

# Mechanical Design Improvement for the Botball 2016 Kit

Regular paper

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**Abstract:** Having a 4 way axle and a Cross Joint hub in the Botball kit allows team designers to successfully achieve their desired mechanical structures, the botball kit however doesn't provide either of them but gives the builder a straight axle that is very difficult to work with.

**Keywords:** 4 Way Axle, Cross Joint, Mechanical design, 3D CAD. [1]

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## 1. Introduction

Botball as an educational robotics program that depends on competition needs constructors to come up with distinguished designs that allow teams to achieve the maximum points possible. To do so, teams need very stable and efficient designs that allow them to finish their tasks as quickly as possible with the least possible errors. The Botball Kit can sometimes be a very crucial factor that makes teams give up on their designs when they can't find the most proper lego piece to use, enabling them to fix whatever they want firmly and tightly (which enables the robot to stay intact during performance without the risk of it falling apart at any moment during the game). To develop an ideal lego kit with more unique pieces that enhance the process of construction was a real challenge for our team members. In order to work on that issue, we called for a meeting and started to think of answers

for some questions that will help us; Is it a question of construction, constructors, lego kit or a blend of all? Can this problem be fixed? How can we make the Botball kit more user friendly?

Over 9 years of participation in different robotics competitions held in different countries under the supervision of different organizations, we were able to collect a large number of lego pieces that we wished were included in the Botball kit to make our robots more practical and efficient. We believe that some of these parts will help us design better robots and will save countless hours of real hard work and thinking.

## 2. Design Proposals:

### 2.1 Four way axle:

Using a 4 way axle is a practical way to link lego pieces together. It gives stability to the design and ease in change and modification. The 4 way axle can help constructors build designs that use netlike structures, box-shaped structures, rotators and propellers. The 4 way axle can also be used as a complementary piece that can help join metal pieces to the lego pieces.

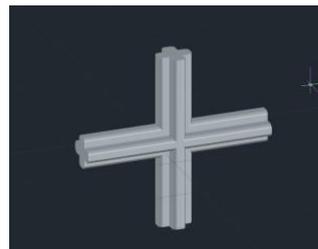


Figure 1. Front view

The 4 way axle saves the builder time wasted in thinking of a way to link three or four lego pieces together in a perfect 90 degree angle. The 4 way axle gives the builder freedom to manage the pieces the way he wants, whether it is used for making a base for a smallbot or a platform for an effector. The piece may also be modified to have a 6 way linkage that gives the builder more flexibility in his design.



Figure 2. Side view

The 4 way axle also helps with the building of complex, multi-sided, multi-leveled shapes that teams may encounter during their builds. The complex shapes allow for a more unique degree of freedom in movement that is not found in simple shapes [2]. The complex shapes need a strong axle piece to join the structure. This piece allows the builder to achieve the stability in his complex design.

### 2.1.1 Testing the 4 way axle:

The 4 way axle increases the accuracy of the robot greatly. It has been tested in various designs. Data has been taken from these tests and is shown in the figure below:

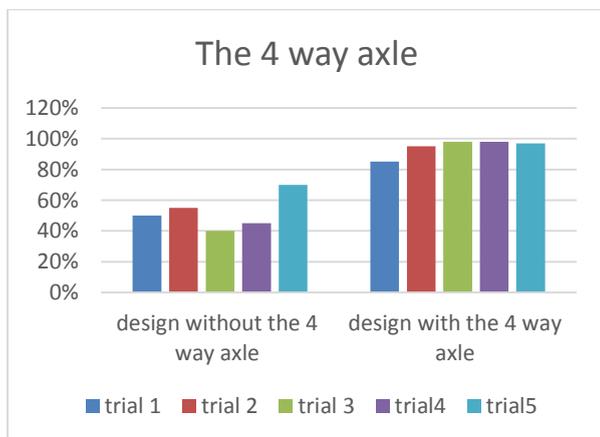


Figure 5. Accuracy test

As seen in the table, the 4 way axle gives the robot stability and accuracy, this allows the robot to complete its task efficiently.

## 2.2 Cross joint:

The cross joint is two beams merged together. It can be pieces of 5, 7 or 9 holes. The cross joint was an idea that one of our team members came up with while he was trying to build a stable base for one of our robots.



Figure 3. Slant view

Cross joints are known for the strength and stability they add to any design, as the builder can add them to almost any part of his robot to give it that small strength boost so that it doesn't break midway through the task. The cross joint can be used in many situations, whether it be joining the base of a robot together or making a claw, it allows the builder to have a significant amount of flexibility in his build.

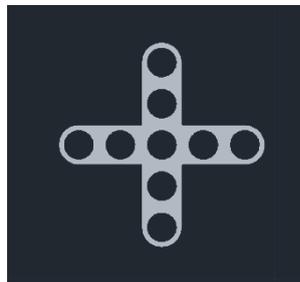


Figure 4. Top view

The cross joint may seem very simple, however it must be one of the most effective and needed for botball. Because it is a four way joint, building symmetrical figures will never be a problem for any team. Symmetry is an essential factor in robot building, one slight deficiency in the robot's design can lead to a catastrophic error ending in the failing of the task, which is every team's nightmare.

### 2.2.1 Testing the cross joint:

The cross joint was part of an extra robot made for this year's competition. The cross joint was tested and data was collected from the trials, results are shown below:

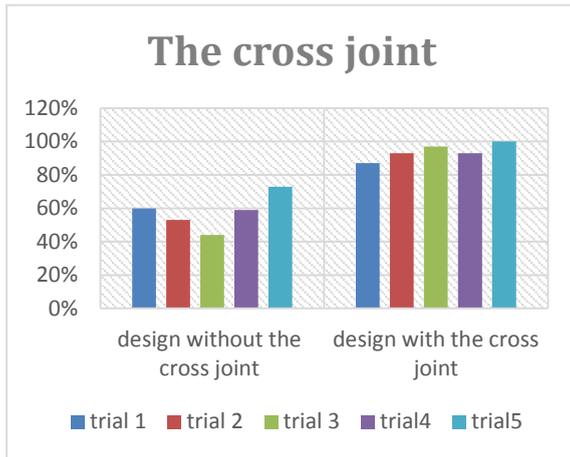


Figure 6. Accuracy test

The results shown on the graph above indicate the difference in efficiency between a robot that uses a cross joint and another one without a cross joint.

### 2.3 Implementation:

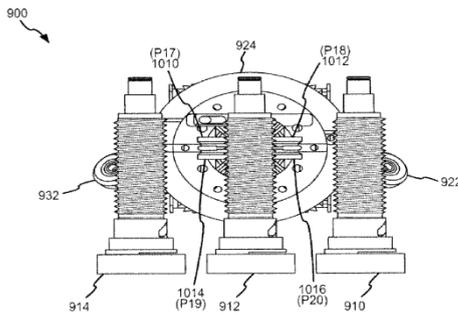


Figure 7. Robotic joint

In the figure above is part of a robotic joint [3], it uses the 4 way axle to achieve maximum efficiency and accuracy. Without the 4 way axle, the robot joint could never be completed.

### 3. Conclusion:

After using these pieces ourselves and testing them out in various situations, we realized how important they are for botball constructors. The new pieces will help maintain stability, flexibility, easiness and effectiveness in designing. Using these pieces help students to design more complicated robots that can solve many problems and carry out different tasks in a very short time. We hope that botball organizers and lego kit makers will take our suggestions into consideration so that we can all have an easier and simpler way to accomplish our goals.

### 4. Acknowledgment:

Eng. Mohammed Naser [4], A mechanical engineer helped us greatly in creating our (3D CAD models) [5], our mentor Mr. Hazem was a great help in arranging our time and appointments.

### 5. References:

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