Open-Source Robotics for Fun & Profit

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MoveIt! PICKNIK

Dave Coleman, PhD

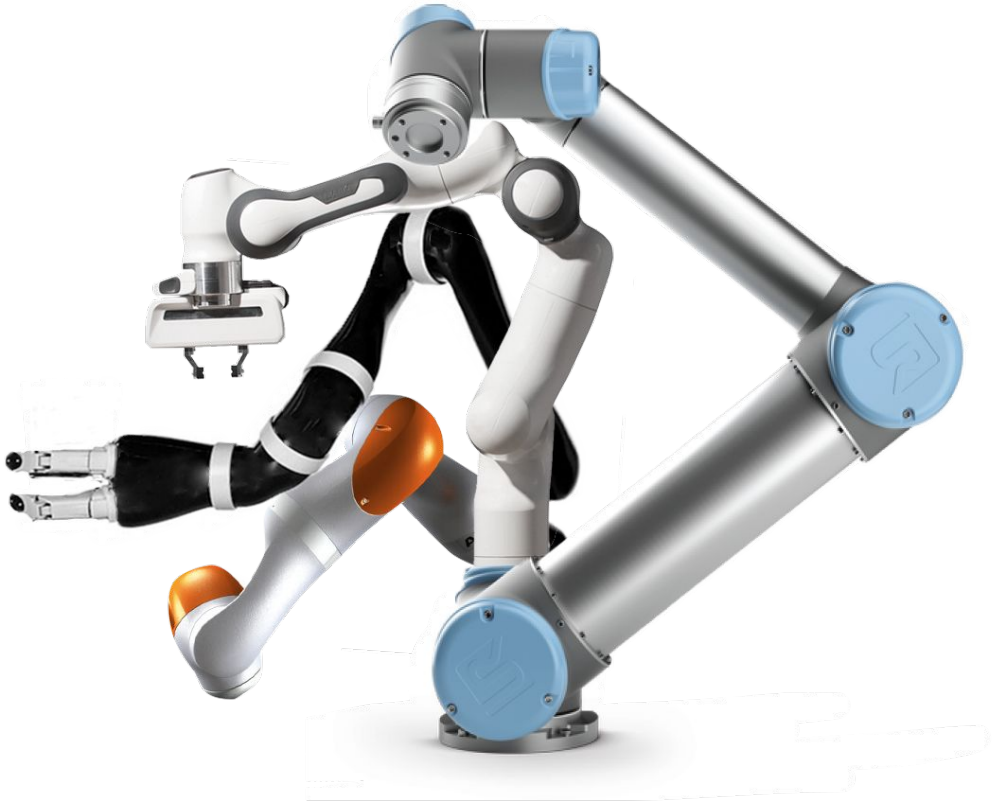
Founder of PickNik Consulting

Lead MoveIt! Maintainer / Community Leader

Also contributor to OMPL, Gazebo, and ROS

Outline

- How I got involved
- A simple idea from Willow Garage
- What is MoveIt! and why is it so fun?
- Transition to lead maintainer
- Building a company around MoveIt!
- Funding open source
- How we are profitable



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How I got involved

arm_navigation

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Ioan Sucan: main author of MoveIt! and my mentor

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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

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zero G
the weightless experience


R
L
PR2


Hobot

A simple idea from Willow Garage

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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.

http://www.ros.org/about-ros/

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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."

http://www.willowgarage.com/pages/about-us

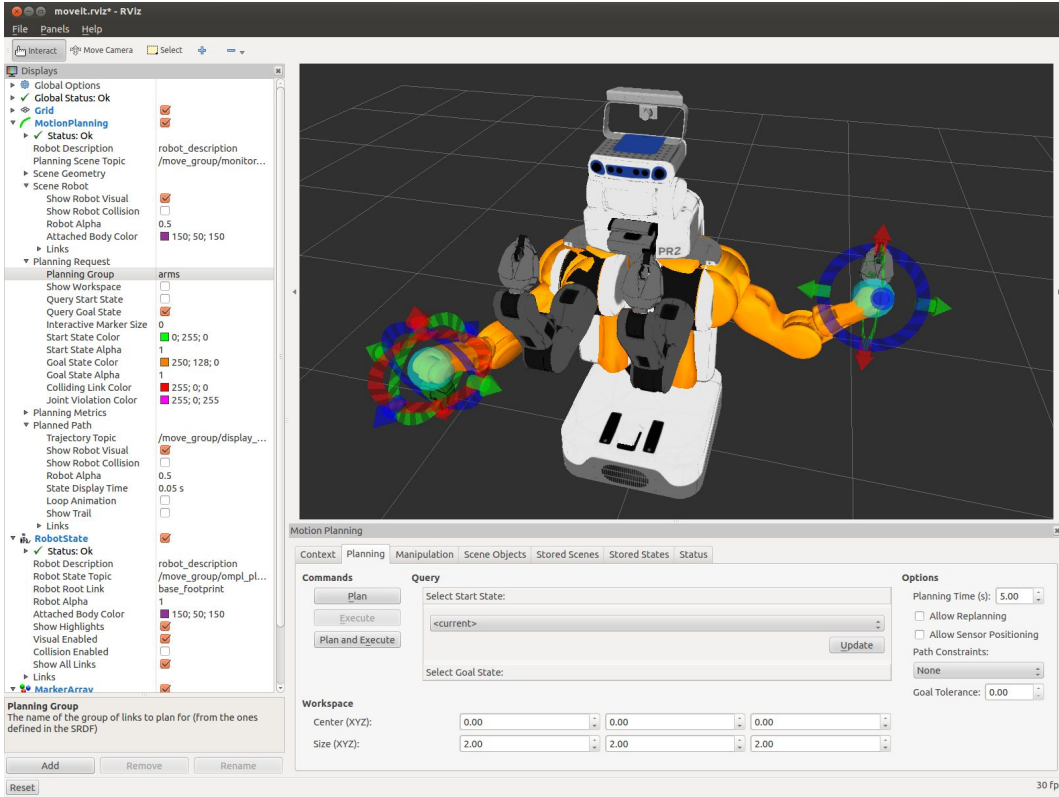
What is MoveIt! and why is it so fun?

Exclamation Marks Are Fun:

MoveIt!

MoveIt! Is A Popular Library In ROS

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



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MoveIt!

107+ Robots integrated to work with MoveIt!

11,496 Downloads per month of moveit_core

432 Academic citations of MoveIt!

75,739 Unique visitors to moveit.ros.org in 2018

1600 Members of MoveIt! Discourse

22,427 answers.ros.org users, also used by MoveIt!

282 Github users have starred the MoveIt! project

153 Github code contributors to MoveIt!

10 International locations participated in World MoveIt! Day 2018

Robot Agnostic

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Methods for Improving Motion Planning Using Experience

Based my thesis off of work to improve MoveIt! + OMPL

New approaches to improve **robotic motion planning** by learning from past experiences especially suited for high-dimensional configuration spaces with many invariant constraints.

This **experience-based motion planning** paradigm:

- Reduces query resolution time
- Improves the quality of paths
- Results in more predictable motions

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Transition to lead maintainer

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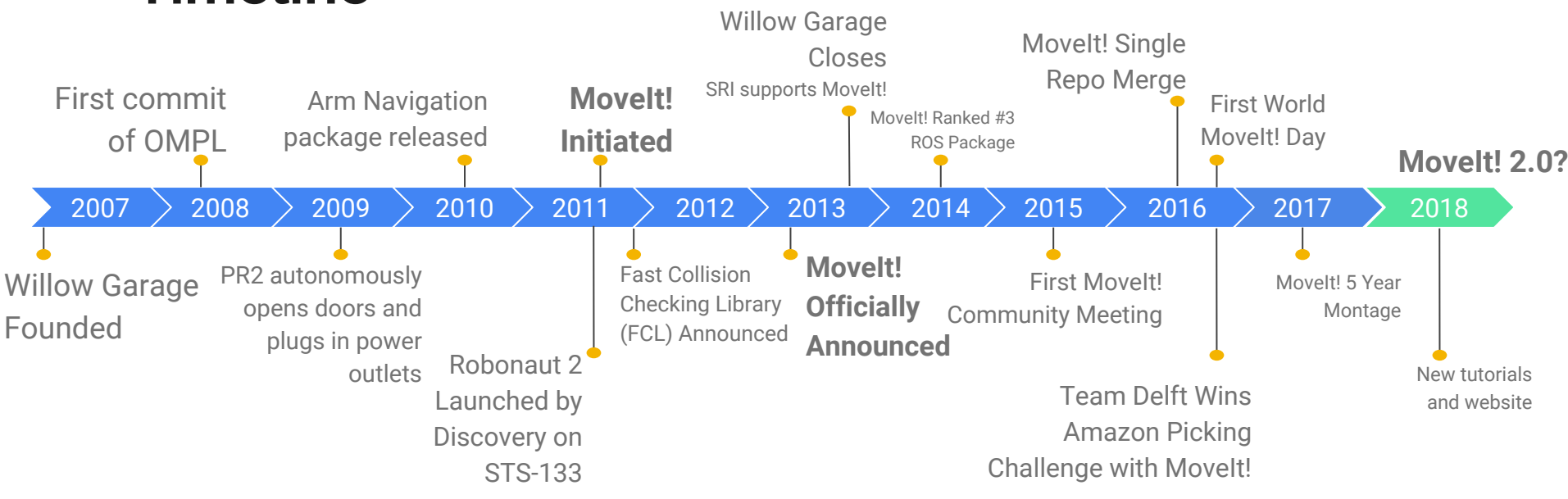
Timeline



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Challenges MoveIt! Faced

- Becoming stagnant
- Too many open pull requests
- Unclear leadership for important decisions

Steps I Took:

- Email and phone discussions with many people
  - Shaun Edwards and Paul Hvass (ROS Industrial founders)
  - Open Robotics
  - Original MoveIt! developers
- Called together our first MoveIt! Maintainer meeting

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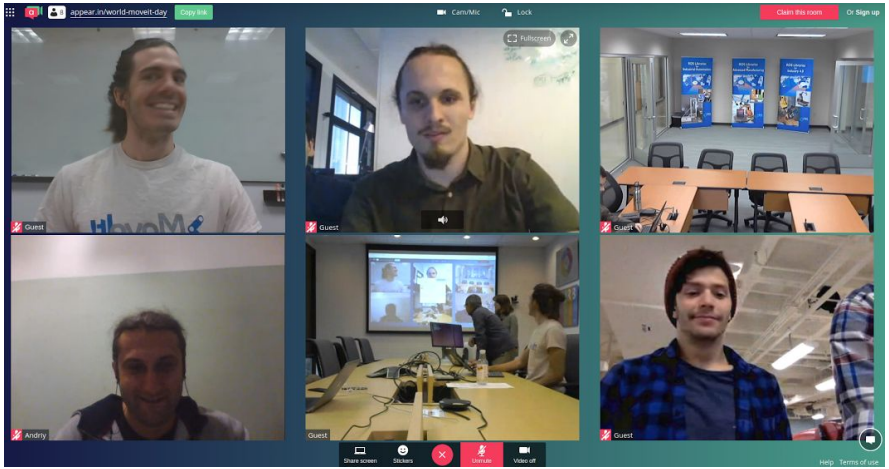
Maintainer Meetings

- May 2016 we had our first maintainer meeting
- Agenda:
  - Maintainers - adding, removing, growing
  - Responding to PRs
  - Consolidating repos
  - MoveIt! 2.0 roadmap
  - Addressing new motion planning use-cases
  - Start recurring meetings
- Other ROS projects have similar meetings:
  - Navigation2
  - Cartographer



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World MoveIt! Day

- Michael Ferguson at Fetch Robotics suggested we have an international hackathon
- Created a lot of excitement around the project
- 2018 Stats:
  - 100 participants
  - 12 locations around the world
  - 85 pull requests merged
  - 41 pull requests opened
  - 97 issues closed
  - 107 issues opened

It Takes A Team

Robert Haschke
CITEC, Bielefeld University

Michael Görner
University of Hamburg

Isaac IY Saito	Plus One Robotics
Michael Ferguson	Fetch Robotics
Ian McMahon	Rethink Robotics
Gijs van der Hoorn	Delft Univ. of Tech / ROS-I
Jorge Nicho	SwRI / ROS-I
Bence Magyar	Heriot-Watt University
Mike Lautman	PickNik Consulting
Jon Binney	Iron Ox
Zak Kingston	Rice University

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Building a company around MoveIt!

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First Projects

- Amazon Picking Challenge 2015
- Took semester off grad school
  - SwRI funding delayed
  - Consulted for Google Robotics
  - Small project around ros_control
- Still needed to finish my PhD

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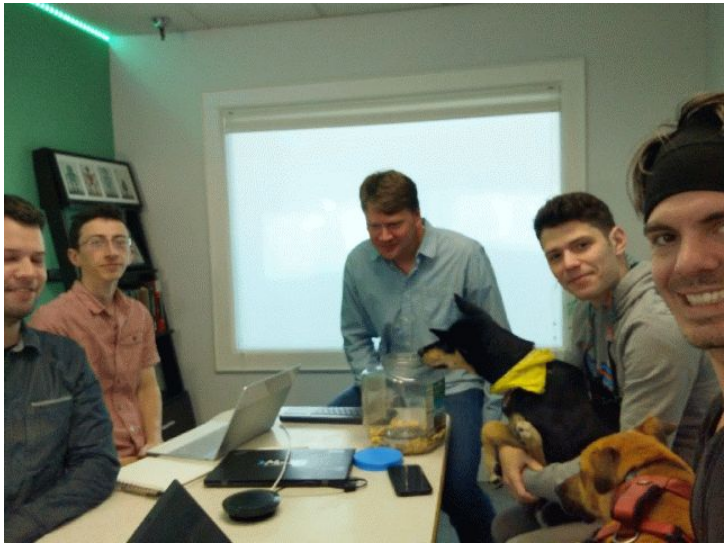
Had too much work, so started to build a team



Completely bootstrapped!

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We've now worked with 20+ companies including:

Funding open source

Funding Open Source Is Hard

Common concerns of clients:

- Cost sharing vs freeloaders
- Building intellectual property vs collaboration
- Funding ongoing software maintenance and support
- Devoting resources to actual documentation

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The Trickle Down Theory of Open Source Contributions

- We understand that not everything can be open source
- We always will protect our client's core IP
- Yet many bug fixes and improvements are not part of a customer's IP and are better open sourced to reduce overall package maintenance

At PickNik we push strongly for legal language allowing open source pull requests be made for all non-critical code development.

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Open Source Legal Language

- For some projects, all we can do is "trickle down" small fixes
- For other projects, the work is 100% open source

Our common contract 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. Open source release will benefit the Company by reducing feature maintenance overhead of forked packages through leveraging the broader community to maintain, test, and debug the software without additional cost to the Company. Sponsorship attribution will be provided to the Company for these Open Source Contributions in the description of each pull request. All other Software developed under this SOW will be Company's Software and treated as confidential and owned by the Company under the Agreement.

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Challenges of Open Source Contributions

- Ensuring quality code contributions
- Training new contributors
  - Code style
  - Best practices
- Overall architecture design decisions
- Ensuring stable API *and* making code improvements
- Time for code reviews
- Responding fast enough to pull requests
- Fixing regressions

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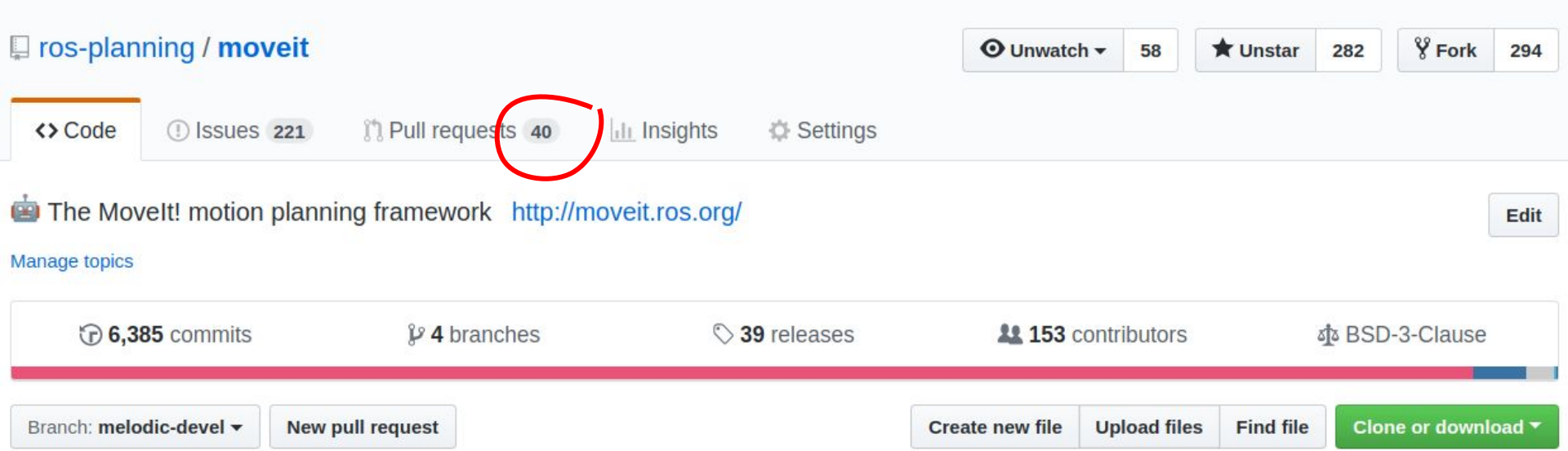
Too Many Pull Requests & Issues



Pull Reminders | Dashboards | PRs | **Leaderboard** | Slack | Backlog

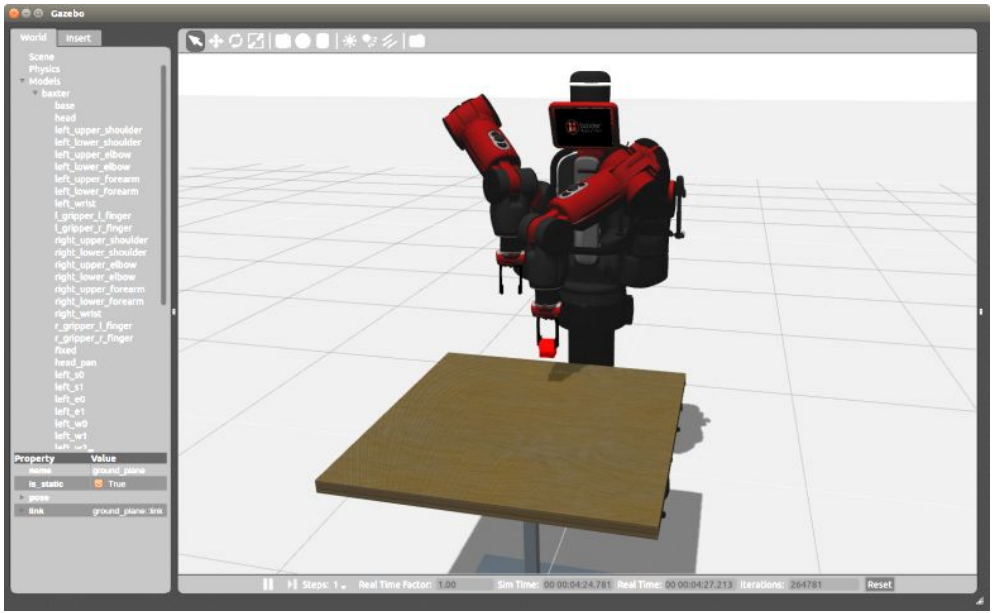
Reviews | Review Turnaround | PR Size

All repos | All teams | 90 days

	REVIEWER	PRS REVIEWED
1.	davetcoleman	**81**
2.	rhaschke	**57**
3.	mlautman	**20**
4.	v4hn	**20**
5.	nbbrooks	**9**
6.	IanTheEngineer	**6**
7.	simonschmeisser	**5**
8.	130s	**4**
9.	jonbinney	**4**

Case Study: Vicarious AI

- Fully open source effort to improve Baxter in ROS Kinetic
- 23 pull requests were created across 5 Github repositories
- Fixes to the upstream Gazebo project
- Load time of the Baxter simulator was improved by 35 seconds!



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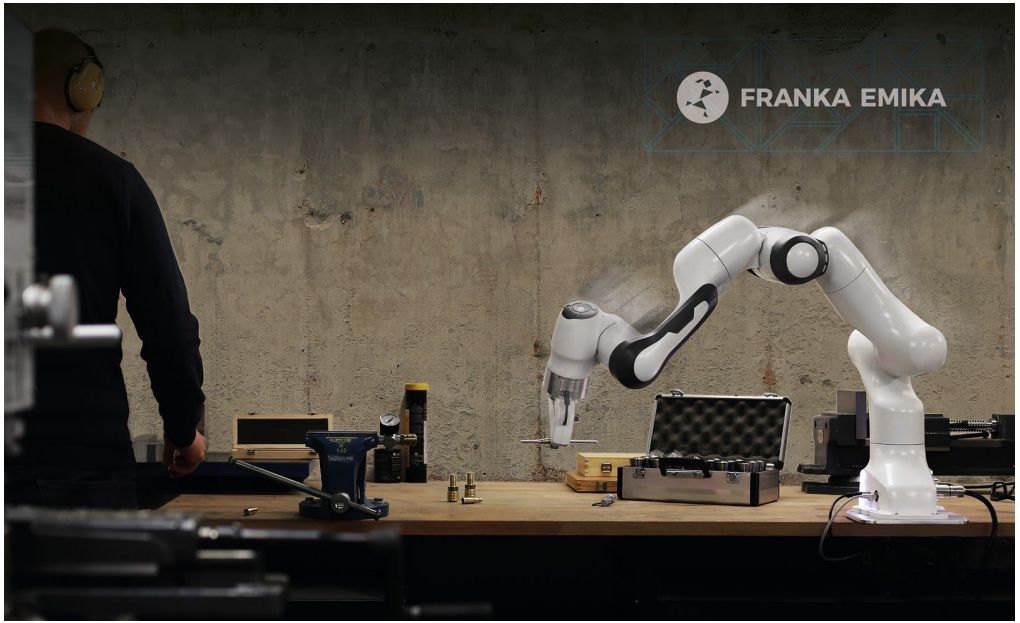
Case Study: Franka Emika

- Official robot of MoveIt!
- Funded new tutorials and website
- Low cost arm ideal example robot for using MoveIt!



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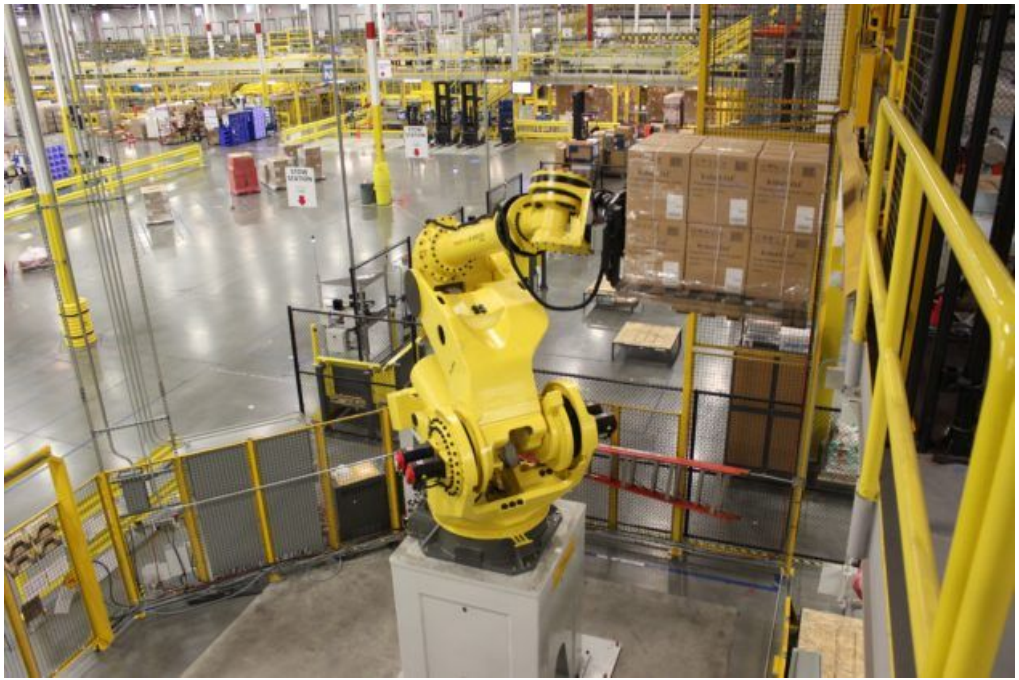
Case Study: Amazon

- PickNik assisting Amazon with ROS2
- Tight timeline for Crystal release
- RQT porting and improvements
- Preparing the PickNik team for MoveIt! 2.0 development



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How we are profitable

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PickNik's Mission

Sustainably provide a globally-recognized open source manipulation platform that enables organizations of all sizes to leverage robotics for their applications.

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PickNik's Strategies

- Collaborate with companies needing robotics expertise through consulting.
- Expand the open source robotics community through grants, consulting support, and commercial contracts.
- *[Future]* Develop premium and enterprise products on top of MoveIt! that provide companies with highly-capable robotic solutions.

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PickNik's Approach to Marketing

Rather than spend money on traditional advertising, simply make a name for ourselves via our open source work.

"PickNik remains committed to open source and dedicates a significant portion of its resources to improving the MoveIt! motion planning framework"

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Accelerate Your Robotics Development

(Our Tagline)

- Our core business is serving our clients to strategically utilize cutting edge open source software
- We help de-risk open source software usage by providing support contracts that enable many companies to leverage MoveIt! and ROS

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How MoveIt! Benefits

- Improved user adoption.
  - More users = more eyes on the codebase and documentation
- Community leadership through PickNik
- We've aligned PickNik's financial success with the success of MoveIt!
  - PickNik financially motivated to maintain MoveIt!
- PickNik has monthly code review requirements for every engineer
  - One of our internal company goals

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PickNik's Past Work

Industries:

- Human surgery
- Space manipulation
- Industrial brazing
- Machine tending
- Bin picking
- Food service
- Body therapy
- Cleaning services
- Smart sensors

Technologies:

- Teleoperation
- Inverse kinematics
- Motion planning
- Realtime Controls
- Calibration
- Impedance Control
- Collision checking
- Grasping
- Virtual reality

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Final Thoughts

Different World from Venture Capital

- We don't have a pitch deck
- We're not currently building intellectual property
- We do not have a fiduciary responsibility to investors to maximize profit
- Besides profit, we optimize for open source impact

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Asks:

- We're seeking funding of MoveIt! on ROS 2.0
- We'd like to collaborate with you on future MoveIt! codesprints
- Chat with me on how your team has used MoveIt!, including any struggles

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Open Source Is Really Rewarding

- Very motivating to see our work used on a global scale
- Seeing MoveIt! run on e.g. the space station is amazing
- Having a big vision is inspirational
- Very lucky to have turned a hobby into a profitable company
- The funding struggle is worth it

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

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Thanks!

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