of Discourse, Movelt's Discussion Forum

1,631 Github users have starred the Movelt project

316 Github code contributors to Movelt

167 International attendees of 2020 MoveltWorld online event



We've applied Movelt everywhere
Land



Agriculture

Plant Harvesting



Food

Kitchen Assistant

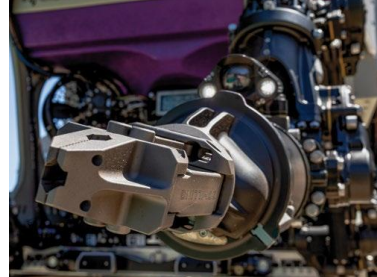
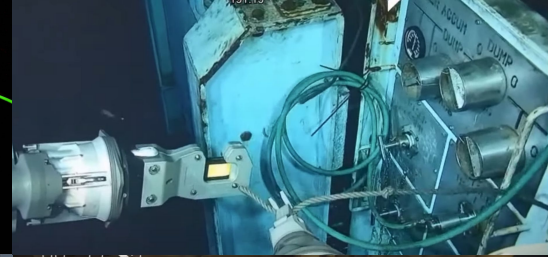
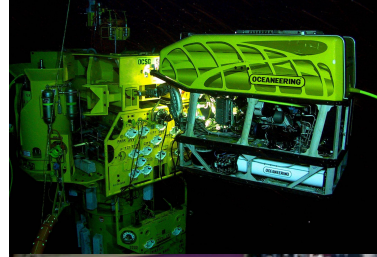
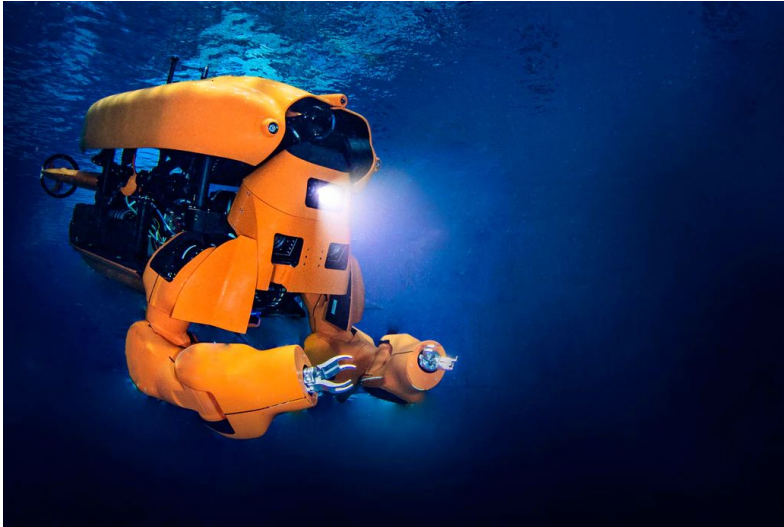


Logistics

Bin Picking



We've applied Movelt everywhere
Sea

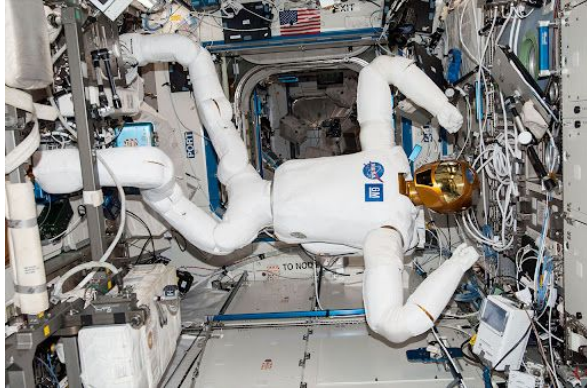


ROVs

Remotely Operated
Underwater Vehicles



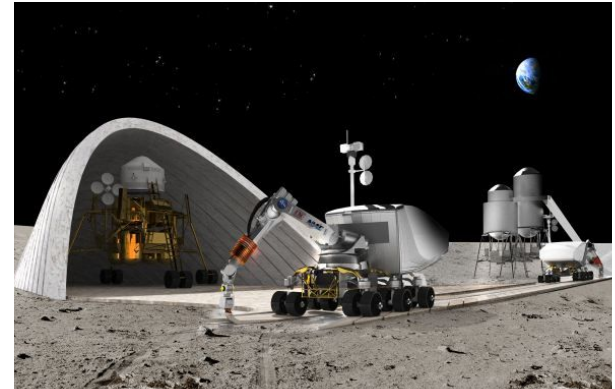
We've applied Movelt everywhere
Space



**Inter Vehicle
Robotics**



**In Space Satellite
Servicing**

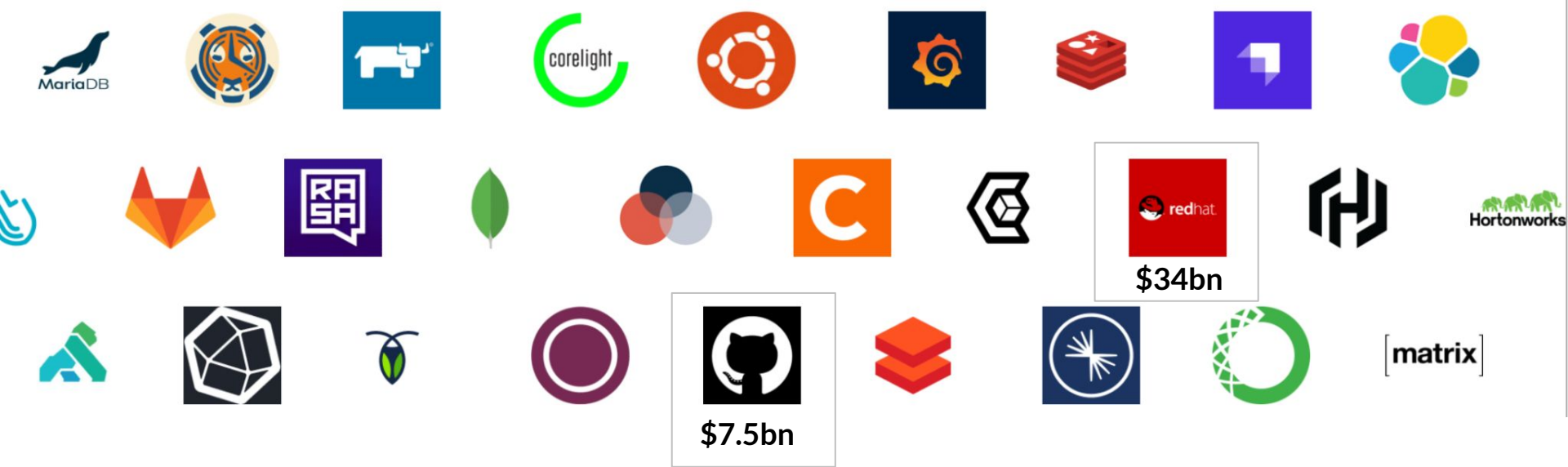


**Lunar Base
Construction**



Open Source Business Models





There have been many highly successful open source business models.

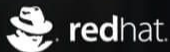
Value-Market Fit Business Models

SUPPORT

What it Commercializes

Support &
Services

Examples



OPEN CORE

What it Commercializes

Proprietary & enhanced
functionality

Examples



SAAS

What it Commercializes

Hosting, tooling &
operations

Examples



The Support Model Is Hard

We've learned

- Not enough profit to make major improvements to the open source project.
- Customers are concerned about open sourcing their IP
- Hard to scale the company
- Grants for open source are very rare

Open Robotics followed the support model until their acquisition by Intrinsic. They now follow a more corporate-backed model.



Open Core

A mix of open and closed source

When a company offers a "core" version of a software product with limited features as free and open source software.

PickNik is slowly migrating to the Open Core model (though we still offer support & services)



Open Source SaaS Model

Charging to host open source software.



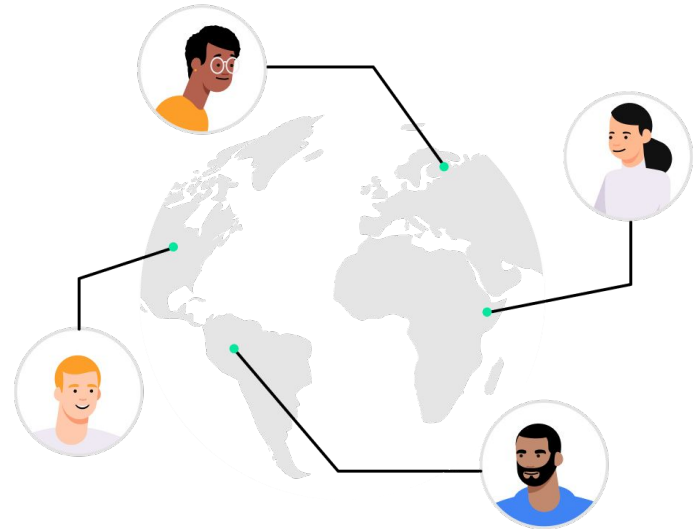


Our Origin: Amazon Picking Challenge 2015





Mission



Enable robotics companies through robust platforms for manipulation applications in real world environments.





Open Source Services

- For some projects, all we can do is "trickle down" small fixes
- For other projects, the work is 100% open source
- Everyone wins because our customers have overall less package maintenance

Our common legal language:

Any necessary bug fixes or improvements to ROS packages originating outside the Company's private code repositories **will be considered Open Source Contributions** using the business-friendly BSD license.





Challenges of Open Source Contributions

- Having sufficient time for code reviews
- Responding fast enough to pull requests
- Ensuring code quality & best practices
- Training new contributors to our guidelines
- Good architecture design decisions in a distributed team
- Breaking API to make improvements without upsetting community
- Fixing unforeseen regressions





Two Strategies



1. Collaborate with companies needing robotics expertise through our engineering services.

2. Develop enterprise products on top of MoveIt and ROS



How Movelt Benefits

- Our financial success aligned with success of Movelt
- We provide community leadership
- We market Movelt to increase user adoption
- We improve and maintain Movelt
- We build on Movelt ourselves with Movelt Studio





Open Source is Really Rewarding

- Very motivating to see our work used on a global scale
- Seeing MoveIt run on, for example, the space station is amazing
- Having a big vision is inspirational
- Very lucky to have turned my hobby into a profitable company

Let's keep alive what Willow Garage started....





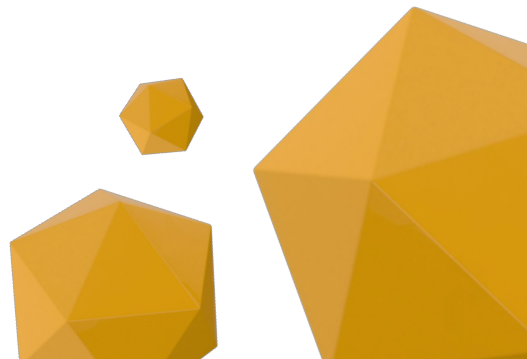
Movelt Studio: Our Desire to Do More



Why we started Movelt Studio

Our Open Core Product

- NASA funded us to develop Movelt for Space
- U.S. SBIR grants required a non-open source commercialization strategy
- We wanted to speed up our ability to innovate
- Growing and maintaining Movelt OSS is still very important to us



We envision a way
where anyone can
easily set up arm
manipulation apps.

No PhD required.





Introducing

MoveIt Studio

**The integrated environment for
developing robot arm applications.**



Integrated Behavior Tree Based Development



Unlimited **extensibility.**

Enabling your engineering team

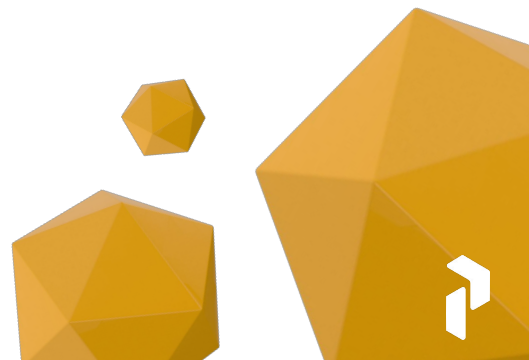
Have a secret sauce ML model for computer vision?

No problem, the **MoveIt SDK** is compatible with your own extensions and custom code!

Your in-house team can create custom Behaviors using Python, C++, and ROS. We are 100% standards based.

See our SDK Docs online:

docs.picknik.ai



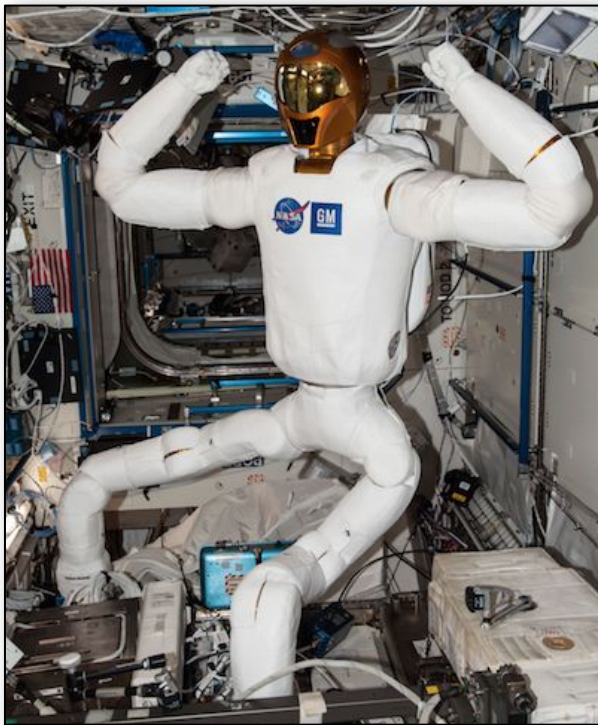


Now let's put it in space.

#moon



ROS and MoveIt have already been to space.



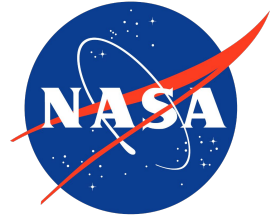
2014: Robonaut 2



2019: Astrobee



How did PickNik get involved in this?



Past Awards

- NASA JSC: Advanced planning capabilities for robots in microgravity environments.
- NASA Ames: An Affordance Driven, Human-in-the-Loop Perception Framework.
- NASA JSC: Improved Capabilities for Dexterous Robot Platforms with MoveIt Studio.
- US Space Force: Integrated Planning and Control for On-Orbit Capture.





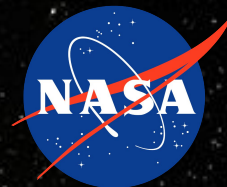
Flight testing planned on the Astrobee





There's a strong desire for a space-rated version of ROS

- A space-certifiable and reusable robotics framework
 - Meets flight software standards with DO178C and NPR7150.2
 - Usable for Class A missions
- Enable rapid development of new robotic capabilities
- Based on open community, frameworks, and standards



BLUE ORIGIN



Space ROS already exists!

- <https://space.ros.org/>
- <https://github.com/space-ros>
- Prior work has been merged upstream into core ROS 2
 - Static analysis, testing, dispositioning and addressing issues



Summary



PICKNIK Summary



- **Movelt** is a powerful open source framework in ROS.
- **PickNik** leads the international Movelt community.
- PickNik partners with companies in leveraging ROS and Movelt in **any industry**.
- **Movelt Studio** is a developer tool to make using Movelt more easier and reliable - available now!
- **Space ROS** is ROS 2.0 with extra code quality checks to ensure certification compliance.



More info:

- picknik.ai/studio
- moveit.ros.org
- space.ros.org

Connect:
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 @waffle
 @picknikrobotics

