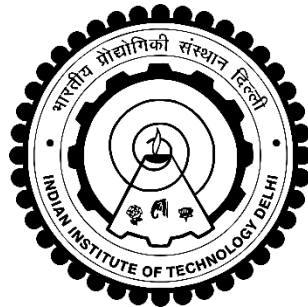




# ROBODIARY 2016



Team IIT Delhi



# ROBOCON 2016

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Like every year, this year's ABU Robocon had a unique theme of '**Clean Energy Recharging the world**' and presented an exigent challenge in front of Robotics Club, IIT Delhi. This report aims to reflect upon the various aspects of preparation and performance of Robotics Club, IIT Delhi in the national level of Robocon 2016 held at Pune, and canvass solutions to improve it.



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# SUMMER TRAINING 2015

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Keeping in mind the preparation for the Robocon 2016, a summer training camp was organized for the incoming second year members in May 2015. The training lasted for approximately 40 days.

For mechanical students, the curriculum involved:

- SolidWorks CAD modelling.
- Theory including linkages, failure of materials among others.
- Assembly and disassembly procedures via practice in Robocon 2015.

For electrical students, the curriculum involved:

- Study of electrical components and their working.
- Assembly of electrical components in robot chassis.

The other part of the training involved multiple hands-on projects given to teams which involved designing and manufacturing of various components such as drives, mountings among others. Also, the previous Robocon diaries were discussed.

## **Review**

- Some of the projects selected for the hands on training were not relevant to the future preparations.
- Instead chosen projects should have been more generic such as line following and focus should have been more on making the existing systems in the club more versatile and reliable. For instance the differential and holonomic drives.
- Also more reliable and novel technologies could have been explored.

# PROBLEM STATEMENT- OVERVIEW

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The theme of the Robocon 2016 was 'Clean Energy Recharging the world'. The teams had to make two robots, namely 'hybrid' and 'eco'. The competition presented a fresh challenge as the eco robot had to be propelled along the predefined path by the hybrid bot using a non-contact force. This time the competition was in the form of matches between two teams where the first team to complete the problem statement i.e. complete a 'Chai-Yo' was declared the winner.

Some other constraints were:

- The eco robot could only have 1 actuator for steering.
- Maximum weight of the robots combined was 40 kg.
- Maximum potential difference in the circuit should not be more than 24 V.
- Use of compressed below 6 bar was allowed.
- The time limit to complete the tasks is 3 minutes.
- The hybrid robot cannot touch the eco bot or the hills/river/spline at any time, it would lead to a points penalty and restart.



# DESIGNING PHASE

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The designing phase commenced with the arrival of the problem statement. Also the arena was made. The methodology used was as follows:

- Four teams were made and each team had to brainstorm and come up with a rough design of robots and identify the various subsystems associated with the problem.
- Weekly meetings were held to discuss the progress of each team.
- After discussion on the various subsystems used by the different teams, the better and the more feasible subsystems were selected. These subsystems were further discussed.
- Calculations and detailed designs for the selected subsystems were held. For instance, airfoil and sail design; grip and wheel based pole climbing; Camera based and array based line follower.

# PROOF OF CONCEPT

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In this phase, the prototypes of ideas selected in the previous stage were manufactured and tested for their reliability. We were able to rule out airfoil in this phase. Also we could select wheel based pole climbing for lifting approximately 20 kg of weight. We were able to obtain the line using camera and the array based sensing.

# OVERALL DESIGN AND CAD

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Keeping the points noted in mind during the POC phase the final CAD designs of the Eco bot and the Hybrid bot were made by the team. The line following modules were then mounted on a crude chassis for the eco bot for testing purposes. The POC was a very important phase as it allowed us to test the ideas before actually making the robot.

## **Review**

The proof of concept phase ensured that all the critical subsystems used were tested before the designing part. A major drawback was the team not being able to decide the method for line following and focusing on that. This later proved to be one of the major flaws. Another problem was that during the designing phase most of the designs came from 2 teams specifically, the discussions weren't held as regularly for the other teams.

The POC phase took a week more than the assigned time.

# MANUFACTURING

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The manufacturing of the robots began as soon as the CAD designs were ready. The Eco bots were ready approximately before mid-December but the Hybrid bot's manufacturing began towards the end of December. This was due to the small design iterations that were made continuously in the robot.

After the next semester began, towards the end of first week, the focus of the team shifted to reducing the weight of the hybrid robot and thus a completely new design. A new design was

manufactured and all the electrical subsystems were moved to the new design.

## **Review**

The extension of the POC phase had already led to the delay in manufacturing, moving to the new design further reduced the practice time. This was probably the gravest mistake made as the team retrospect. Even though the weight of the robot was reduced, it led to Purnendu, the driver of hybrid bot having less time to practice and less time to correct the unseen errors that were made in the mechanical and electrical subsystems.

Another critical mistake made during this time was not deciding on the line detection system. Focus of the Eco team was on both, camera and opt sensor based.

Also, the PCBs to be printed were not designed accurately and it almost took the whole of January to get the correct ones printed.

Various manufacturers used:

**Sardarji:** He shows versatility in manufacturing and has the infrastructure of aluminum welding. Also, he has fewer customers, so he is generally quite free and at service most of the time. The hybrid chassis for the robot was cut and welded by him. He also worked on the hub and shafts of the drive systems and many other small components. However, a person has to accompany him otherwise he loses focus and is not productive enough. Also, he charges exorbitant rates at times, and bargaining over prices is common with him.

**Okhla manufacturer:** He has multiple workmen and good infrastructure including a CNC machine and a CNC lathe. However, he is a bulk manufacturer and has a large workload from other sources. He manufactured the second (final) version of

the Hybrid robot. One or two team members had to be always there to get the work done. This led to the fatigue of the team members.

**Laser Cutting, Pahar Ganj:** Here we were able to get the parts for the eco bot including the base and the bearing housing manufactured at ease.

**Printing of circuit boards:** To avoid inaccuracies in manually soldered boards and making compact boards for complex circuits which require traces on both faces, all the circuits were designed on DipTrace and printed from Lajpat Nagar.

# AT PUNE

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Even though the practice wasn't done as much as planned, and not all the subsystems being tested multiple times, the team was confident about reaching the quarterfinals. Approximately 110 registrations were made in this version of Robocon.

On reaching Pune and unpacking the robots, the team started focusing on the practice slots which were to be given in every 8 hours for just 15 minutes. The robots were assembled and the working of the subsystems was checked.

Practice session 1- As planned, the first practice session was to be utilized for calibrating the eco robots and Purnendu would drive the hybrid bot on the practice arena. In this session only the crossing of river was kept in mind and not the further tasks. This session went as planned.

Practice Session 2-In this session since the eco robots had been calibrated, it was planned to drive them using the hybrid bot. But the slider subsystem was not duly checked and upon reaching it was found that one of the connections was loose and the slider wasn't working. This wasted a precious 15 minutes practice session. At this point not many teams were able to complete all the tasks. IIT Kanpur could reach till the river.

Practice Session 3- This practice slot was of lesser duration, approximately 5 minutes. Taking cue from the mistakes of the previous practice session, this time the subsystems were duly checked. During the practice session the eco robot with camera malfunctioned as its Raspberry Pi burnt due to unseen reasons. Also the array based line follower robot was not able to cross the river. There were some calibration errors still existing. After this practice session the team felt disheartened. Upon deliberation with the third

year students and Rishabh sir, it was decided that we needed to focus on one Eco robot only, which should have been done long back. With their recommendation and after raising relevant points, the team chose the opt-array based eco robot.

Practice Session 4- This was the last practice session before the first match. This time only the eco robot was taken to the arena. The eco robot could not reach the river. The reason cited was that due to the eco bot falling during the last practice session, the IMU calibrations got disturbed. Now there was no practice session before the final match.

Before entering the final league match, the team tried to adjust with the other teams to calibrate the eco robot. Niles and Amal, who designed the algorithms for eco-robot did the calibrations on the main field during the two minutes that were given. The team was not confident and there was tension in the air.

Format for the league matches was such that a total of two games of 100 points and each lasting 3 minutes were to be played in each match. Therefore we had a total of 400 points from the two matches at stake.

Match 1- In the league matches, the team aimed to complete the propeller picking task and score at least 200 points which would suffice for the qualification in the next round. Purnendu was a bit nervous because of less practice on the red side. The pit crew which comprised of the coordinator- Varan and Amal had two codes with different calibrations ready to be uploaded. Purnendu started driving the hybrid bot with the blow of whistle. The eco-robot successfully climbed hills 1 and 2 but went off path on slope 3. We had scored 20 points but the fall disturbed the IMU sensor. The referee didn't allow us to change the code in the middle of the match. In an attempt to drive it further the arm of hybrid bot touched the eco bot and a penalty of 5 points was awarded. In the

second round the eco bot was somehow pushed to the second hill and we ended up scoring just 15 points out of 200.

After the first match, Nilesh and Amal were out of ideas, the team also felt like giving up. There were very narrow chances of qualifying, with us needing a Chai-Yo. While some ideas were being discussed to make the array based eco robot work, the camera based eco robot seemed to work on the mock practice fields built by the students. The team finally decided to play the second match with the camera based eco bot.

Match 2- Purnendu was more confident in the second match as he had practiced well on the blue side. The eco robot started off well, crossing hill 1, 2, 3 with ease. To our dismay, it could not cross the river and hit the islands instead. We took a retry only to see the same result. The reason cited was that the Raspberry Pi circuit got burnt and also the calibration of the river region was incorrect. This gave us 30 points in the second round and ended all our hopes to qualify. The second round gave us 10 points and thus 40 for the second match.

Exiting the tournament at such an early stage with 55 points out of 400 left the team broken, with all the hard work going into vain. Some of us even shed tears. It took some time but we took the loss in a competitive spirit and vowed to work next year with a winning attitude. We then saw other team's performance and compared their strategies and performance with ours. It was good to see one of the IIT's, Kanpur upholding the prestige and standing third. It was also good to see the innovative design of COEP, Pune who faltered just once in the tournament in doing the Chai Yo, which was the finals. Vadodara Institute of Engineering won the competition in a neck to neck race. Their robot was not very well manufactured but their subsystems were resilient. They came back from the semifinals where they were unable to climb the pole in one go.

# LEARNINGS

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After this experience, the team discussed with the professors the various reasons for the outcome. A set of learnings was cited to make improvements the next time:

1. After the problem statement is released, it is important to adapt the existing subsystems to the problem and make them more reliable. Starting work on new technologies doesn't make them countable.
2. The manufacturing should be finished during winters and no further changes in the design should be made. Small changes to make the existing designs more reliable should be made.
3. Designs should be made extensively robust and resistant to failure. For instance, PCBs should be used and not the soldered circuit.
4. Designing phase should be made more intense.
5. More input should be taken from the seniors and faculty. Also, seniors are experienced and their advice should be taken into account. For instance, new hybrid design shouldn't have been manufactured.
6. Goals should be clearly defined at the start. We were dicy about the automation part. The time spent on automation was unfruitful.
7. The basic pillars of working in a team are communication and coordination. This was lacking as only the people responsible for a particular subsystem knew their working.



# SUMMARY

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Summing up the whole journey of more than six months, despite not being able to win, it was an eventful and a memorable experience for the team. We were very disappointed with what happened initially. The whole experience taught us the various aspects of building a product that achieves the target and at the same time is robust. Working in a team helped us learn to communicate and coordinate. The competition brought out the best in us. We worked hard, sacrificing other things and striving to build a perfect robot.

Now looking forward, it is important for us to take the club forward and work this year with a winning attitude. It is important to have an attitude of not settling with an average performance, but being the best. More than that it's important to see ourselves as a part of the team and the club and look at how rewarding the journey was.

# THE TEAM

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Rishabh Agarwal, Mentor

Varan Gupta, Overall Coordinator

Jyotirmoy Ray, Mechanical Coordinator

Vaibhav Gupta

Rishabhjit Singh

Ayush

Nalin Bendapudi

## Electrical:

1. Rahul Fandan
2. Amal George
3. Nilesh Jha
4. Nikhil Gupta
5. Nishant Agarwal
6. Aditya Jain
7. Shreyansh Gattani
8. Pranjal
9. Mohit

## Mechanical:

1. Purnendu Tripathi
2. Gaurav Sardal
3. Aditya Chaurasia
4. Rohit Patel
5. Rithul Perethra
6. Sanket Chaudhary
7. Qaim Abbas
8. Amogh Gupta

# THE ROBOTS

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Hybrid Robot



Eco Robot

