

# **FIRST® LEGO® League**

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AN ALTERNATIVE APPROACH TO  
FIRST LEGO LEAGUE ROBOTS:  
MINIMIZING ATTACHMENTS

HOTSHOT HOTWIRES

# ABOUT THE AUTHOR

The Hotshot Hotwires is a community-based FIRST LEGO League team in the mid Hudson Valley region of New York.

The team started in 2012, although all of the original coaches and students have graduated.

The photograph is of our 2018-19 team, comprised of 5<sup>th</sup>-8<sup>th</sup> graders.



# THE CONVENTIONAL APPROACH

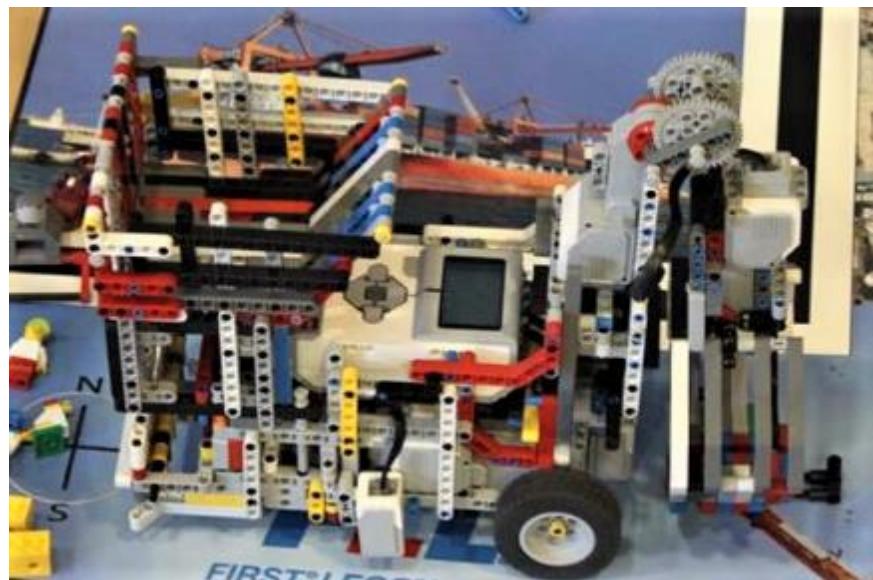
- A common approach to robot design by many experienced teams is as follows:
  - Build a base robot for mobility, with access to power from two motors (the other two of the four motors are used to drive the robot).
  - Build attachments that draw power from the motors on the base robot. Each attachment performs a few missions.
  - Change attachments between programs.
  - Rubber bands or pneumatics can be used as additional power sources.

# A SIMPLE AND EFFECTIVE ALTERNATIVE

- Goal: obtain a respectable score...
  - Without using complex attachments
  - While minimizing attachment change
- Approach:
  - Combining actuators so that when one or both motors move, it enables the robot to perform a wide variety of missions.
  - Enables simultaneous and independent movement in all three axes of 3D space, like a 3D printer.

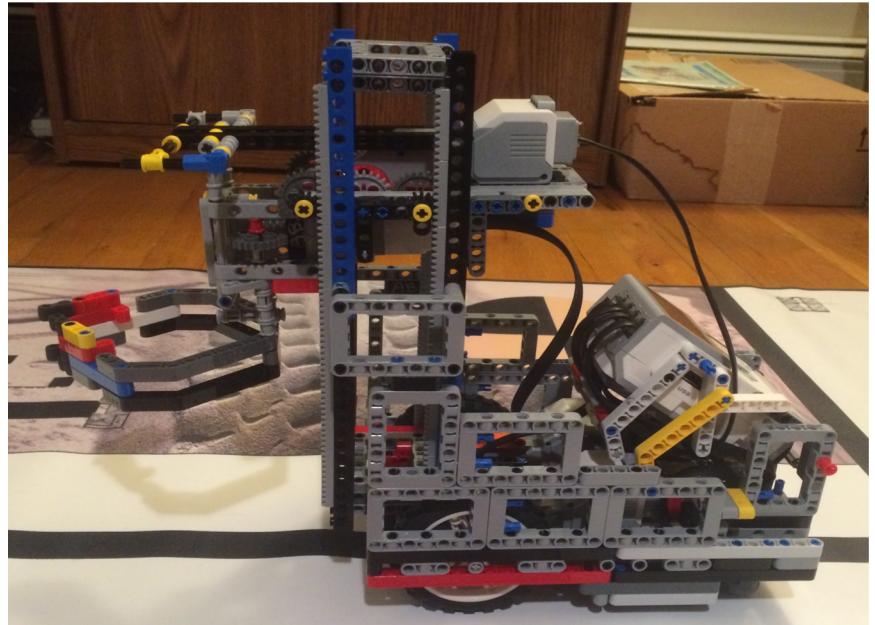
# NO ADDITIONAL ATTACHMENTS

- Sometimes, it might be possible to solve several missions with no added attachments on your robot
- **Pros:** Saves time in base, reduces errors, and reduces complexity
- **Cons:** May not be able to complete all missions, but will complete most
- Examples:
- Watch the video to see our robot complete more than half the missions in one program with no attachments added to the robot:
- <https://youtu.be/0rPKrHTP688>



# NO ATTACHMENT SYSTEM

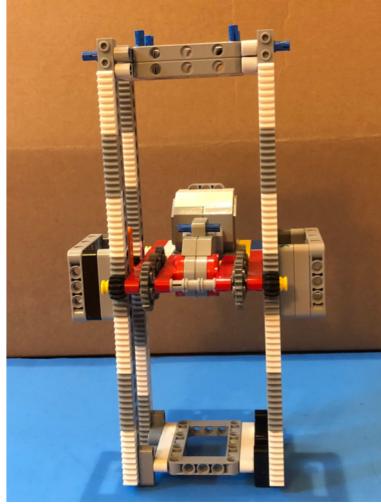
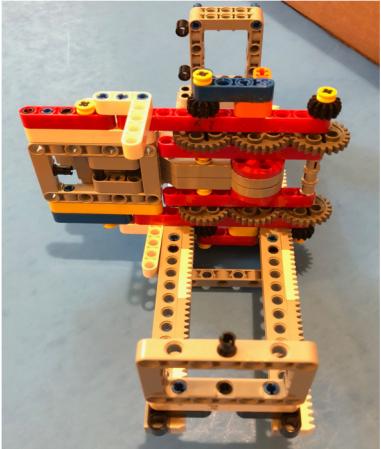
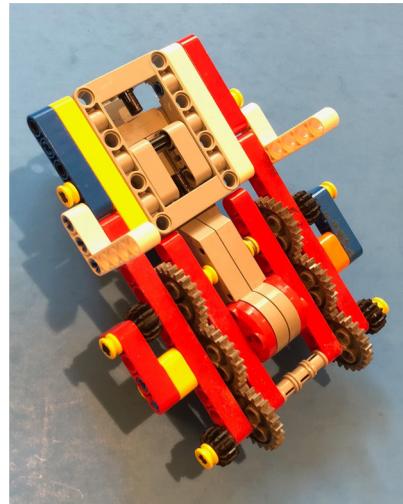
- If you plan to add nothing to your robot, then you have to think about what versatile tool that would complete the most missions
- Hotshot Hotwires recommends learning to make a **forklift** and learning to make a **claw**
- This allows for **up-down** and **grab-release** movements that are universally needed for FIRST LEGO League missions



# FORKLIFT BASICS: RACK AND PINION SYSTEM

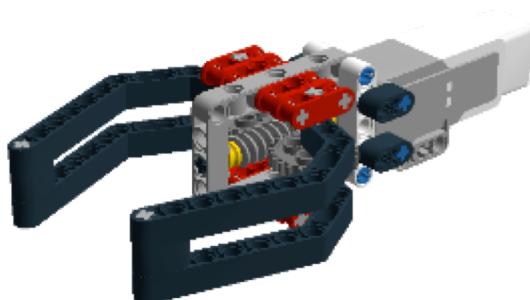
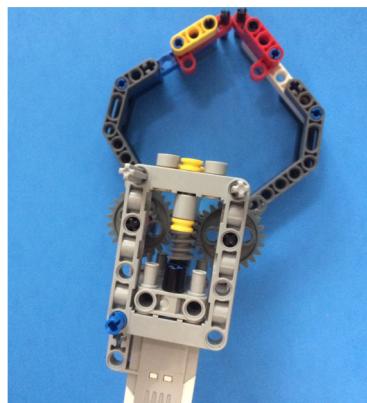
- A forklift can be made in many ways including using string or LEGO chains
- We used 2 pairs of rack and pinion gears for ours
- Watch this 20sec video on rack & pinion:  
[https://www.youtube.com/watch?v=oS7QyMNCZ\\_4](https://www.youtube.com/watch?v=oS7QyMNCZ_4)
- The component with the Large motor moves up and down along the racks to complete the forklift

Expert tip: for strength, sandwich gear rack (#3743), technic bricks (eg #32018), and optionally thin system plates (eg #3460) together.

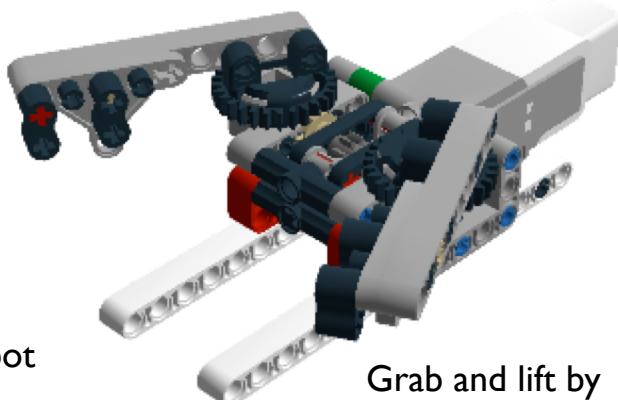


# CLAW ARM BASICS

- Start with the design from Yoshihito Isogawa's LEGO MINDSTORMS EV3 Ideas book and modify it to suit your needs (make it stronger, larger, make it grab and lift, etc.)
- Whatever claw you design will need to be motorized and connect to the forklift



"Most Simple EV3 Robot Claw" by William

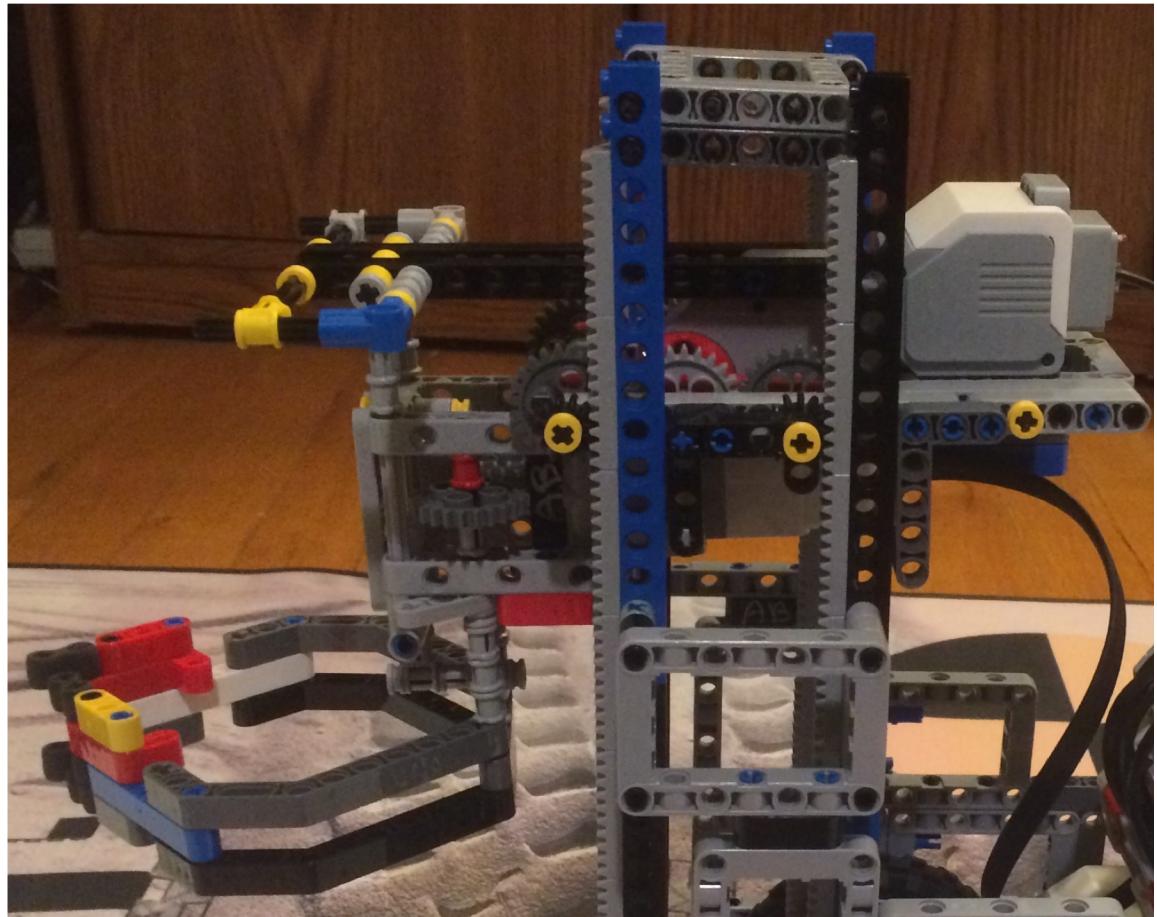


Grab and lift by Ogaworks

# PUTTING IT TOGETHER

- Add the claw arm to the forklift.
- The claw arm on the forklift allows for a versatile tool that we call “compound actuator”
- You can now **move up-down** and **grab-release**
- You can complete a lot of missions with this one permanent tool
- Watch video to see our robot complete missions with this tool.

<https://youtu.be/EUToojAwfa4>



# CREDITS

- This tutorial was created by Hotshot Hotwires.
  - Facebook Page: <https://www.facebook.com/hotshothotwires/>
  - YouTube Channel: <https://www.youtube.com/channel/UCC2U3CBy-QDIDr09WZRx2Ug>
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