Including Neurodiverse Students in FIRST LEGO League: A Framework for Innovative Approaches

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Neurodivergent kids brought us here!

- Interest-driven, with inconsistent focus.
- Difficulties with:
  - Response inhibition
  - Working Memory
  - Set-shifting
  - Time management
  - Consistent motivation
  - Relationship management
  - Emotional regulation
  - Socialization/Networking
  - Speech/Communication

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How FLL is good for Neurodiverse learners

- Encourages Neurodivergent strengths (Creative problem solving, attention to detail, etc.)
- In FLL, the project allows students to apply what they learn to outside interests, building momentum.
- Regular opportunities to practice communication with peers and mentors from different teams
- Clear goals and objectives in games and challenges provide accessible tasks for ND learners.
  - How to score points and win the Robot Game is easy to understand.
- Excellent opportunities for reflection and self-assessment

How FLL Challenges ND Learners (and it's a good thing!)

- Learning Communication and Consensus Building
- Ability to look at challenges from whichever approach works best
- Repetitive processes for game solving can limit engagement
- Subjective parts are confusing and in some cases a reason for disengagement
- Season length stretches time and project management skills
- Lightly Scaffolded tasks (Engineering Notebook, Project Development) make it hard to teach documentation well
- Experience with failure and persistence
  - Opportunities to practice emotional regulation and restraining impulsive responses

What we Learned about Neurodivergent Students

- Interest-Driven
  - Difficulty changing tasks once focus is established
- Top-Down (What can it do?) vs. Bottom-Up (How does it work?) thinkers
- Slower Development and Work Process
- Prefers clear instructions and task definition
- Needs highly structured work environments and well-scaffolded approaches to project management
- **Engineering Process is hands-on and very kinetic. Documentation is secondary to Discovery.**

Dean Kamen on the Role of Mentors (1998, emphasis added)

"I have to tell you, FIRST is not an educational institution. Its okay if the kids build the whole robot, its okay if they don't touch it. FIRST ought to be to education what the NFL or the World Series is to little league." …

"You are the Michael Jordan that the kids can meet and actually can emulate and get some sense of what's possible, what's really possible for them. *And maybe get attractive enough to get their attention away from that stuff is what we're trying to do." …*

"And this is a long way of saying to you, so if you think that the point of this is another soap box derby and you've got to make sure that the kids did this and that, you're not going to get their attention. ***Again, imagine them having to learn to spend ten years learning to play football without after having seen professionals do it.*** *You're kidding yourselves."…*

Our Definition: The role of a Mentor is to inspire students and scaffold learning opportunities to build excitement, momentum, teamwork, and STEM learning through FIRST's games and challenges.

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Mentoring For Inspiration and Momentum

It's time to build your toolbox with:

- Robot Design Techniques
- Accessible Programming Platforms
- Technical Tools for Challenge Solving
- Support for Specialization
- Practice Design Support
- Documentation Support

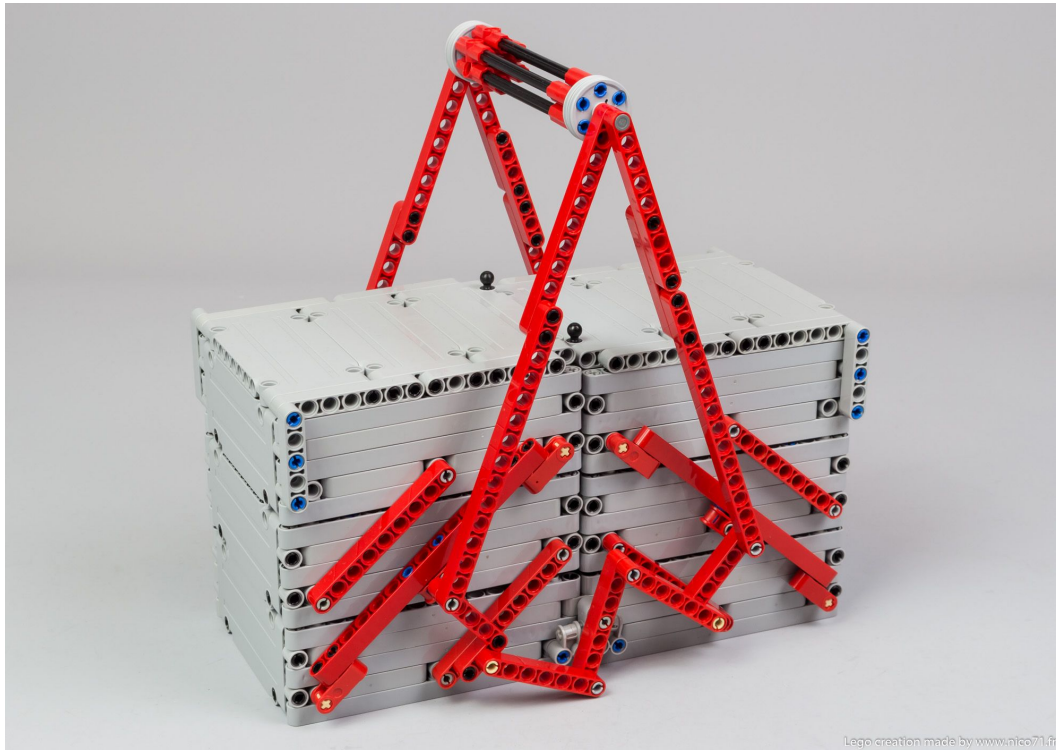

Image: https://www.nico71.fr/simple-toolbox/

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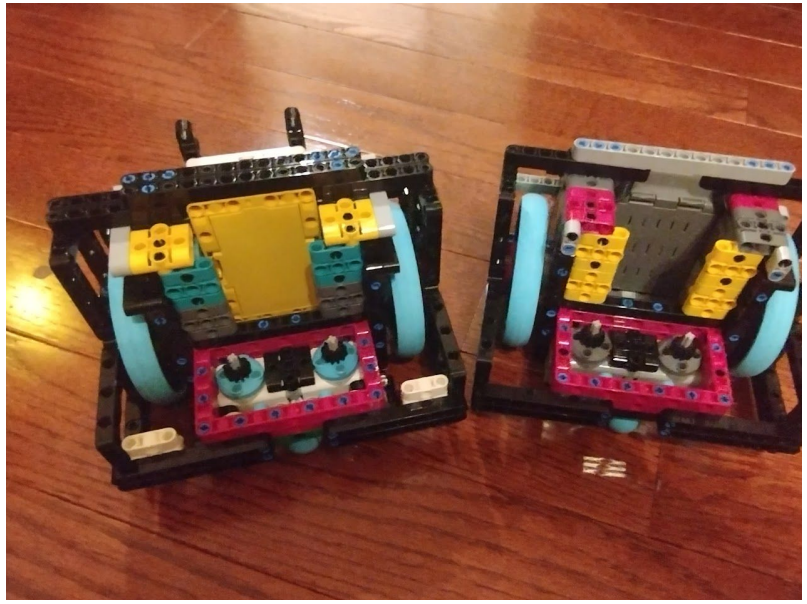
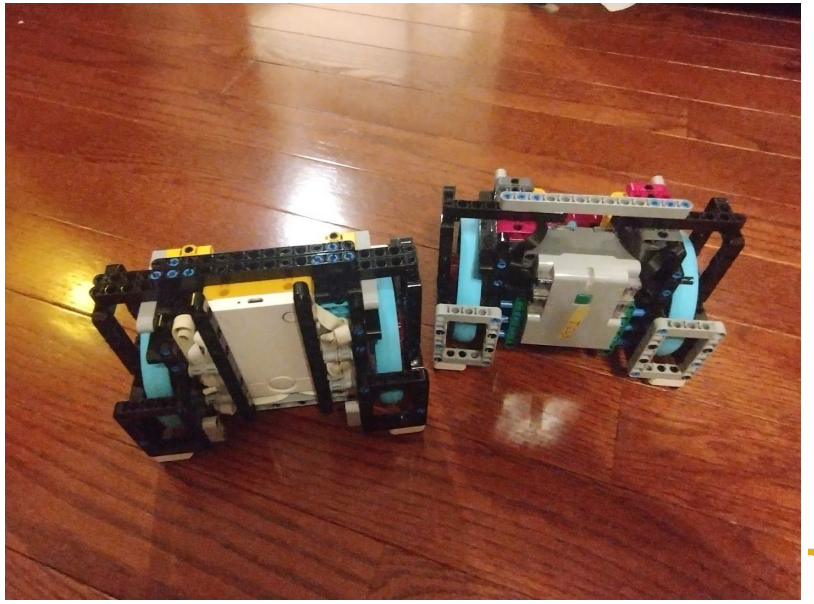
Robot Design Approach

- MockBots
  - Technic Hub-based robots that can mimic the functions of SPIKE Prime hubs.
  - Inexpensive to build and deploy
  - Allows students to experiment at home with robot and attachment design
  - Maintains momentum when students are focused on robot design and performance, but practice time is limited.





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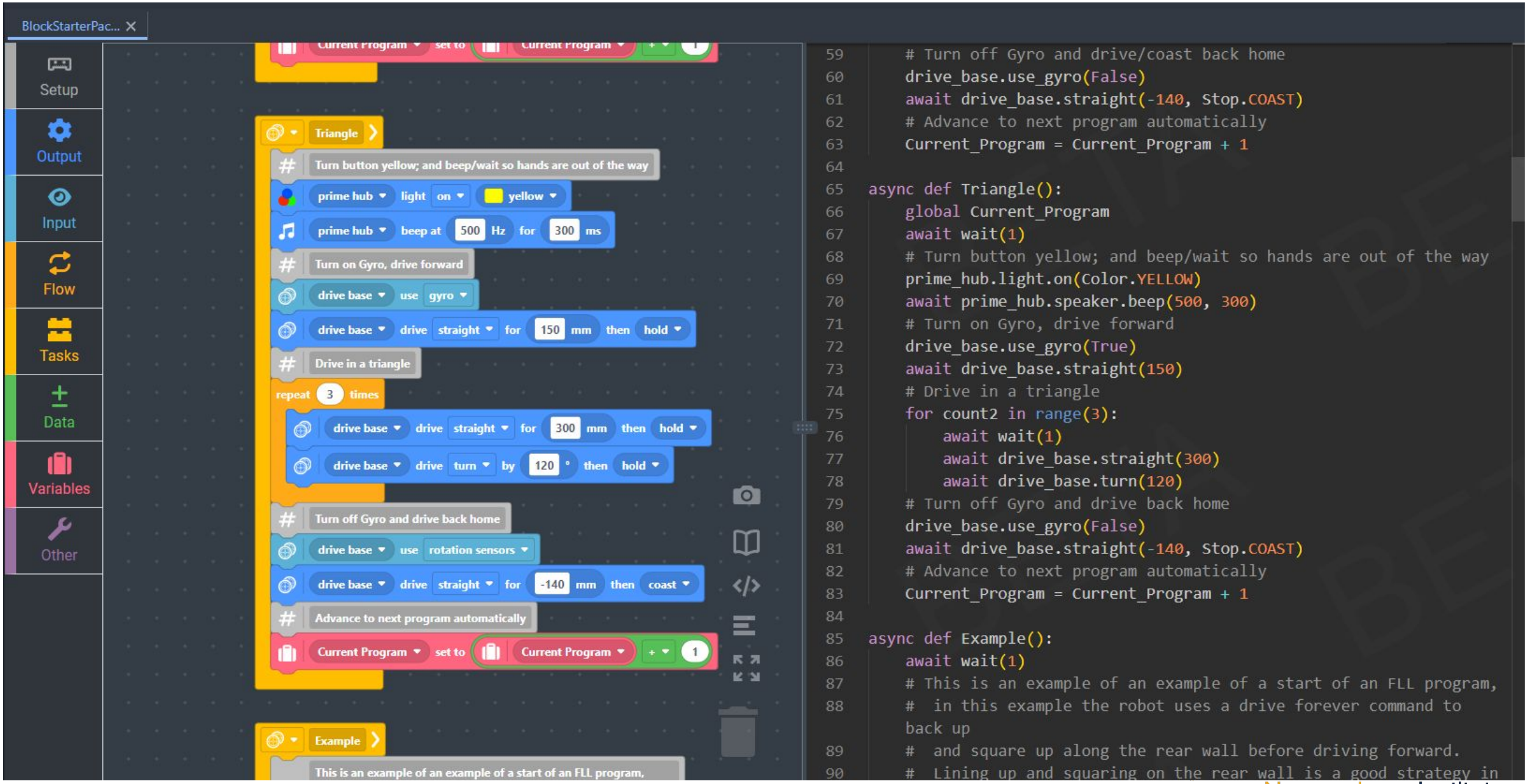
Universally Adaptive Coding

- Pybricks
  - Interface shows block-based and text-based coding side by side
- Why use both?
  - Block coding is not colorblind-friendly, and is hard for some students to read
  - Block coding lays foundation for text-based coding that students can see in real time.



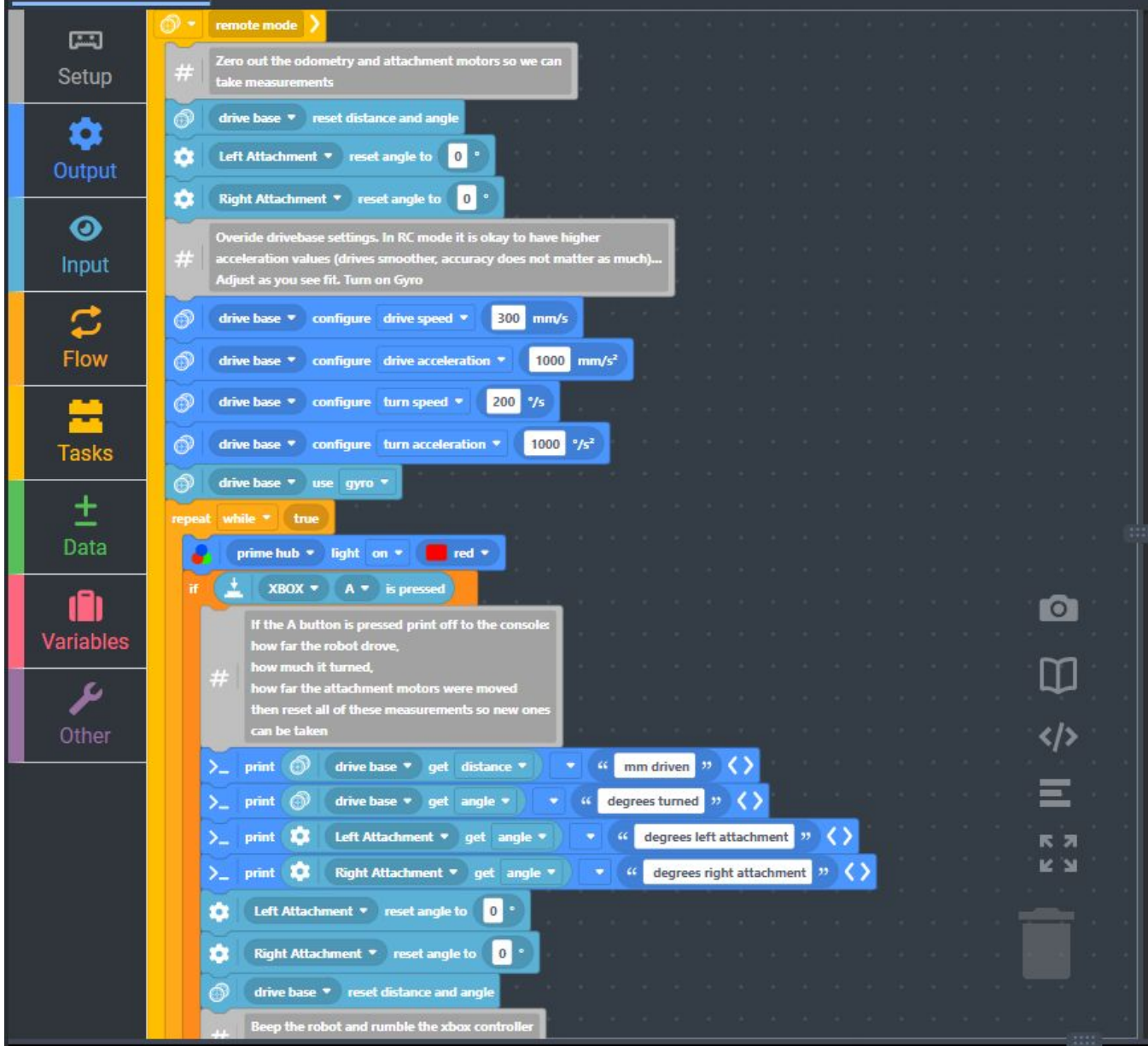

```
    # Turn off Gyro and drive/coast back home
    drive_base.use_gyro(False)
    await drive_base.straight(-140, Stop.COAST)
    # Advance to next program automatically
    Current_Program = Current_Program + 1

async def Triangle():
    global Current_Program
    await wait(1)
    # Turn button yellow; and beep/wait so hands are out of the way
    prime_hub.light.on(Color.YELLOW)
    await prime_hub.speaker.beep(500, 300)
    # Turn on Gyro, drive forward
    drive_base.use_gyro(True)
    await drive_base.straight(150)
    # Drive in a triangle
    for count2 in range(3):
        await wait(1)
        await drive_base.straight(300)
        await drive_base.turn(120)
    # Turn off Gyro and drive back home
    drive_base.use_gyro(False)
    await drive_base.straight(-140, Stop.COAST)
    # Advance to next program automatically
    Current_Program = Current_Program + 1

async def Example():
    await wait(1)
    # This is an example of an example of a start of an FLL program,
    #  in this example the robot uses a drive forever command to
    back up
    #  and square up along the rear wall before driving forward.
    #  Lining up and squaring on the rear wall is a good strategy in
```

Technical Tools for Challenge Solving

- Remote Control mode for MockBots and SpikeBots.
  - can remove the remote code before competition
- Remote Measuring tools in code
- Calculators and Other Resources
  - Sariel's Wheels and gear calculators
- Mockups of Mission Models for kids to work with offsite.




```
118     drive_base.settings(turn_acceleration=1000)
119     drive_base.use_gyro(True)
120     while True:
121         await wait(1)
122         prime_hub.light.on(Color.RED)
123         if Button.A in XBOX.buttons.pressed():
124             # If the A button is pressed print off to the console:
125             # how far the robot drove,
126             # how much it turned,
127             # how far the attachment motors were moved
128             # then reset all of these measurements so new ones
129             # can be taken
130             print(drive_base.distance(), ' mm driven')
131             print(drive_base.angle(), ' degrees turned')
132             print(Left_Attachment.angle(), ' degrees left
                attachment')
133             print(Right_Attachment.angle(), ' degrees right
                attachment')
134             Left_Attachment.reset_angle(0)
135             Right_Attachment.reset_angle(0)
136             drive_base.reset()
137             # Beep the robot and rumble the xbox controller
138             #  to let it known that a measurement was taken
139             await multitask(prime_hub.speaker.beep(500, 400), XBOX.
                rumble(50, 400))
140         elif Button.X in XBOX.buttons.pressed():
141             # X exits RC mode and allows a new program to be selected
142             # Reset drivebase back to where it was
143             drive_base.settings(straight_speed=Straight_Speed)
144             drive_base.settings
                (straight_acceleration=Straight_Acceleration)
145             drive_base.settings(turn_rate=Turn_Speed)
```

```
127  mm driven
29  degrees turned
726  degrees left attachment
349  degrees right attachment
```

Sariel's Tools for AFOLs

Tool	Description	Mobile app	Address
Gear Ratio Calculator	Calculates final ratio of multiple pairs of gears, shows theoretical output for selected motor and lists available gears combinations for a given spacing.	GET IT ON Google Play	gears.sariel.pl
Pulley Ratio Calculator	Calculates final ratio of multiple pairs of pulleys.	N/A	pulleys.sariel.pl
Model Scaler	Allows to calculate dimensions of your model from a blueprint of the original object.	N/A	scaler.sariel.pl
MOC Manager	Allows creating and sorting a detailed list of your projects.	N/A	mocs.sariel.pl
Unit Converter	Converts between multiple units, including studs, milimeters, inches, bricks, stacked plates and track links.	GET IT ON Google Play	studs.sariel.pl
Angles Chart	Lists angles that can be achieved using single LEGO pieces, includes Bricklink links for the pieces.	N/A	angles.sariel.pl
Wheels Chart	Lists LEGO wheels with their dimensions, weights, subparts, available rim/tire combinations and Bricklink links.	GET IT ON Google Play	wheels.sariel.pl
Monorail Network Planner	Drag & drop tool for designing Monorail track layouts.	N/A	monorail.sariel.pl
Town Parcel Planner	Drag & drop tool for designing town parcels layouts.	N/A	town.sariel.pl
Bricksafe Thumbnail Helper	Generates easy-to-use BBCode to include in your post to create a thumbnail gallery from a selected Bricksafe page. You can choose from several thumbnail and image sizes.	N/A	bs.sariel.pl
Brickshelf Thumbnail Helper	Generates easy-to-use BBCode to include in your post to create a thumbnail gallery from a selected Brickshelf page.	N/A	thumbs.sariel.pl
Brickshelf Stats	A statistics tool for your Brickshelf gallery.	N/A	stats.sariel.pl

Structure and Scaffolding

- Time
  - Let students know what you will work on ahead of time
    - Highly structured/planned workflow
    - Subject to change, but a visual cue for what needs done when
  - Time checks/advance notice for changing tasks
    - 10, 5, 2-minute warnings
    - Time Timers
  - Harder work first
    - Front load the tasks that are the most difficult as much as possible
- Stuff (Resources in the Works)
  - Worksheets for Robot Design
  - Worksheets for Mission Model Solutions
  - Project Design/Management Scaffolding

How FIRST's Teams, Students and Mentors Can Include ND Students

- Quiet Rooms with Streams of Event
- Earplugs and other Assistive Devices
- Space for Specialization in FLL
- Documentation Challenges
  - Some curricular scaffolding available, but not specific to the task or easy to specifically apply to the Project.
  - Clarified expectations for Engineering Notebook and Robot Design Criteria
  - Recognition that engineering process isn't perfectly linear or circular
  - Support for ND students converting a workflow into a story

Resources To Start:

- Monongahela Cryptid Cooperative GitHub
  - Pybricks Starter Pack
  - Pybricks Remote Code
  - Block Code Pybricks Starter Pack
  - Coming Soon: Design & Project Worksheets
- Open Source LEGO Design Libraries
  - Prime Lessons
  - BrickLink
  - FLLTutorial
  - Sariel's Tools (http://tools.sariel.pl)
- Books
  - Jessica McCabe, *How to ADHD* (Book and YouTube Channel)
  - Sharpe & Strosnider, *Everyday Executive Functioning Strategies*

Questions & Thanks

- Mountaineer Area RoboticS #2614
- Garrett Coalition #1629
- Pybricks
- Neurodivergent of FIRST

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MCC GitHub

"As Einstein said, imagination is more important than knowledge. The kids have the imagination to come up with a neat way to solve the problem, but they don't have the knowledge that can take the engineering tools and turn this great imagination into reality. That's where the mentors come in. ***The kids have the enthusiasm to try some big ideas and the mentors have some way to implement it.*** *" - Dean Kamen*

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