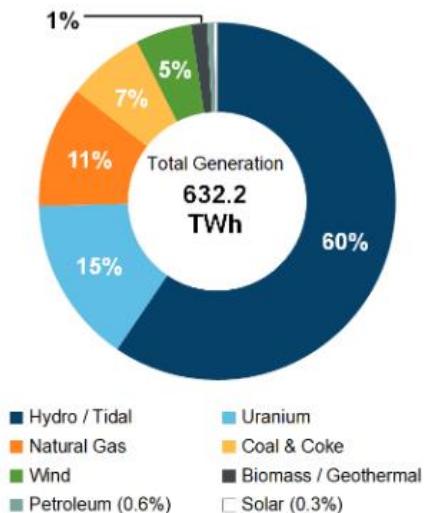
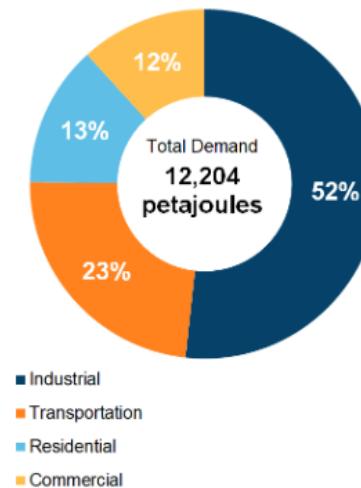


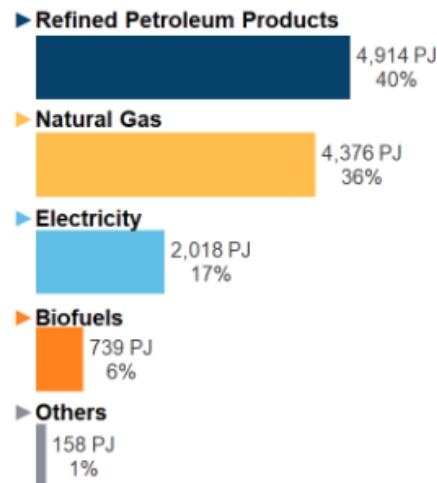
Electricity Production



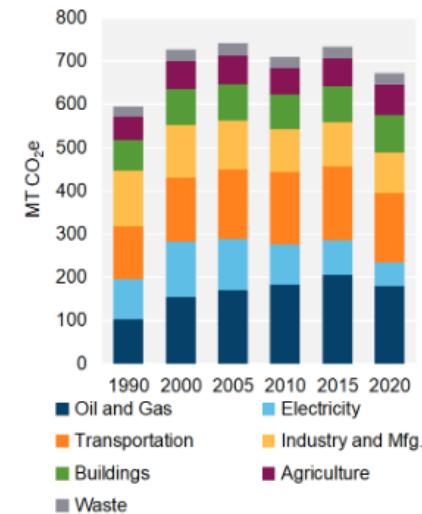
End-Use Demand by Sector



End-Use Demand by Fuel



GHG Emissions by Sector



Latest Data (2019) Source from



Canada Energy
Regulator

Régie de l'énergie
du Canada

Energy Simulation



Natural Resources
Canada

Ressources naturelles
Canada

Canada

Calculation Result

Baseline			
Total Annual Energy Consumption	138.506	GJ	
Annual Heating System Energy Consumption	71.762	GJ	
Annual Cooling System Energy Consumption	8.813	GJ	
Annual Fuel Consumption	adjusted @ \$.361/m ³		
Quantity		\$	
Electricity	10423.4	kWh	940.83
Natural Gas	2710.3	m³	1587.82
Oil	0.0	Litres	0.00
Propane	0.0	Litres	0.00
Wood	0.0	1000 kg	0.00
Total	2528.65		
2200 sq.ft single detached, 23 dC heating & cooling. House locates in York Region, ON, Canada.			
OK			

Calculation Result

MACH assisted			
Total Annual Energy Consumption	122.057	GJ	
Annual Heating System Energy Consumption	55.076	GJ	
Annual Cooling System Energy Consumption	8.710	GJ	
Annual Fuel Consumption	adjusted @ \$.361/m ³		
Quantity		\$	
Electricity	10324.0	kWh	933.85
Natural Gas	2278.4	m³	1363.13
Oil	0.0	Litres	0.00
Propane	0.0	Litres	0.00
Wood	0.0	1000 kg	0.00
Total	2296.97		
2200 sq.ft single detached, 20 dC heating & cooling. House locates in York Region, ON, Canada.			
OK			

National avg. 2,385 m³, from Canadian Gas Association

Natural Gas	Baseline (without MACH)	Innovation (with MACH)	Savings	Reduction
m ³	2710.3	2278.4	431.3 m ³	
\$ (historical price)	1587.82	1363.13	\$224.69	
\$ (adjusted price)	3496.29	2939.91	\$556.38	16%

Previously on Cargo Connect

What is a Follow me robot?

- A Follow me robot is a four-wheel smart robot with sensors to follow user's movements
- Max speed: 6 km/h
- Battery: 6 – 8 hours
- Cargo capacity: 38 cubic ft
- Payload: 300 kg

Follow me robot and aTrolley

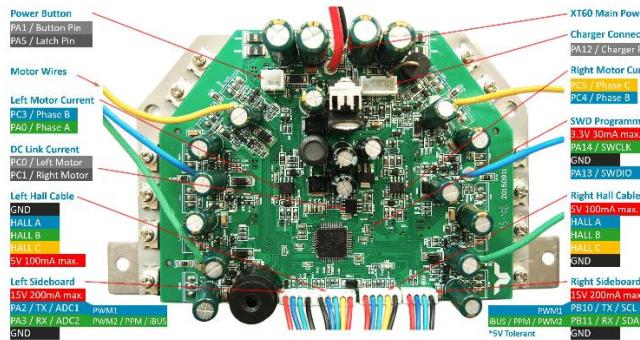


? Bigger Payload



Up to 220 lb Payload

! Hacking in Progress



BUT

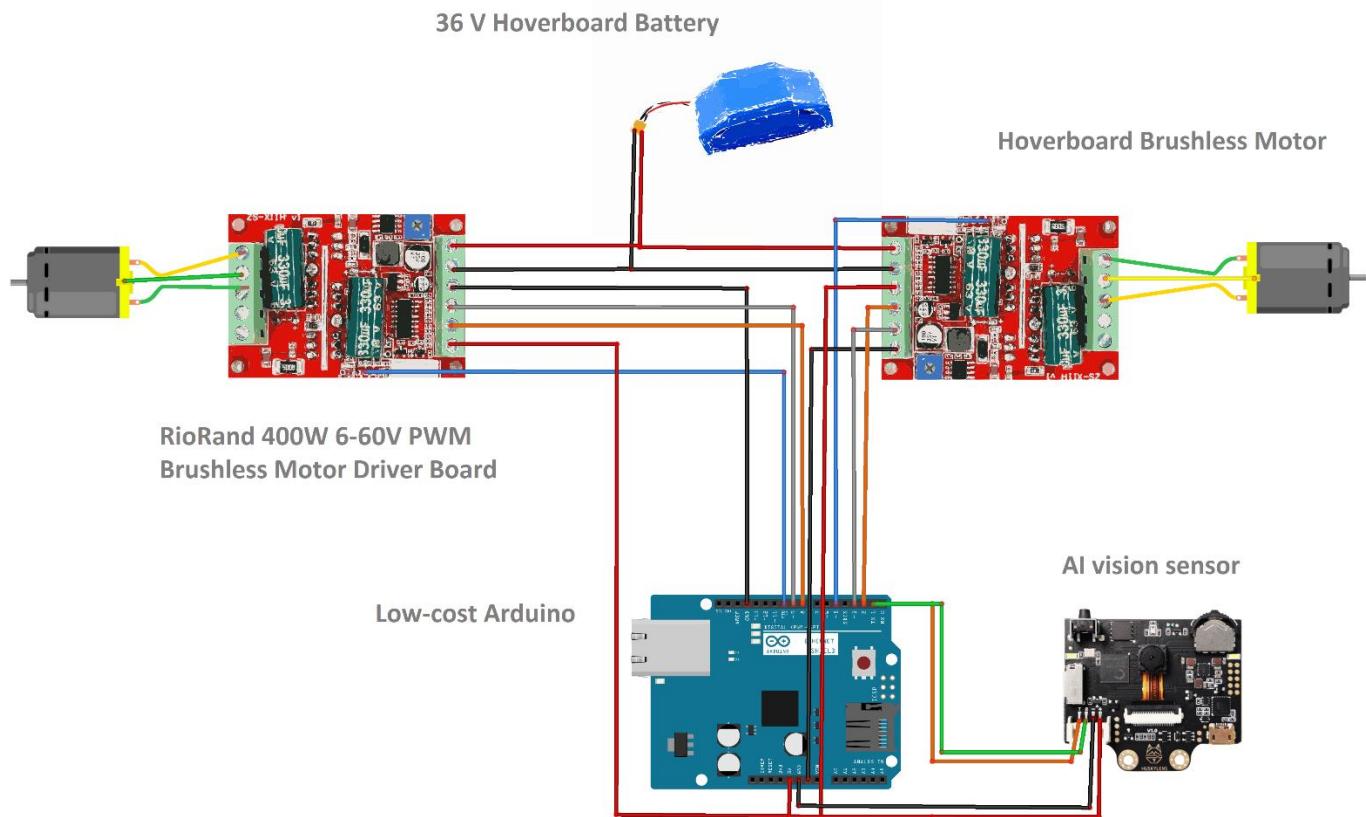
New Problem

STEADY & SLOW

~~FAST~~



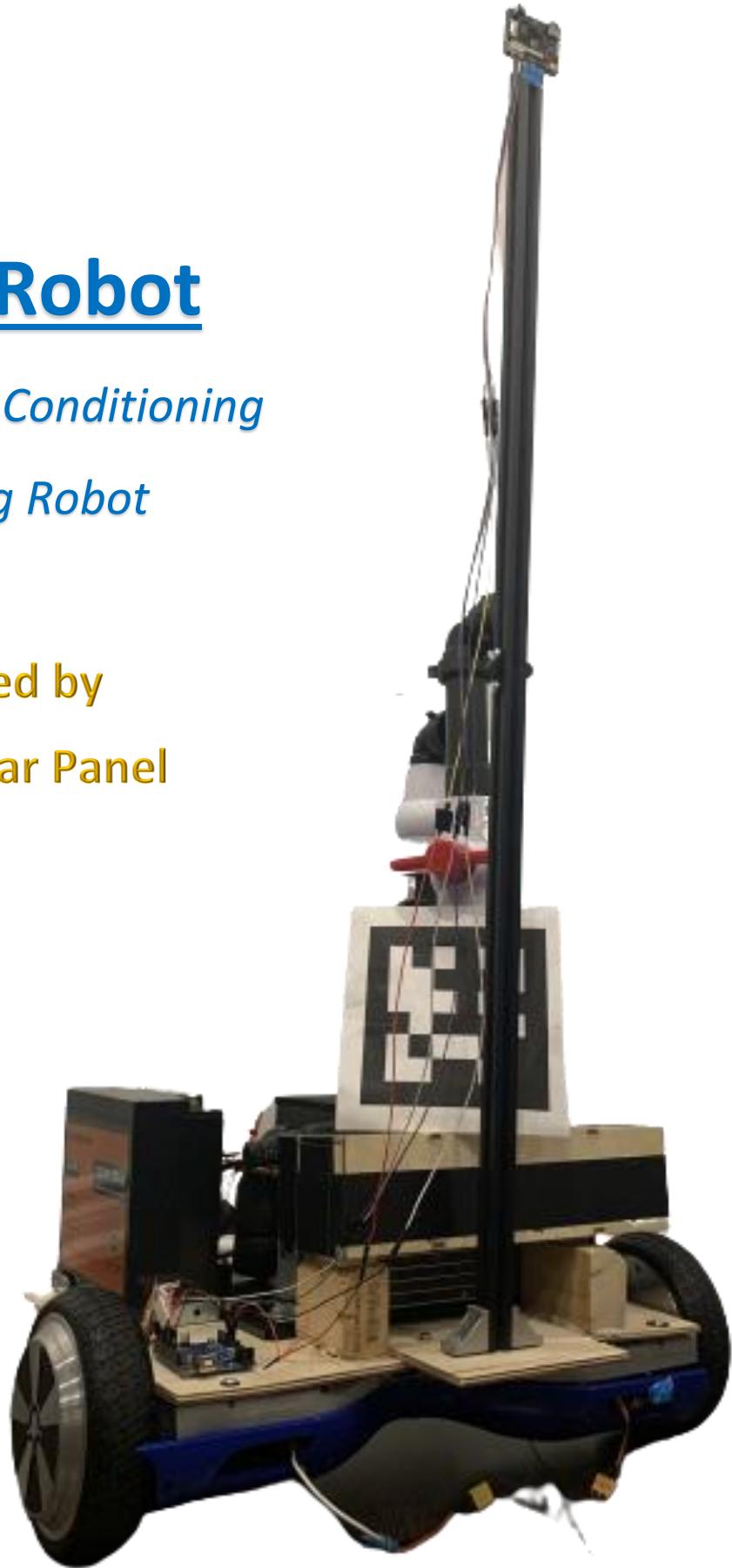
Solvers' NEW Solution



MACH Robot

*The Mobile Air Conditioning
& Heating Robot*

Powered by
100 W Solar Panel





Greenhouse Gas Equivalencies Calculator



Greenhouse Gas Equivalencies Calculator

Did you ever wonder what reducing carbon dioxide (CO₂) emissions by 1 million metric tons means in everyday terms? The greenhouse gas (GHG) equivalencies calculator can help you understand just that, translating abstract measurements and emissions data into concrete terms, such as the annual emissions from cars or households.

There are two options for entering reduction data into this calculator:

[If You Have Energy Data](#)

[If You Have Emissions Data](#)

Please note that these estimates are approximate and should not be used for emission inventory or formal carbon footprinting exercises. Read more about the caveats and explanations on the [Calculations and References page](#).

Amount	Unit	Gas
0.419	Metric Tons	CO ₂ - Carbon Dioxide or CO ₂ Equivalent*
	Metric Tons	Carbon or Carbon Equivalent
	Metric Tons	CH ₄ - Methane
	Metric Tons	N ₂ O - Nitrous Oxide
	Metric Tons	HFC-23 - Hydrofluorocarbon gases
	Metric Tons	CF ₄ - Perfluorocarbon gases
	Metric Tons	SF ₆ - Sulfur Hexafluoride

**0.42 mT
saving**

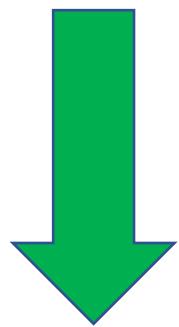
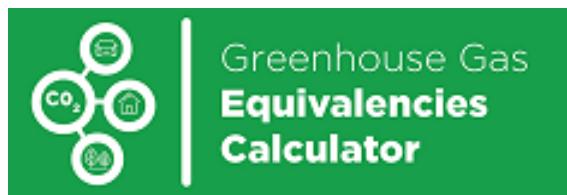
[Calculate](#)

*If your estimated emissions of methane, nitrous oxide, or other non-CO₂ gases are already expressed in CO₂ equivalent or carbon equivalent, please enter your figures in the row for CO₂ or carbon equivalent.

Equivalency Results

CO₂ emissions from

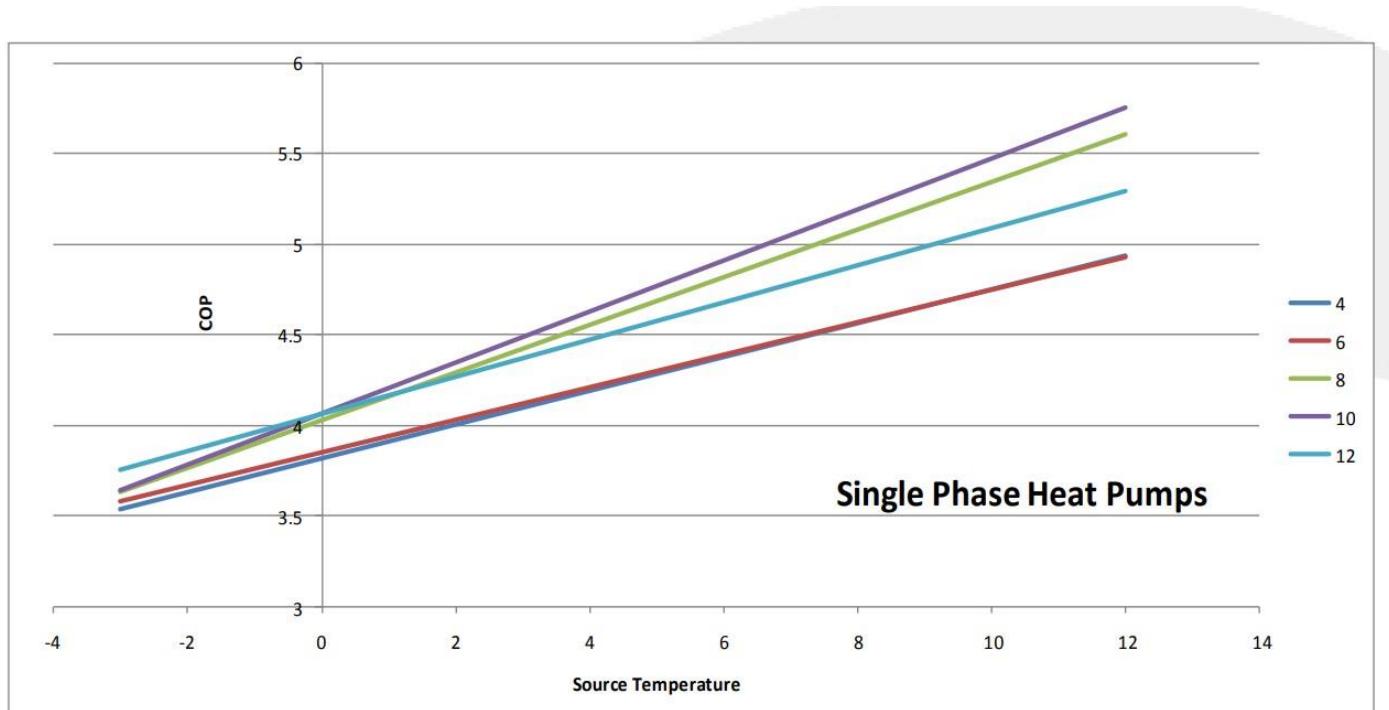
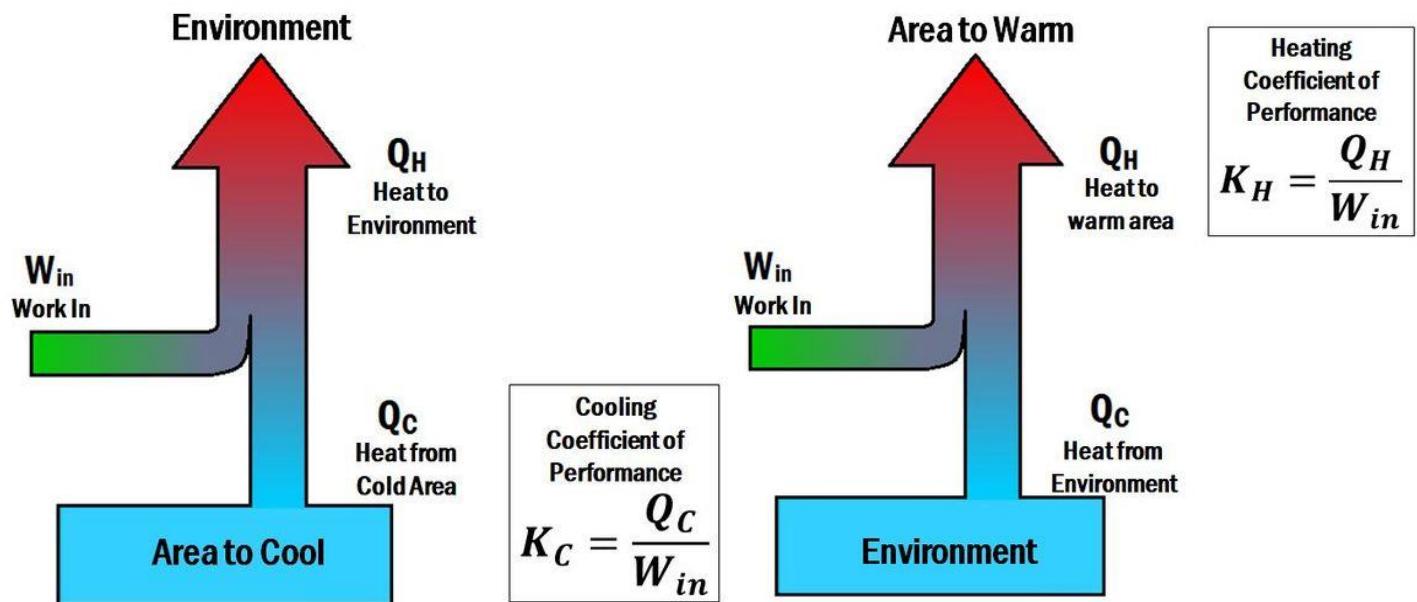




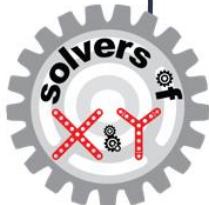
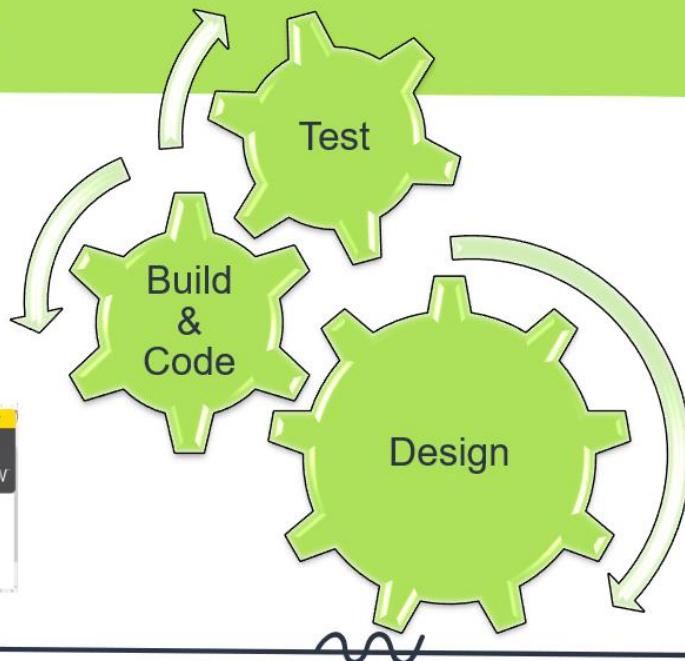
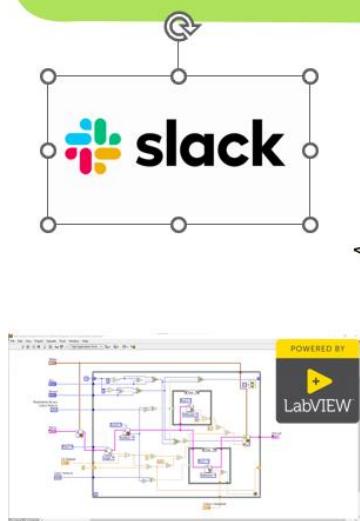
1%
1%

Total GHG Reduction!!!

COP (Coefficient of Performance)



DESIGN PROCESS



SCALED ERROR (LINE DETECTION CORRECTION)

2000 rotation + 2% error



200 rotation
+
2% error

4 << 40!



Chassis

- Compact
- Sturdy

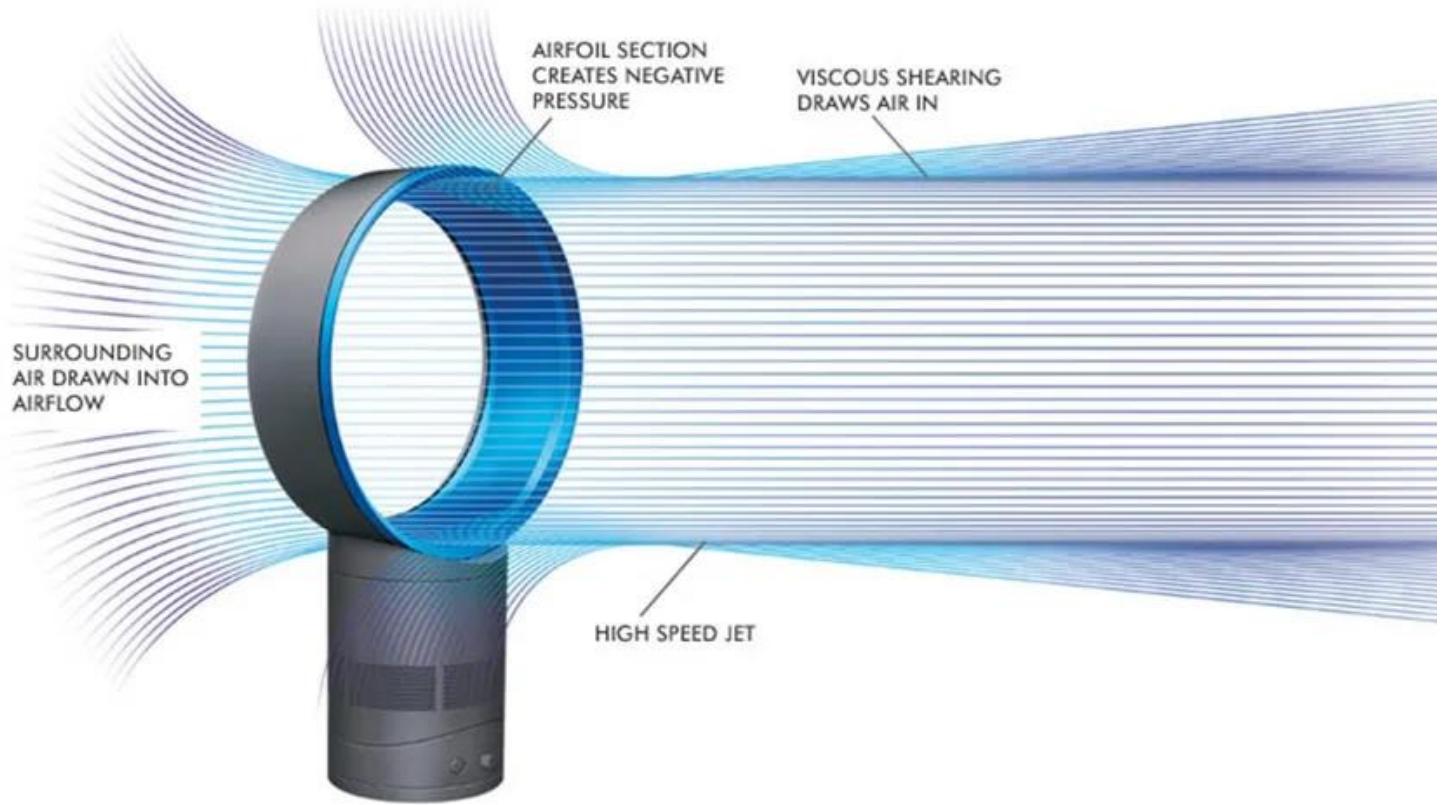
Attachment

- Innovative
- Forklift & dumper
- Passive & active
- Parallelogram
- Multi-tasking

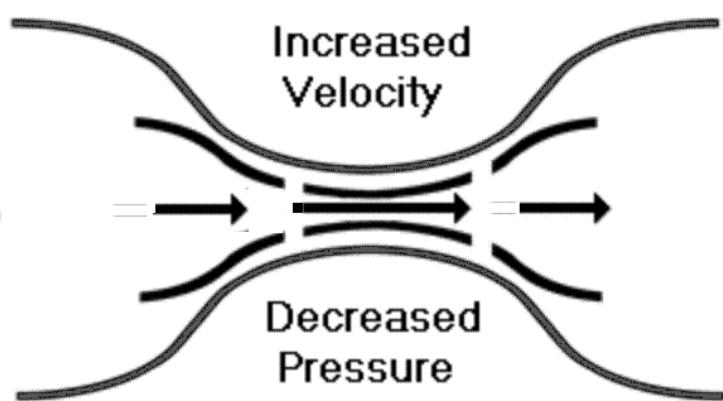
Funnels

- Accuracy

To be continued...

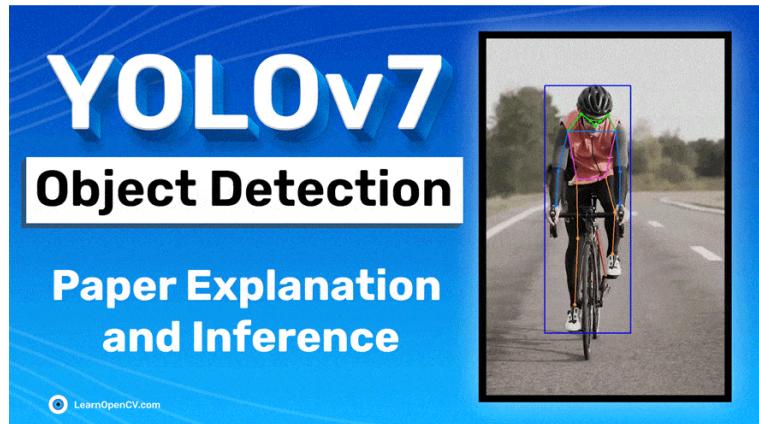
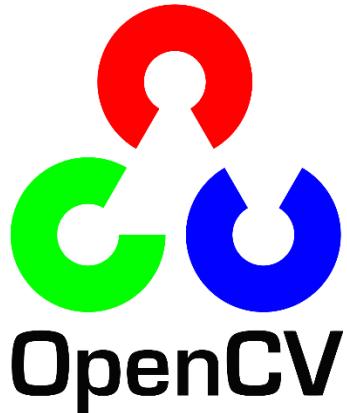


Where physics always helps...



Bernoulli's principle

To be continued...



Partner with



Toronto and Region
Conservation

for The Living City®

Mini Heat Pump Performance



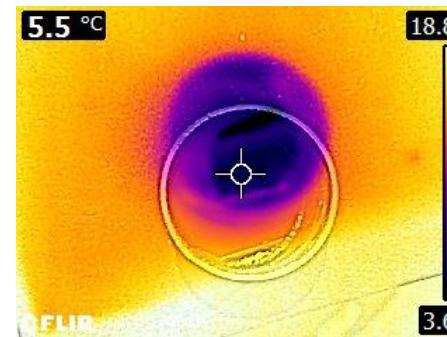
Specifications

- Up to 450 W cooling capacity
- Up to 150 W power usage
- COP 3.0
- Up to 600 W heating capacity
- 12 VDC

Infrared Thermal Imaging



Heating source



Cooling source

* Heating source up to 36 dC from the upper section of the condenser * Cooling source down to 3 dC from the evaporator

First Principle Thinking

QUICK
INSIGHTS

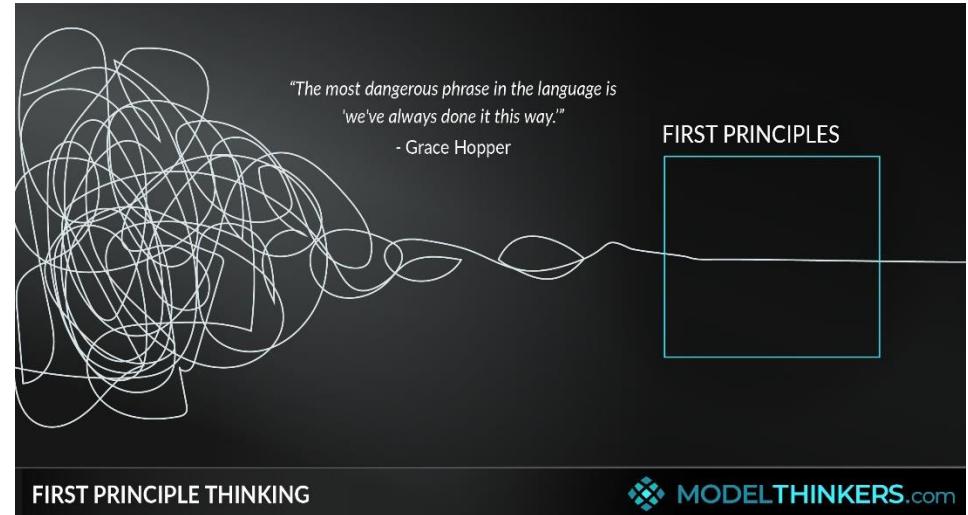
First Principles



"First principles is a physics way of looking at the world. You boil things down to the most fundamental truths and then reason up from there."

(For example) people may say 'battery packs are really expensive and that is the way they will always be'. No, that's pretty dumb. If you apply that reasoning to anything new, you wouldn't ever be able to get to that new thing."

- Elon Musk



Our Fundamental Question

WHAT do we really want to **HEAT** or **COOL** ?



House or Occupant



~120 W Power



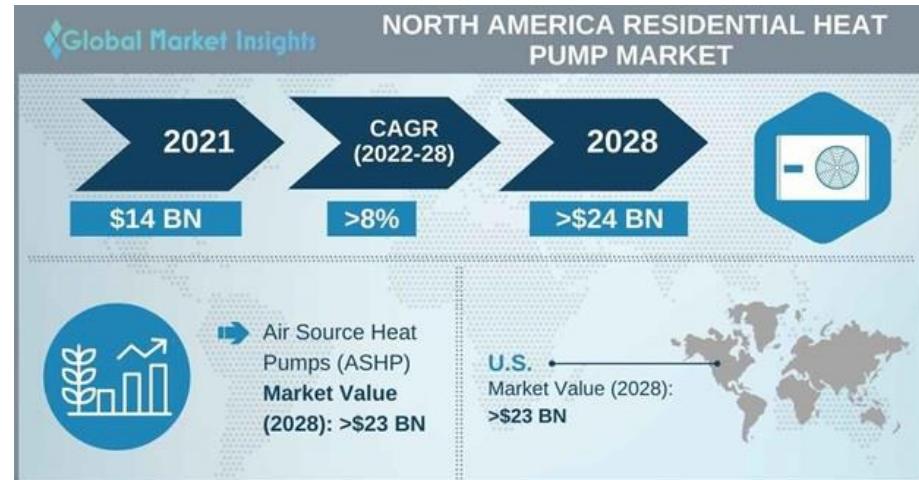
WHY Heat Pump?



TESLA

Do you know?

- Combined heating & cooling in one unit
- High Coefficient of Performance (COP) to 3.0 above
- Using cleaner electricity and reduce GHG emissions
- Solar-assisted Heat Pump market size up to USD 140 billion

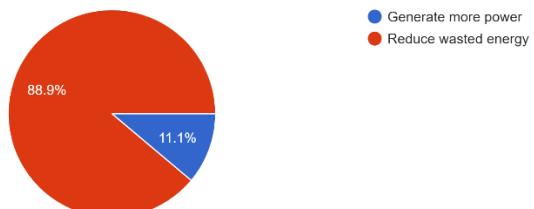


FLL Mat



Survey

3. Which approach do you prefer to address the heating & cooling issues in buildings?
36 responses



Internet

iea
International Energy Agency

Statistics Canada

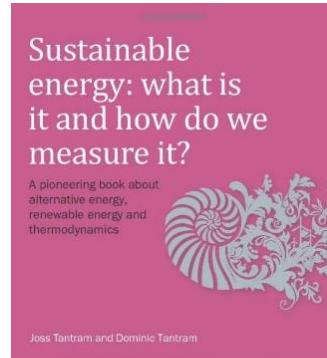
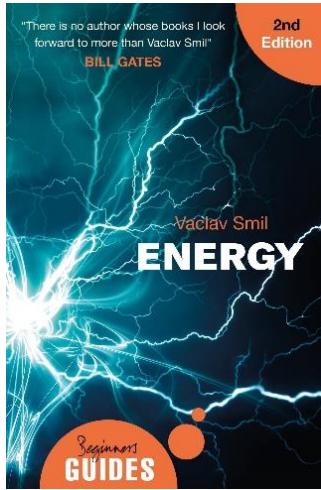


Natural Resources Canada Ressources naturelles Canada
Canada

Canada Energy Regulator Régie de l'énergie du Canada

Toronto and Region Conservation
for The Living City®

Books



Site visit: The Archetype House



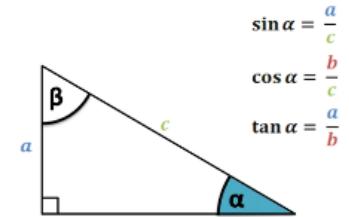
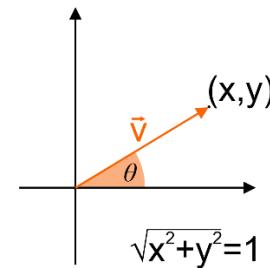
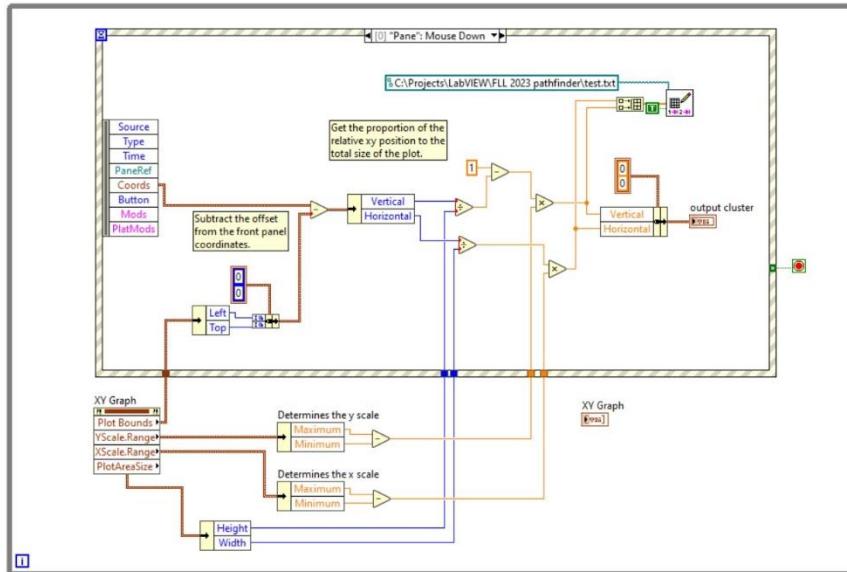
Path Planner

Inspired by

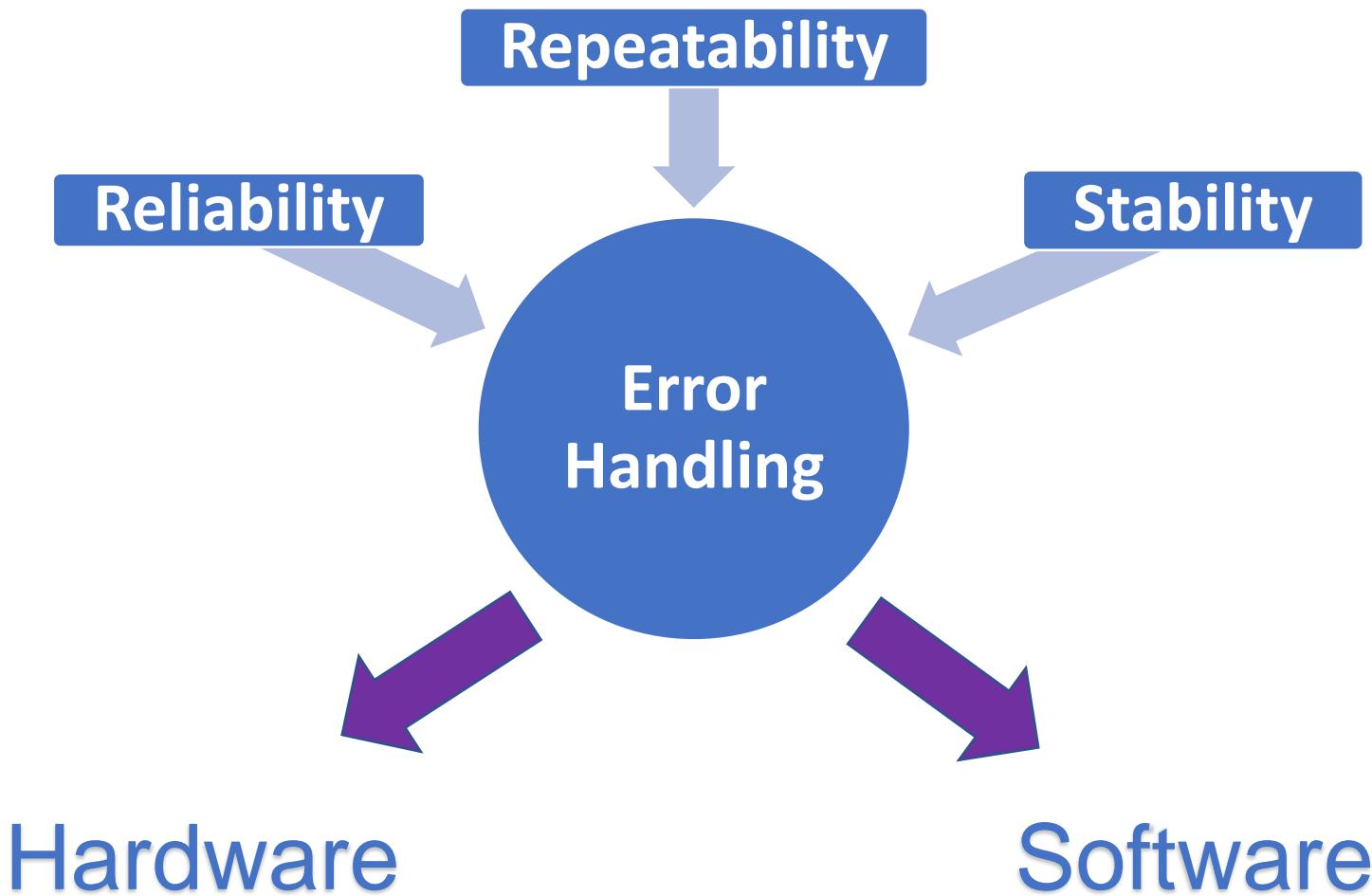
Challenge

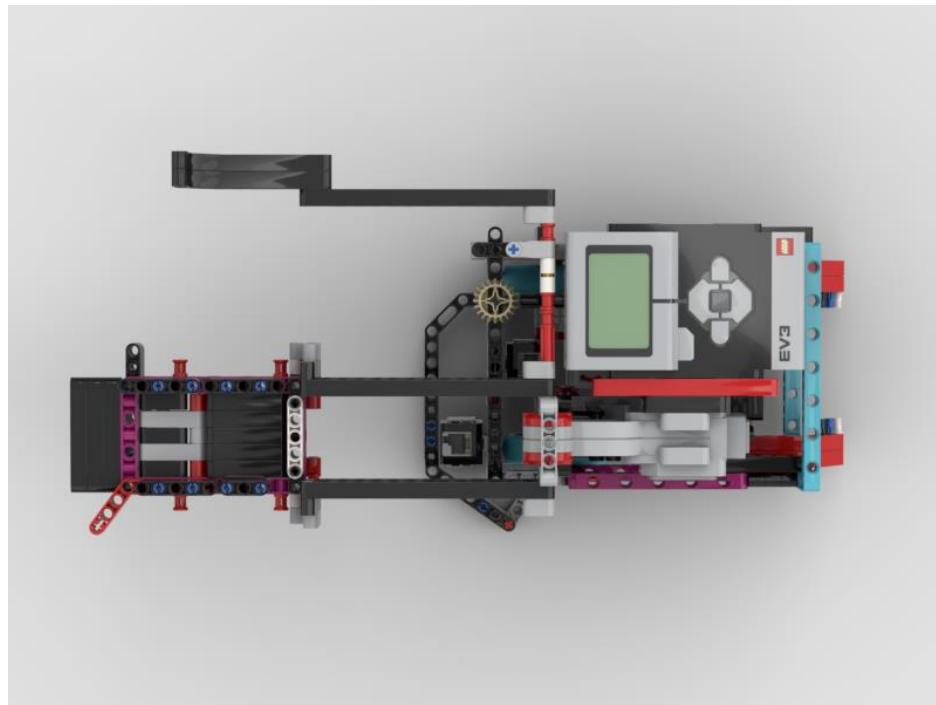
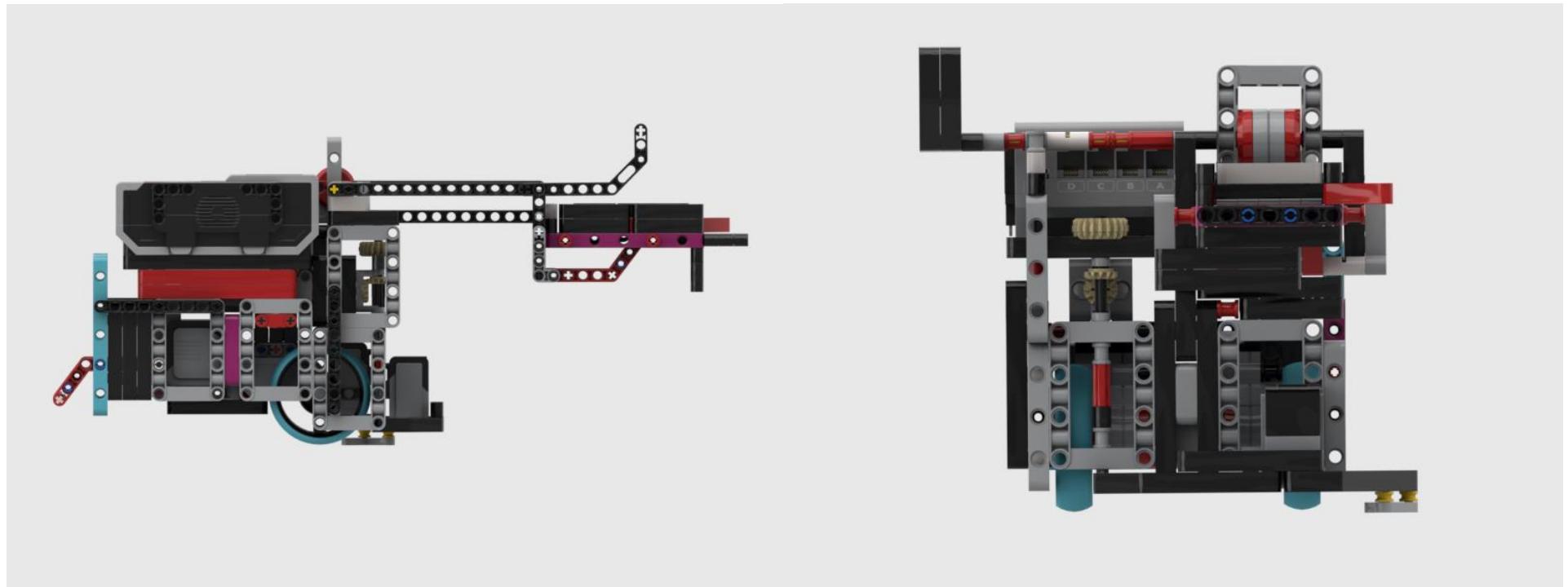
Impact

Fun



Robot Design







PID

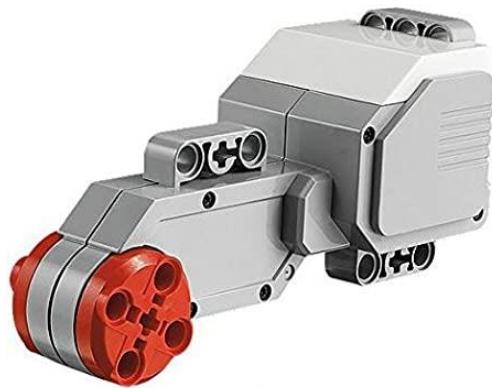


Line
Detection



Advanced
Line
Squaring





+



Stall

Detection

Color Assisted

Gyro-PID

Path Planner