# BASE SOLUTIONS FOR TOSSR

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**SUMMARY**
Description and explanation of the design choices made during the creation process of the TOSSR's base and driving system. We go in-depth on what and why we chose for driving and support systems for our machine as well as the little details that make TOSSR the TOSSR.

# 1. INTRODUCTION

In the process of designing and manufacturing the TOSSR (the Terrain Overseeing and Selectively Sorting Robot) we had to make everything from the ground up using as many LEGO NXT components as possible. In this article, we are going to present our choices for every element located in the bottom part of our bot.

# 2. DESIGN PROCESS

The first design choice we had to make was selecting the right drivetrain. Most popular, commercially used solutions for driving all sorts of motorized vehicles include wheels (either front-, rear-, or all wheel drive), tracks (most often with separate motors for each side) and various jets (i.e. waterjet or air jet). We have settled on four rubber tracks (two per side) with a single NXT motor to drive each side. The tracks we have build[1] have an angle of attack of about 20° which was forced on us by the available tracks and bricks. This solution, however, combined with a bumper-like casing for each track allowed us to make the robot approach even a 60° incline  and continuously climb a 45° incline. Using one motor for each side allowed us to achieve a turn radius nearing zero, because if we drive one motor forward and the other backwards, the robot rotates almost in place. One of the most important and impactful choices we made was connecting the tracks rigidly in the back of our base, but leaving the front pair swiveling on a hinge-like joint. This elasticity has allowed the robot to overcome steep obstacles (aforementioned 60°) without tipping over.

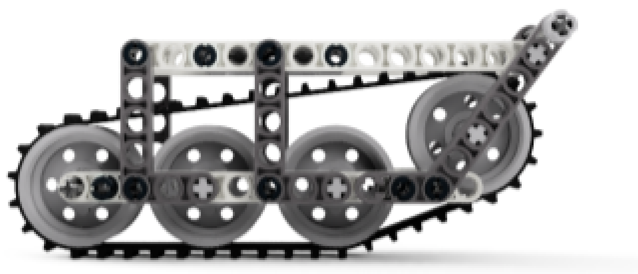
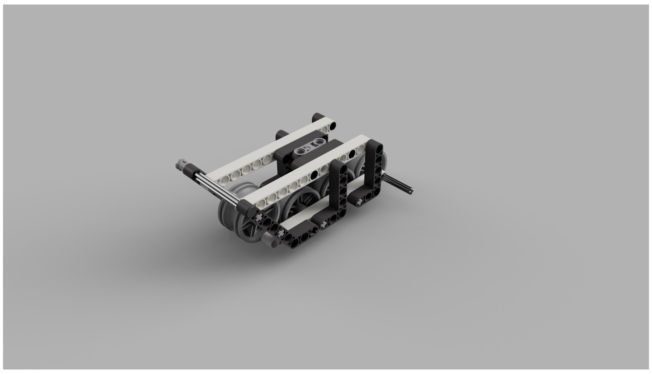


fig. 1&2: front right track



Another factor important for the balance is the placement of NXT control bricks. We had to use two of them in order to fully control the robot. One is responsible for receiving the input from the controller and powering the motors, and the second one, set as a slave, operates the arm and sorting mechanisms. Placing them just above the track joints adds to the rigidity of the construction and ensures that the center of mass is placed in the rear, again, allowing our robot to overtake steep obstacles and get on sharp inclines. The mass is spread evenly because of the symmetricality of our construction - except for the collector cup and its mechanism, everything is perfectly symmetrical.

Speaking of the marble collector - the Noodle Bowl - it also plays an important role in providing rigidity. Although the cup itself is attached only to the motor, the mount for this motor is a rigid platform with no gaps. Thanks to the added stiffness, our base passed the bend test with no problem. It also has facilitated designing the supports, because we could not have asked for a better bottom connector than a rigid panel of bricks.

The other joint point between the tracks is the Upper Bridge. It serves not only as a stabilizer to keep the track modules parallel, but also is a host to the NXT bricks. In our rigidity testing, it was enough to keep the construction stable. The choice of using the NXT bricks allowed us to achieve full wireless between the robot and its operator - we do not need any wires to either power the machine or carry the control signal.

## 3. TESTING

fig. 3: incline test using our legs

Our first tests consisted of a bump track build of books, flip-flops, and our legs. Thanks to that test we came up with an idea not to connect front tracks of our base to maximise the flexibility of our robot.

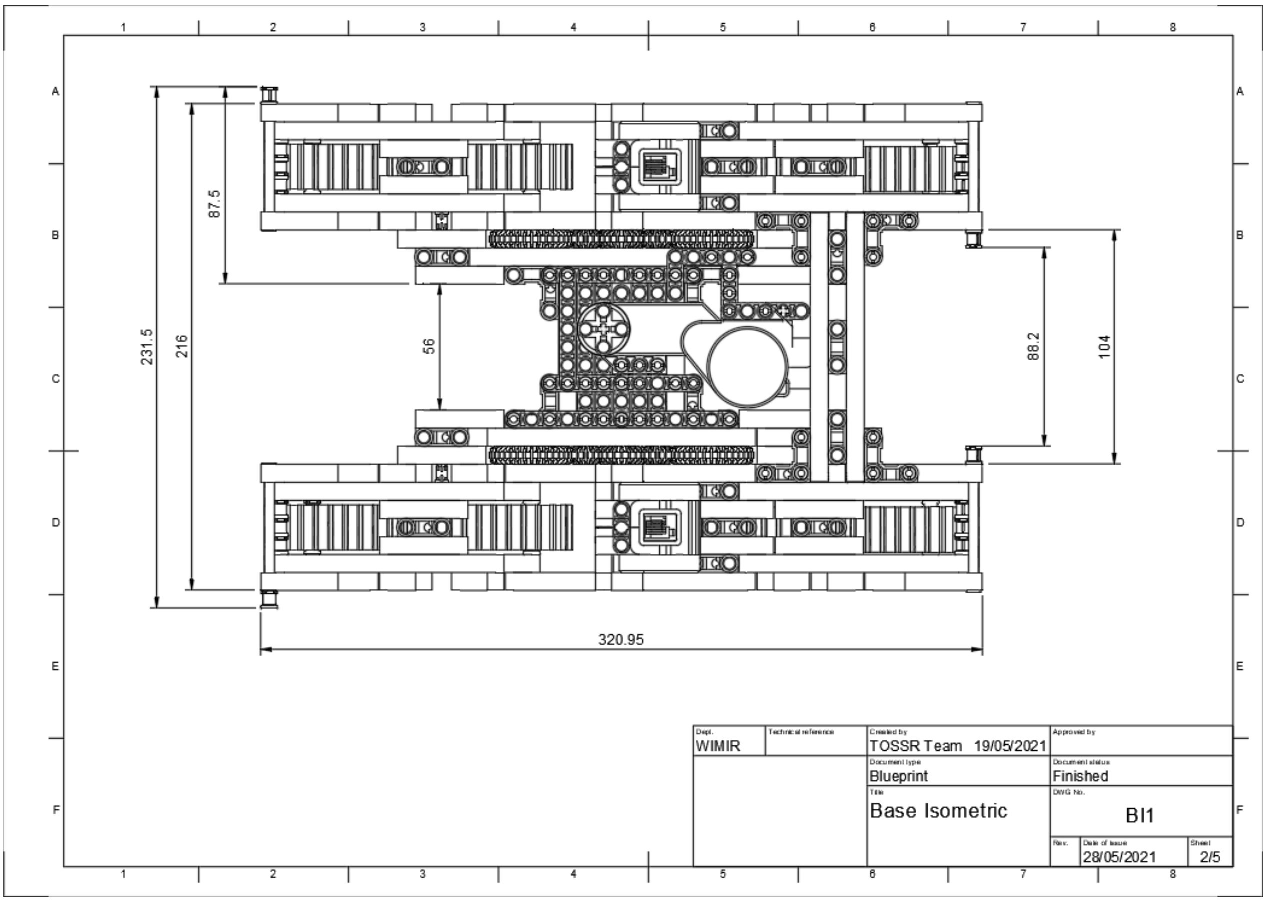
Further testing depended on checking how the base is working with the arm (stability, spread of mass and whether the power of our motors is enough to handle the arm).

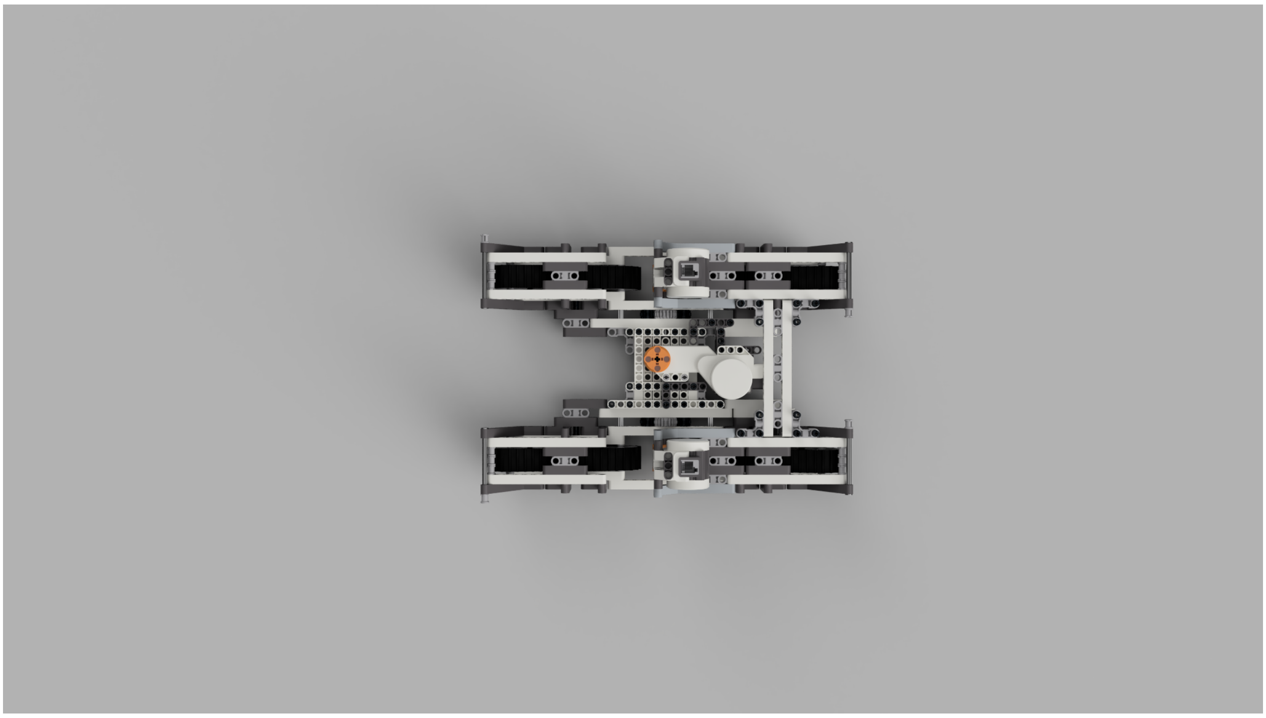
Next experiments tested our newly programmed ‘Noodle Bowl’ that stores our collected balls based on their color and rotates correctly.

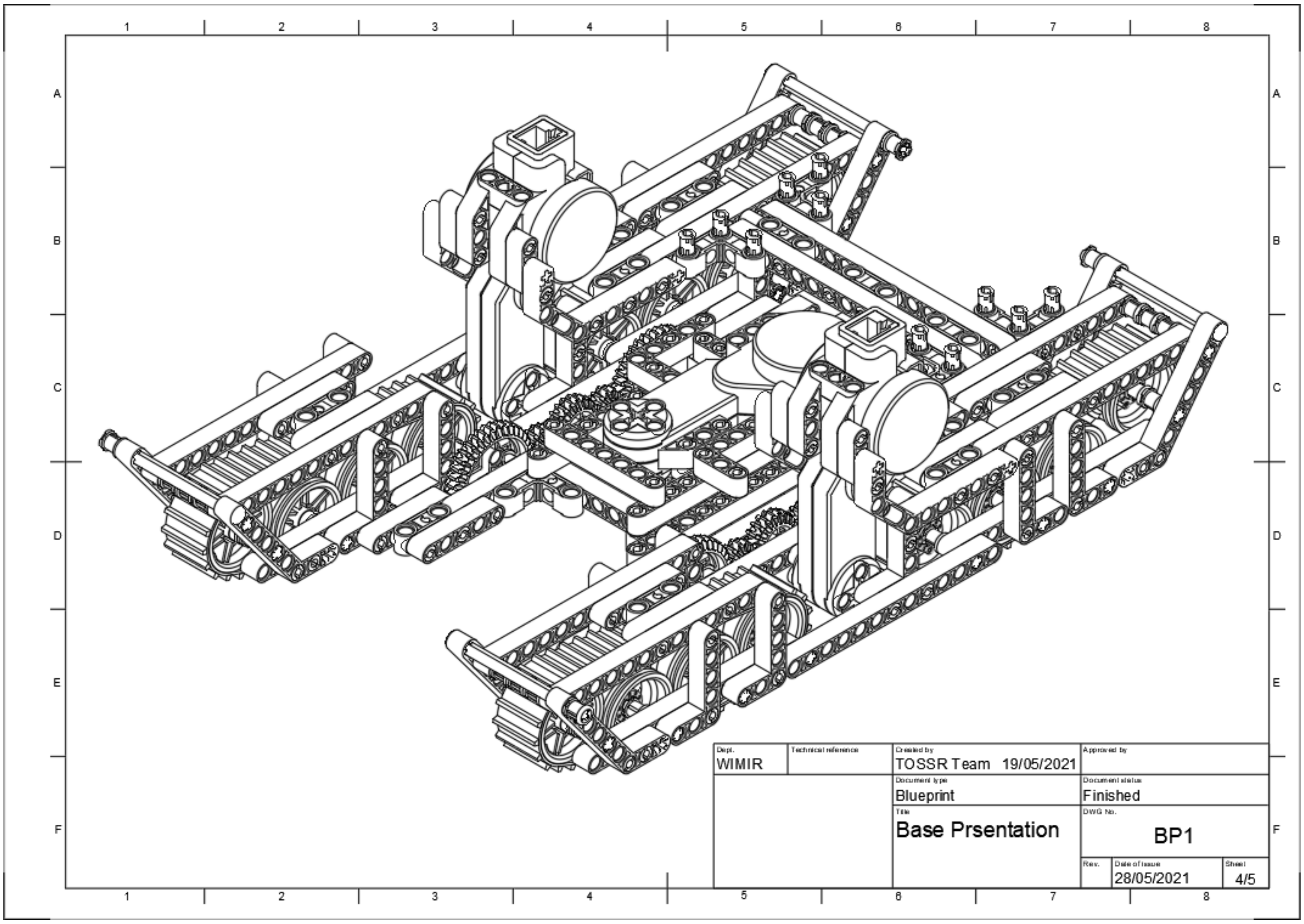
We did a gear ratio test and chose the optimal of 5:9. Thanks to this we can power each pair of tracks with just one motor without losing on speed and torque. In the current configuration the robot can stay still on an incline with both motors set to idle.

Last test was to check if everything works simultaneously. For that, we assembled the robot and checked whether each of its parts works alone, then tested it with the final software. It has succeeded in riding up a slope we made from a big board which we were continuously raising.

# 4. MEASUREMENTS, CAD MODELS AND RENDERS

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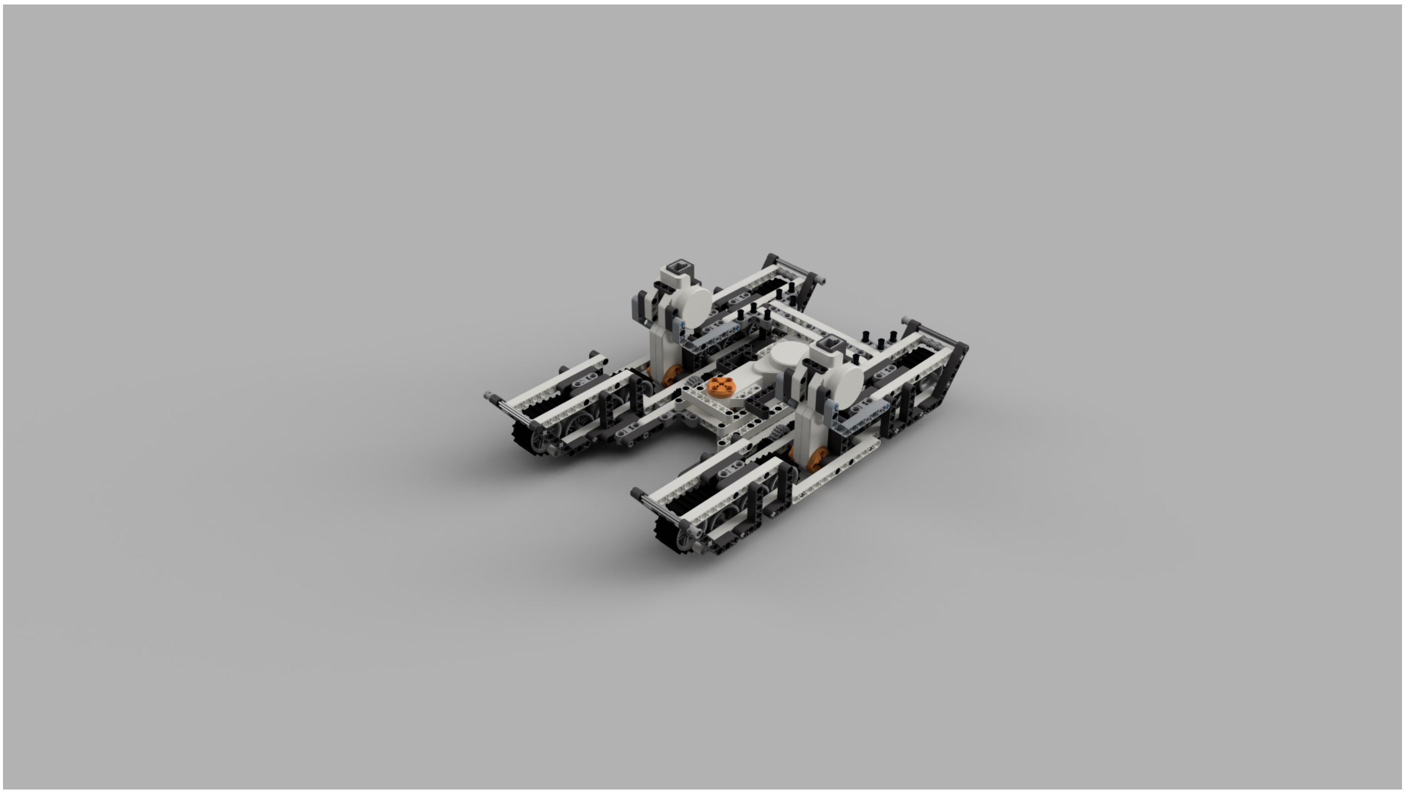

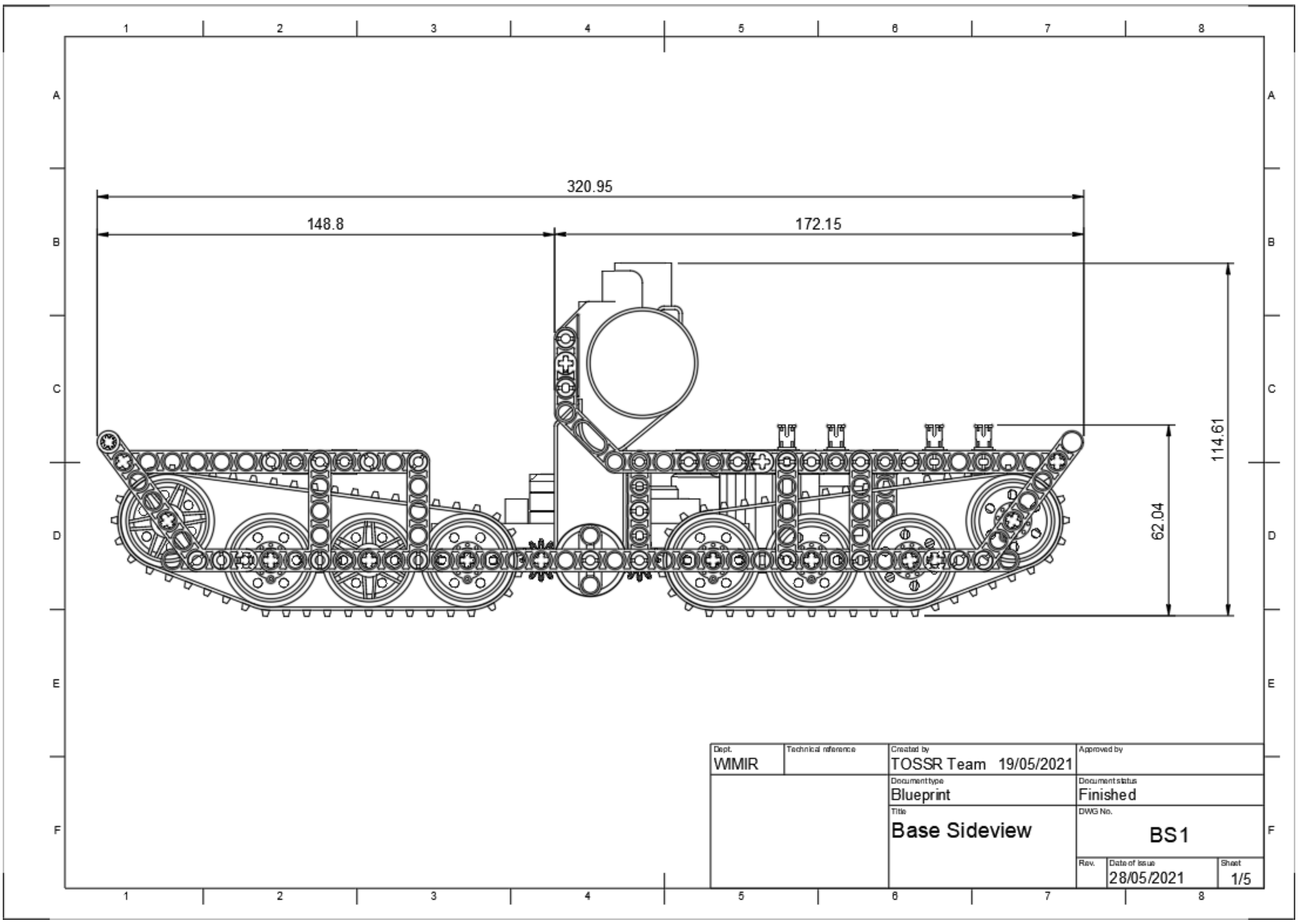
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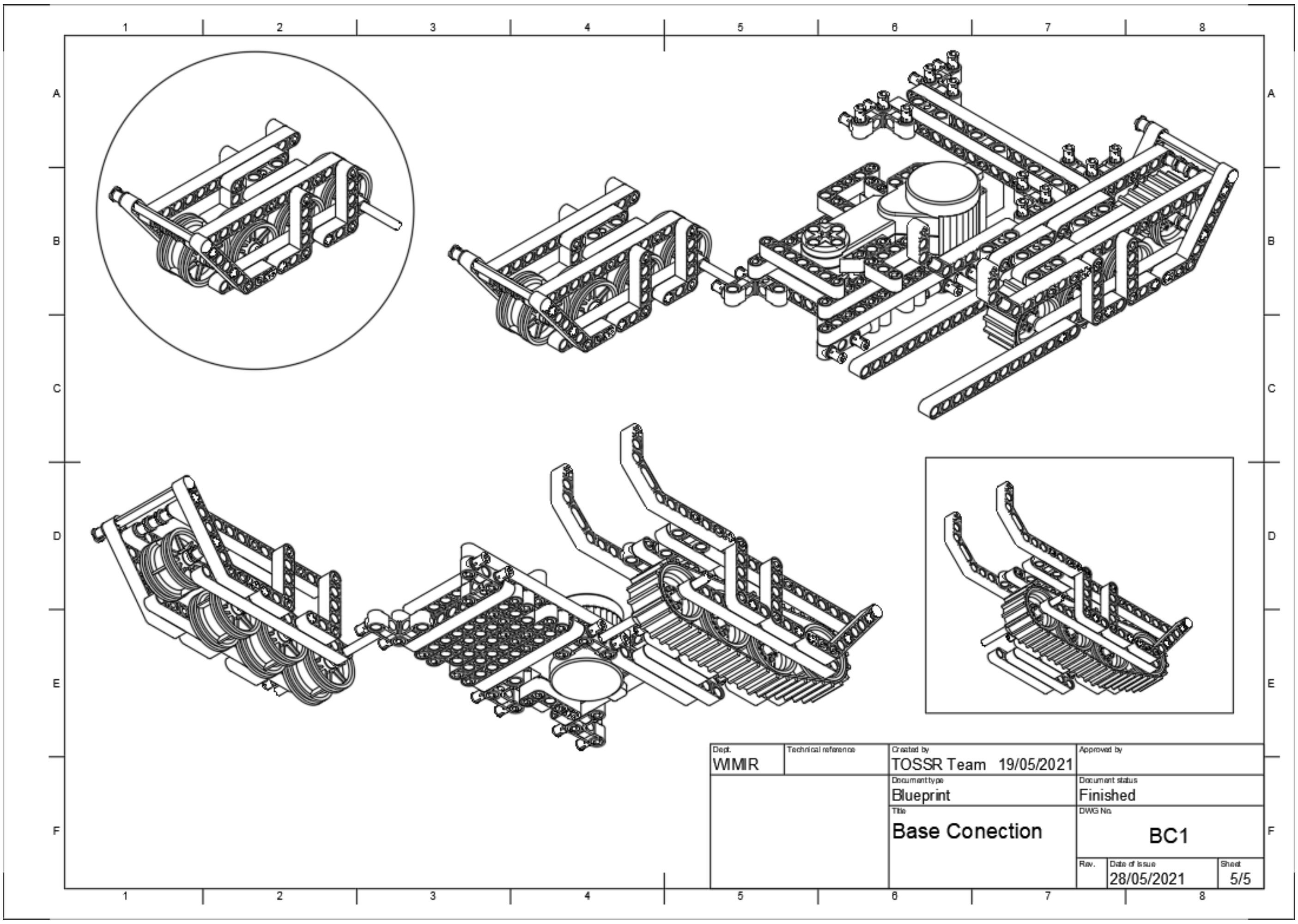
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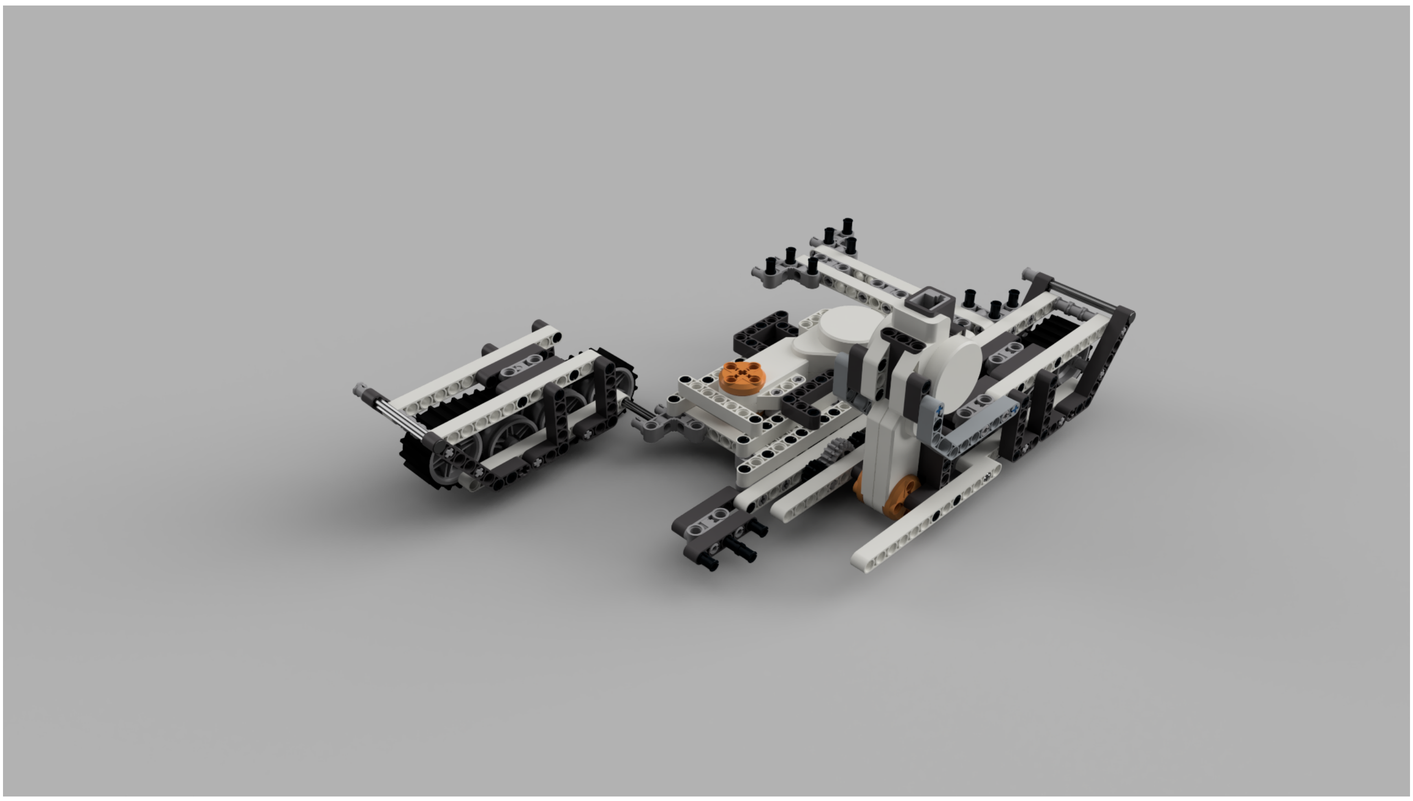

## 5. CONCLUSION

By choosing the correct solutions and LEGO parts, we achieved a base that was rigid enough to support the entire construction while still being able to drive with a reasonably good speed. Assuring the front tracks move freely allowed the robot to overtake obstacles that most LEGO robots would have failed at. The only non-LEGO components are the Noodle Cup and Fork Grabber, because their purpose and shape requirements did not allow us to build them using bricks.