Center for robotics
Physics-Mathematics Lyceum 30

Engineering book of
Competition First FTC

Team PML30-φ 9746

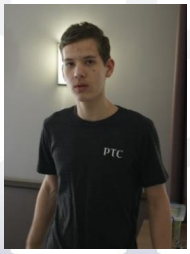
PTC® IRISOFT

StarLine®

Saint-Petersburg, Russia
2015

Team PML30-phi

Physics and Mathematics Lyceum №30, Saint-Petersburg, Russia



Georgiy Krylov
Captain, responsible for efficiency of working in the team

Evgeniy Maksimyshev
Operator №1, engineer, responsible for programming

Nikita Safronov
Operator №2, engineer, responsible for technical documentation

Ivan Fokin
Engineer, responsible for purchasing materials

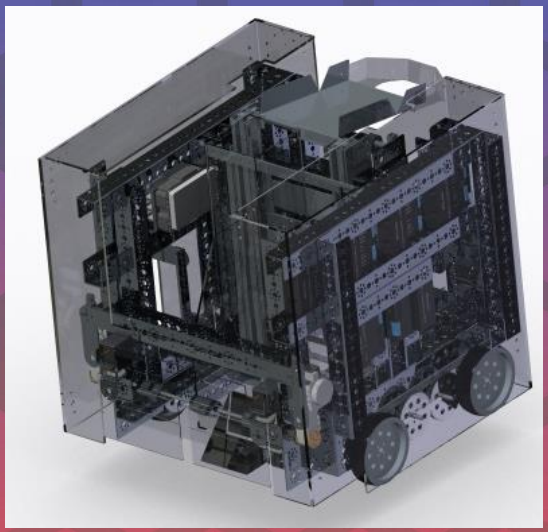
Maksim Radionov
Engineer, responsible for public relations

Strategy(number of scoring points is noted in brackets)**:**

1. Autonomus period (2 options):
   1.1. Riding out from the ramp, scoring autonomus balls into 60 and 90 cm rolling goals and delivering them to the parking zone. (**120**)
   1.2. Start from the parking zone, scoring autonomus balls into 30 and 90 cm rolling goals and delivering them to the parking zone. (**100**)
2. Driver control period: carrying 90 cm rolling goal and filling it with balls (**200 - 270**). During end game scoring 4 big balls into central goal(**180**) or delivering rolling goals to the ramp (**120**).

Construction features(numbers of following pages in engineering notebook is noted in brackets)**:**

1. Strength:
   1.1. Most of construction elements are made of metal (aluminum or steel).
   1.2. Elevator works stable, because it is made of furniture rails. (pages 27 and 41)
   1.3. Robot is heavy, so it's hard to turn it over.
   1.4. Robot is protected from collisions with Plexiglas.
2. Mobility:
   2.1. Robot has 6-wheel drive. Six motors and gear 2:1 for speed provide maximum power and maneuverability of moving. (page 198)
   2.2. With standard TETRIX omniwheels robot easily turns, and because of special construction it has no problems with riding up to the ramp. (pages 169 and 200)
3. Balls control:
   3.1. Gripper for balls consists of two fast rotating vanes. (pages 26, 122 and 176)
   3.2. The bucket for balls rises up with elevator and overturns backwards. (pages 103 and 178)
   3.3. Balls from the bucket move to the guide with hole at the end of it. Balls fall down from the hole vertically, so they always get into the goal.(pages 82 and 108)
   3.4. Robot captures the rolling goal with a special mechanism and carries it with itself. (pages 124, 202)



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ФИНИСТ

Contact information:

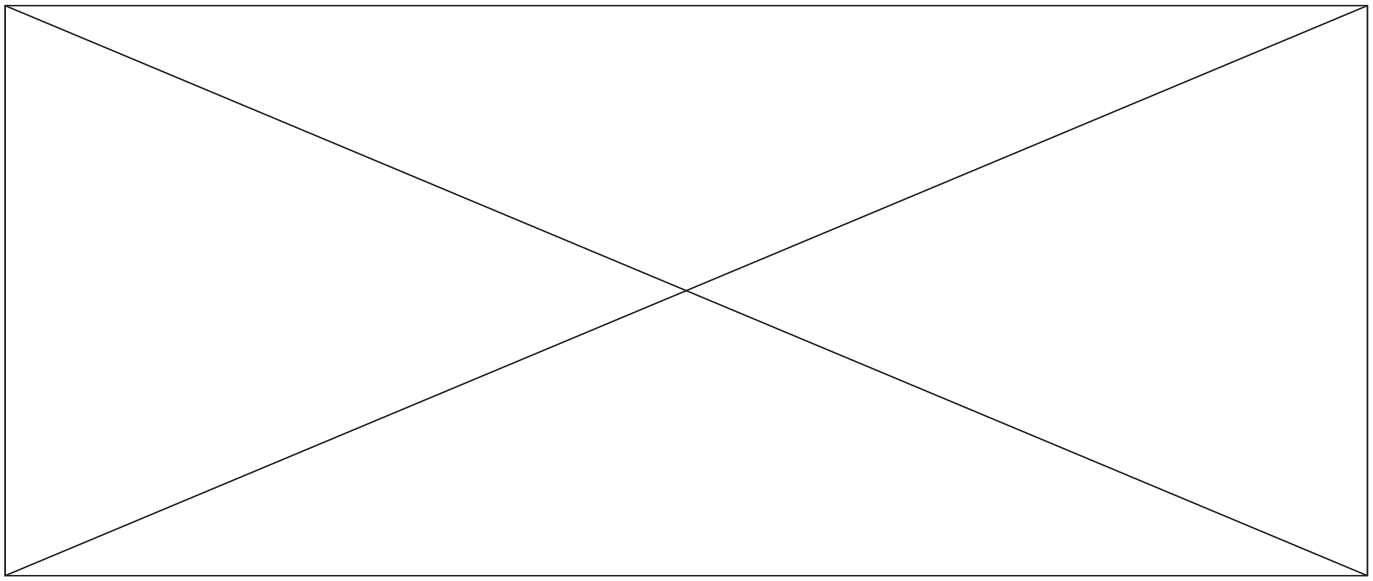
Website:
http://school30.spb.ru/robot/
e-mail:
robodepartmentPML30@yandex.ru
Facebook:
https://www.facebook.com/pages/FTC-team-PML30-PHI/1410799752560522

Содержание

1 Team PML 30 φ

Team PML 30 φ was assembled in September 2014 in the Russian city of St. Petersburg from 3 novices and 2 participants with experience. Tasks and roles were distributed among the participants, and we established safety rules. In the first place the team put spreading principles of gracious professionalism to others. All decisions were made collectively inside team with discussion to find the most optimal solutions. During the year we took part in many events and everywhere we have tried to attract attention to our team and encourage people to take part in FTC. Also we pursued and distributed the principles of honorable professionalism. Talking to the press, we hoped to attract more attention to our team and to the competition in general, as well as attracting sponsors. The latter was important because of the need for funds - purchasing materials and equipment costs a lot. The team took part in the three qualifying competitions and in the regional finals. In all of them we made new contacts, shared experience and provided mutual assistance to other teams. In the first qualifying rounds in Sochi we met Stuy Fission 310 from USA and maintain contact with them to this day. On regional finals, we met with a team from Romania, Auto Vortex, and keep in touch with them through Facebook. Also, there is an active group chat with a large number of Russian teams. You can find the team page in Facebook at the address https://www.facebook.com/pages/FTC-team-PML30-PHI. To increase the efficiency of our team work we used the version control system GitHub, which allows the entire team to work simultaneously on a single projects without losing files and providing easy way to resolve roblems. Also for writing technical books we been used professional typesetting system LaTeX.

[H]



1.0.1 Instructors

:

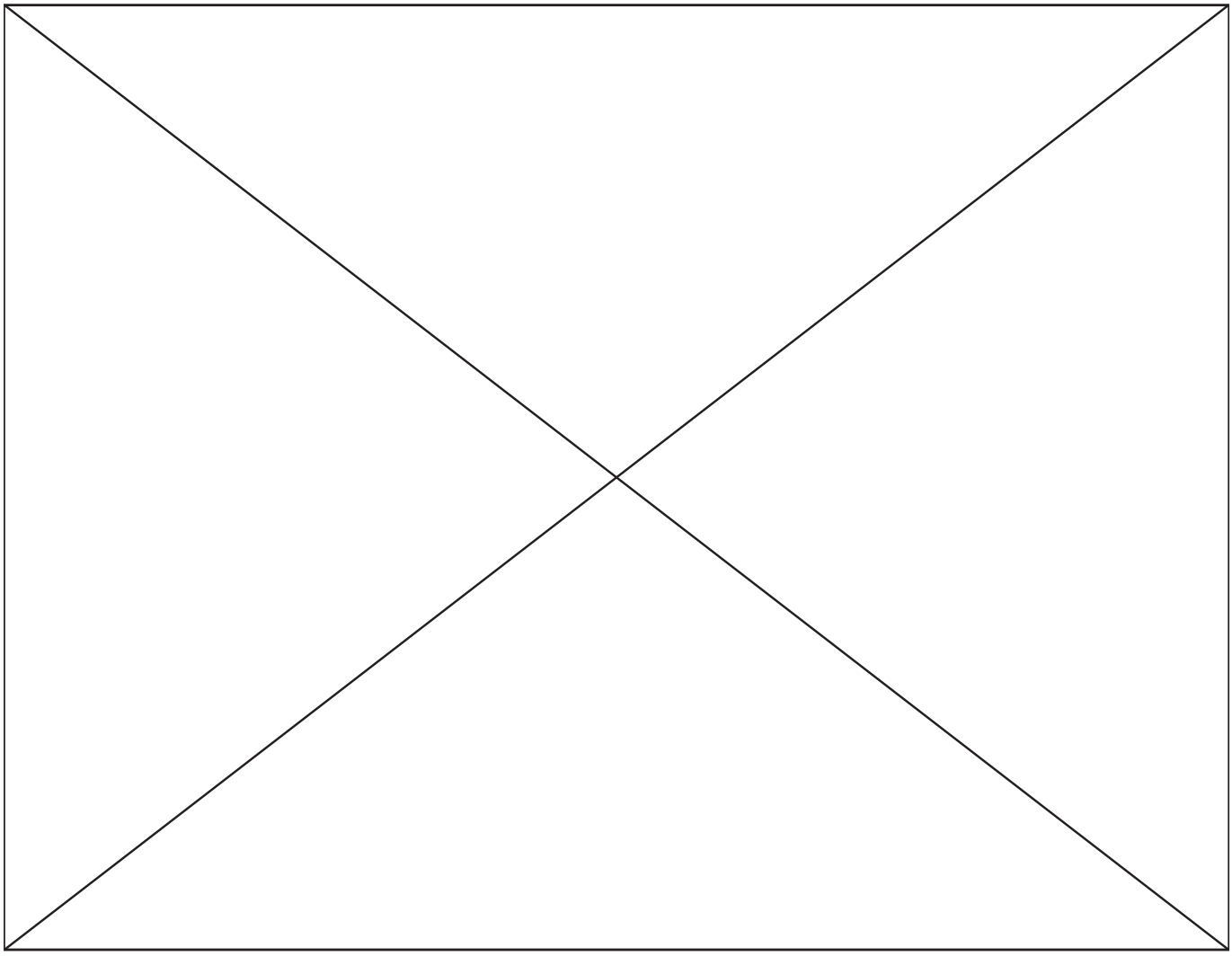
Luzin Dmitry
Head of Robotics Department in Phys-Math Lyceum 30, Saint-Peterburg, Russia. Main coach of FTC team.
Information: 25 years old, in robotics 5 years, in FTC 3 years.

Luzina Ekaterina
Professor of Robotics Department in Phys-Math Lyceum 30, Saint-Peterburg, Russia. Tutor of FTC team.
Information: 25 years old, in robotics 5 years, in FTC 3 years.

Fedotov Anton

Professor of Robotics Department in Phys-Math Lyceum 30, Saint-Peterburg, Russia. Tutor of FTC team.

Information: 22 years old, in robotics 4 years, in FTC 3 years.



1.0.2 Team members

Krylov Georgii
Role in team: captain, coordinator of the action operators in game, responsible for the modification of robot.
Information: 17 years old, in robotics 3 years, in FTC 3 years.
Why I chose FTC: "I chose the FTC, because I like to come up with the design of robots and turn their ideas into reality, because every time I feel the Creator, who created a new creature."

Radionov Maxim
Role in team: communication with the team and community, decorating robot, Power Design, reserve operator.
Information: 16 years old, in robotics 3 years, in FTC 1 year.
Why I chose FTC: "Because I like to create a robot from scratch, from somethink, I can do with my hands: cut, drill and assemble."

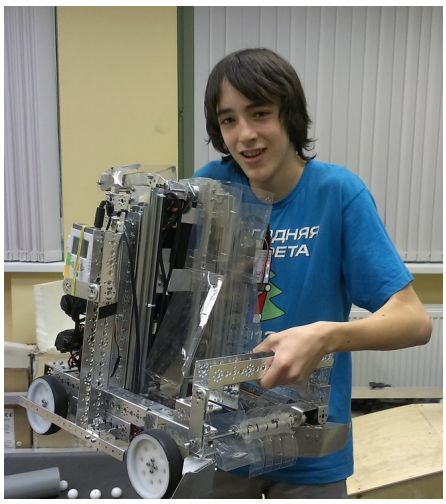
Safronov Nikita
Role in team: manipulator-1, creation of 3D models, chief engineer, responsible for the assembly robot.
Information: 16 years old, in robotics 3 years, in FTC 1 years.
Why I chose FTC: "I have chosen FIRST because I enjoy working with mechanisms and finding unusual technical decisions for solving problems. Also working on this project helps me to get new skills in a sphere of engineering. In this case I know, that I don,t spend my time in vain."

Maksimychev Evgeny

Role in team: manipulator-2, responsible for the technic of safety, responsible for the writting of technical book.

Information: 15 years old, in robotics 2 years, in FTC 1 year.

Why I chose FTC: "This is an interesting project that allows to implement some innovative solutions. In addition to the skills of designing robots, we also obtain the skills of the technical documentation and communication with colleagues which makes this competition as close to real engineering problems."

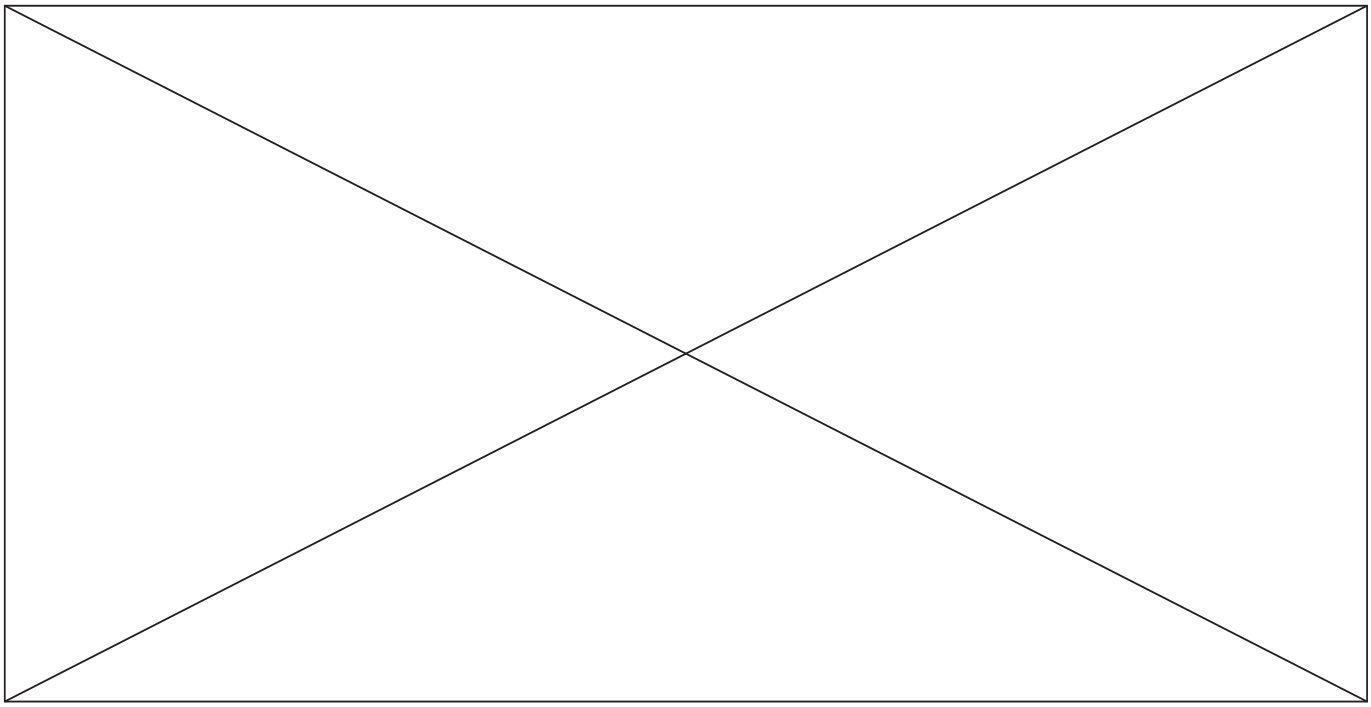


Fokin Ivan

Role in team: purchase of materials, development strategy in the game, communication with the press, reserve manipulator.

Information: 17 years old, in robotics 5 years, in FTC 3 years.

Why I chose FTC:"When I first I attended the event FTC saw hefty metal robots, with enthusiasm and without hesitation decided that I would like to do this."



2 Events

2.0.3 Qualifying competitions

1. Sochi. 21-23.11.2014. Sochi was the first time the team participated in a comptetition. There, our team felt the spirit of FTC comptetion and noble professionalism for the first time. We got work experience all day and all night, began to make acquaintance among the teams, and providing all possible help we could. The planning and organization were all very nice. The most memorable contact we made was with the American team Stuy Fission 310, with which we now keep in touch. As a result we won a Think Award and a pass to the Regional final.

2. Ryazan. 13-14.12.2014. Our first priority was to train on a real field. These competitions were quite small and quiet, all the teams communicated abundantly and shared ideas freely. We all felt comfortable there. The team helped to assemble and disassemble the field. As a result - Winner Alliance Award and Think Award.

3. Perm. 27-29.01.2015. Dress rehearsal before the regional final. It was great organized event where we were able to practice all aspects of the competition. Including such important skills as the choice of Composes alliances finale. Also we strongly helped to organized technical part. As a result - the Winner Alliance Award and Inspire Award.

2.0.4 Regional final. 11-13.02.2015

This was the event, to which the team had been preparing for for six months. Approaching the competition with fully finished. At competitions communicated with all the teams that were there, discussing strategy and offering their help. During the competition statistics were conducted on all the teams. It helped in choosing allies for the final. Was also had an action plan for an alliance with any team. In the final, having received a the choice of allies, we chose the team with the most stable results, and the bet was at collaborative interaction of any pair of robots. Results: Winner Alliance Award, Inspire Award and the pass to World Championship in Saint Louis.

2.0.5 CRDI RTC. 24.11.2014

Central Russian Institute of Robotics and Technical Cybernetics. A tour was organized for the team in the institute, where we could see the real processes of development of detailed design for robotics. There we saw several project summaries at different stages of development - from drawings to finished models, as well as commercially ready products. From there we learned some ways on how to organize. Internet adress http://www.rtc.ru.

2.0.6 PML30 POLYGON. 08.02.2015

PML30 POLYGON competitions are carried out by our organization. Their main misrepresented that participant receives a rear and parts for its decision merely on the competition, compliance with the maximum being equal. We also demonstrated the FTC involving the participation.

2.0.7 GeoScan. 10.03.2015

A Russian company thatproduces and sells unmanned aerial photography systems. There we were clearly shown how the office is designed, as well as the distribution of responsibilities and tasks, and what the internal

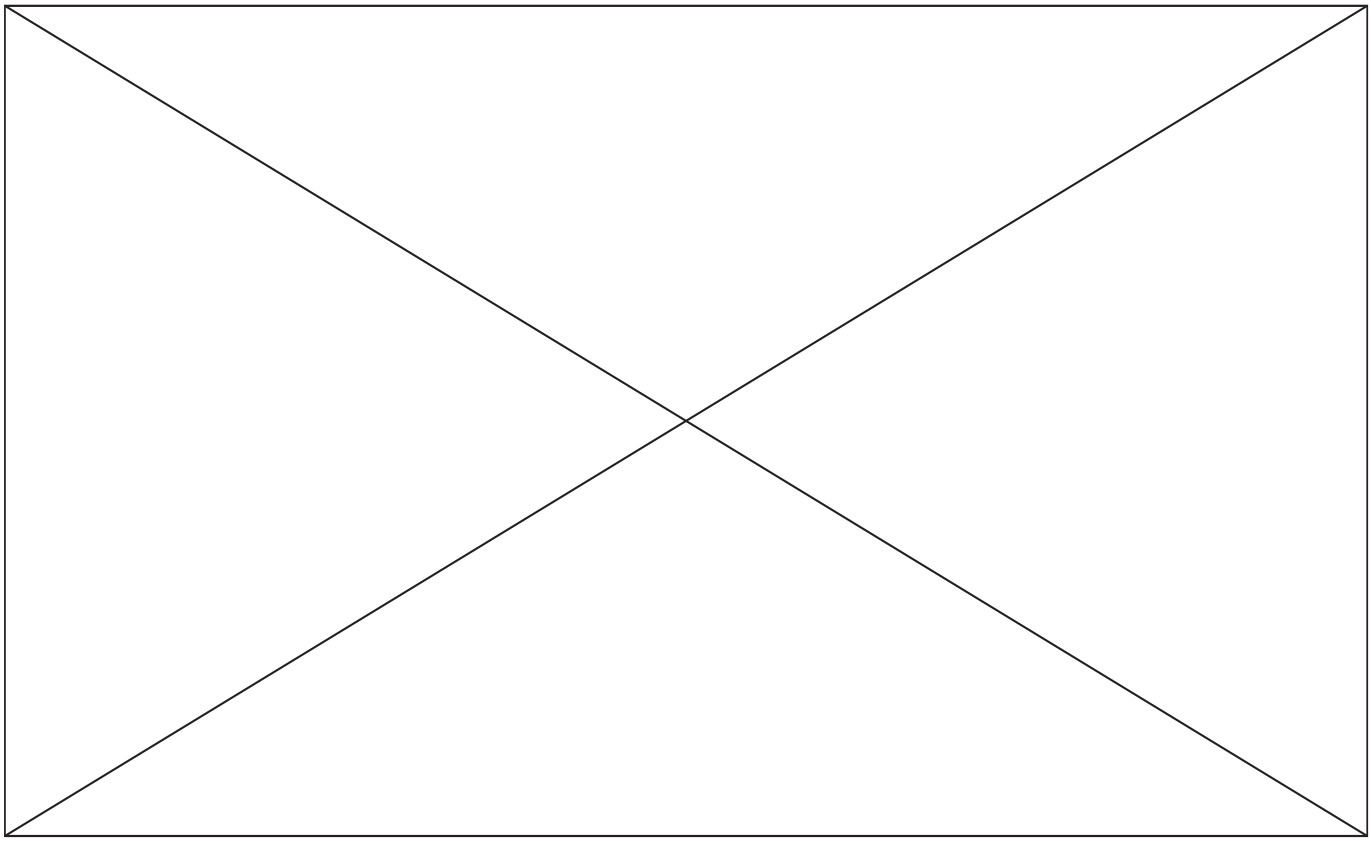
interaction is like. Also, we were shown the whole production line. Internet adress http://geoscan.aero/.

2.0.8 PTC live Tech Forum. 24.03.2015

The team was invited to participate in PTC Live Tech Forum. We will present the successfull path of 3D model creation in Creo Parametric, tell about important tips and show how CAD modelling helped us to build the robot.

2.0.9 Summer camp on Robotics

In the camp in 2015, team members will conduct a robotics engineering course based on constructor TETRIX, attracting more people to the FTC.



3 Business plan

3.1 introduction

We take a responsible approach to finding sponsors. And also try to spend money effectively advance thinking through the details and equipment, finding ways to get them maximum benefit. Some sets we received as prizes in competitions.

3.2 Our sponsors and their support

3.2.1 PTC and Irisoft

PTC and Irisoft representative in Russia is the one company that has helped us to begin to engage FTC. They provided us the first set of Tetrx within the program's Score Thehnic which involved our Lyceum. They provide us with a different command symbols plus small gifts for other teams. They help us with the delivery of details from U.S.A. We use them programa Creo for creating 3D models. We also take part in events organized by them.

3.2.2 Robofinist

Robofinist Charitable Foundation organized by Temur Amindzhanov and by Starline. They offered us its assistance as an organization in our city with outstanding achievements. They help to financially each month to give us 2000 Dolars, parts and equipment.

3.2.3 Volnoe Delo

Volnoe Delo is one of the largest charitable foundations in Russia. It was established by Oleg Deripaska. We are participants of the program ROBOTOTEHNIKA.As support they sent us free game field.They also engaged in training teachers and judges, including our own.They engaged in the organization of competitions FTC in Russia and are sponsoring a trip this year's winners to St. Louis.

3.2.4 Physics-Mathematics Lyceum №30

Physics-Mathematics Lyceum №30 is a school in which is our organization. It provides us with a comfortable space and material assistance, as well as leaders.

3.3 Purchase of materials.

3.3.1 Our method

When we started robotics we had not a lot of money and we used only some basic materials. Now we found sponsors and firstly plan the details and equipment that we need to buy and then buy them.Such an approach allows us to find more effective solutions.

3.3.2 Our materials

We have 6 primary kits and 3 resource kits.We buy individual parts we need.At this point was made 2 large purchases from U.S.A for 1600 Dolar in November 2014 and March 2015.

4 Engineering section

4.1 Concept of robot

4.1.1 Construction

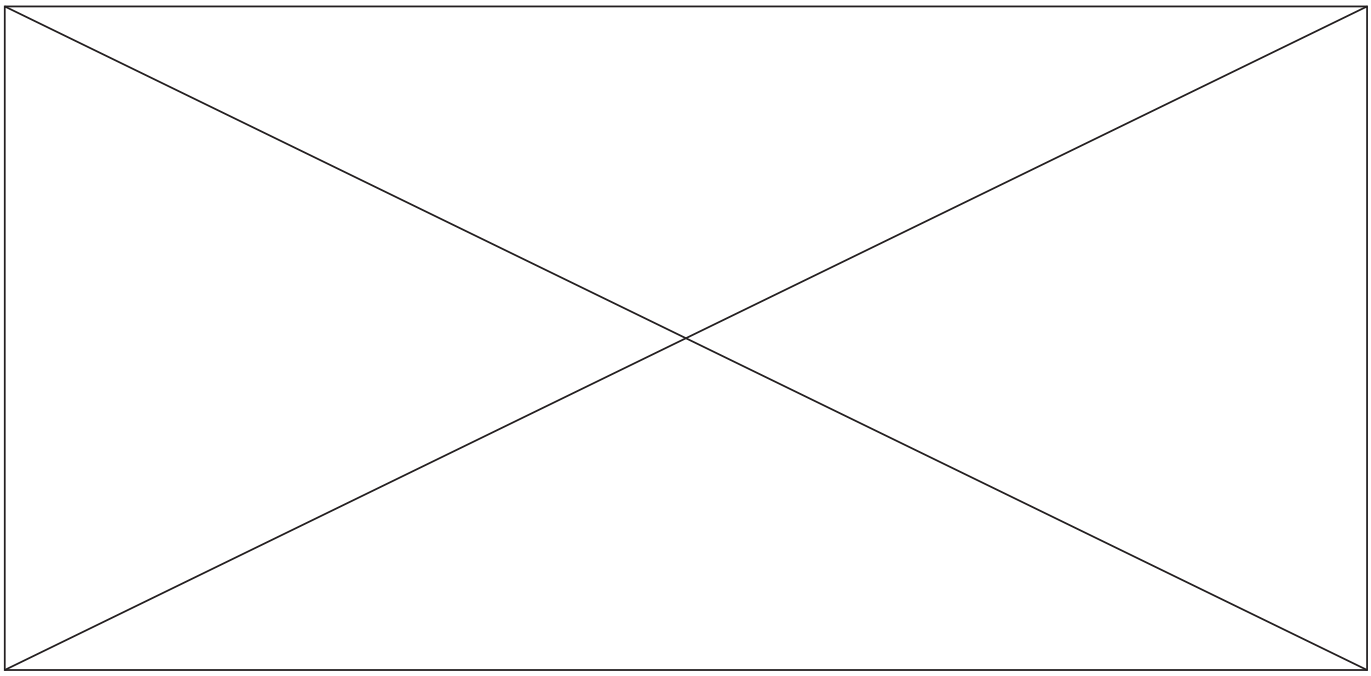
- Robot should be mobile, move quickly, and, if possible, in all four directions.
- Robot should have four sensors of angle (encoders) to use in the autonomous period.
- Robot should be compact not fill too much space, since it shouldn't hinder allies.
- Robot must be able to monitor all five (5) goals simultaneously.
- The robot must have a special device for moving the movable baskets.
- If possible, the robot should be lightweight. It will be easier to carry.
- The construction of the robot should allow for quick change of some parts.

4.1.2 Autonomous period

- Robot should have different versions of the autonomous period and use them depending on the ally's capabilities, its start place, and other conditions.
- The autonomous period program should be simple.

4.1.3 Driver-controlled period

- Robot control should be simple and convenient
- One operator is fully responsible for the movement of the robot, the other for all another functions.
- Some steps in the controlled period may be implemented independently to help the operator.
- Operator should control speed of robot, since the robot should be able to perform precise manipulation.



4.2 Strategy

4.2.1 Autonomous period

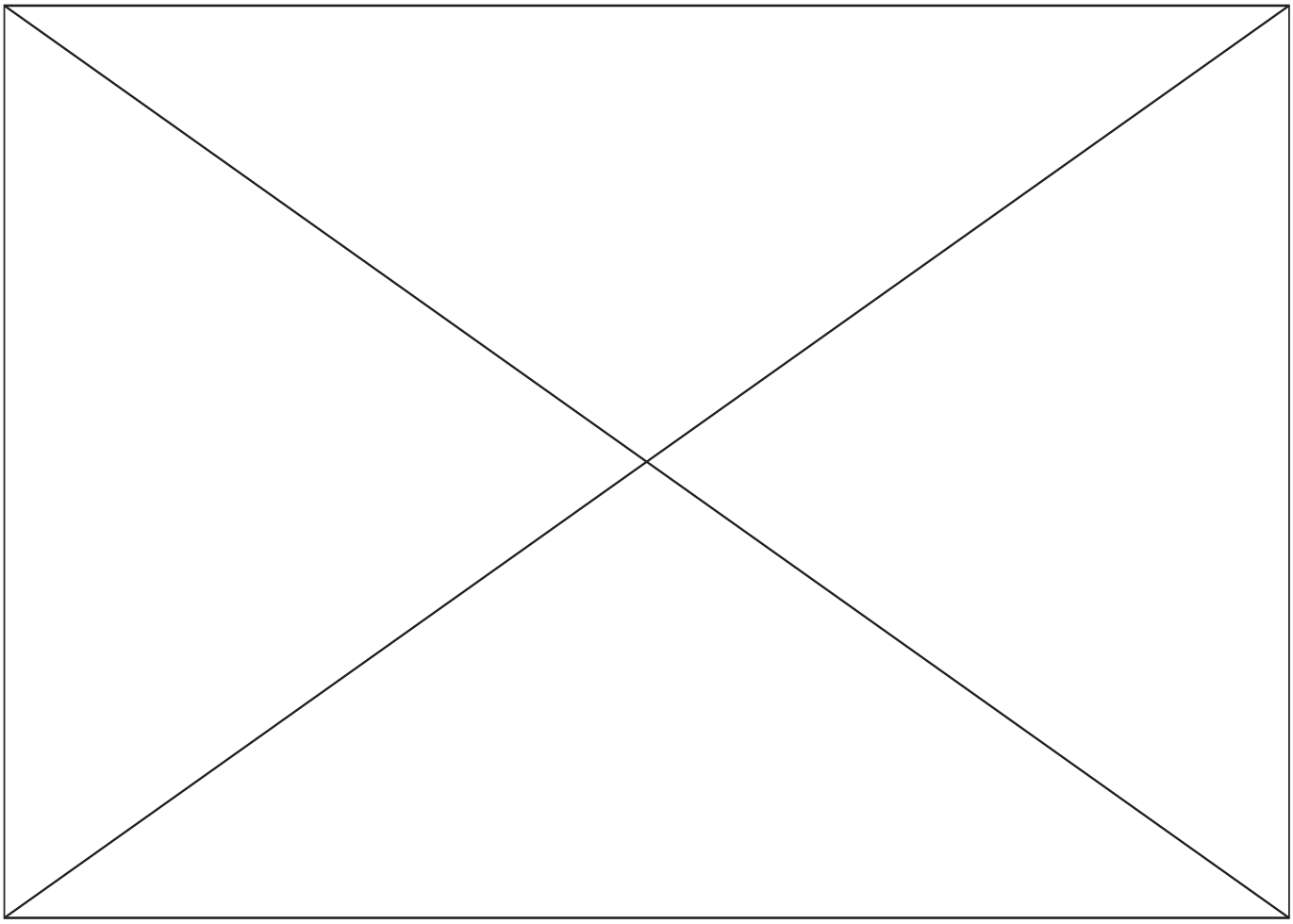
1. Put two balls in two different baskets.
2. Take the maximum number of mobile baskets and place them next to the parking area.
3. On the way to the parking area, the mechanism of ball release should be activated.

4.2.2 Driver-controlled period - main part

1. Allow our ally free access to the moving baskets. But, at the same time, it should carry one basket, because we have to save time.
2. First the 90-cm basket should be filled with balls, then the 60-cm one and 30-cm one.
3. Avoid collisions with ally and opponents, it is a waste of time.

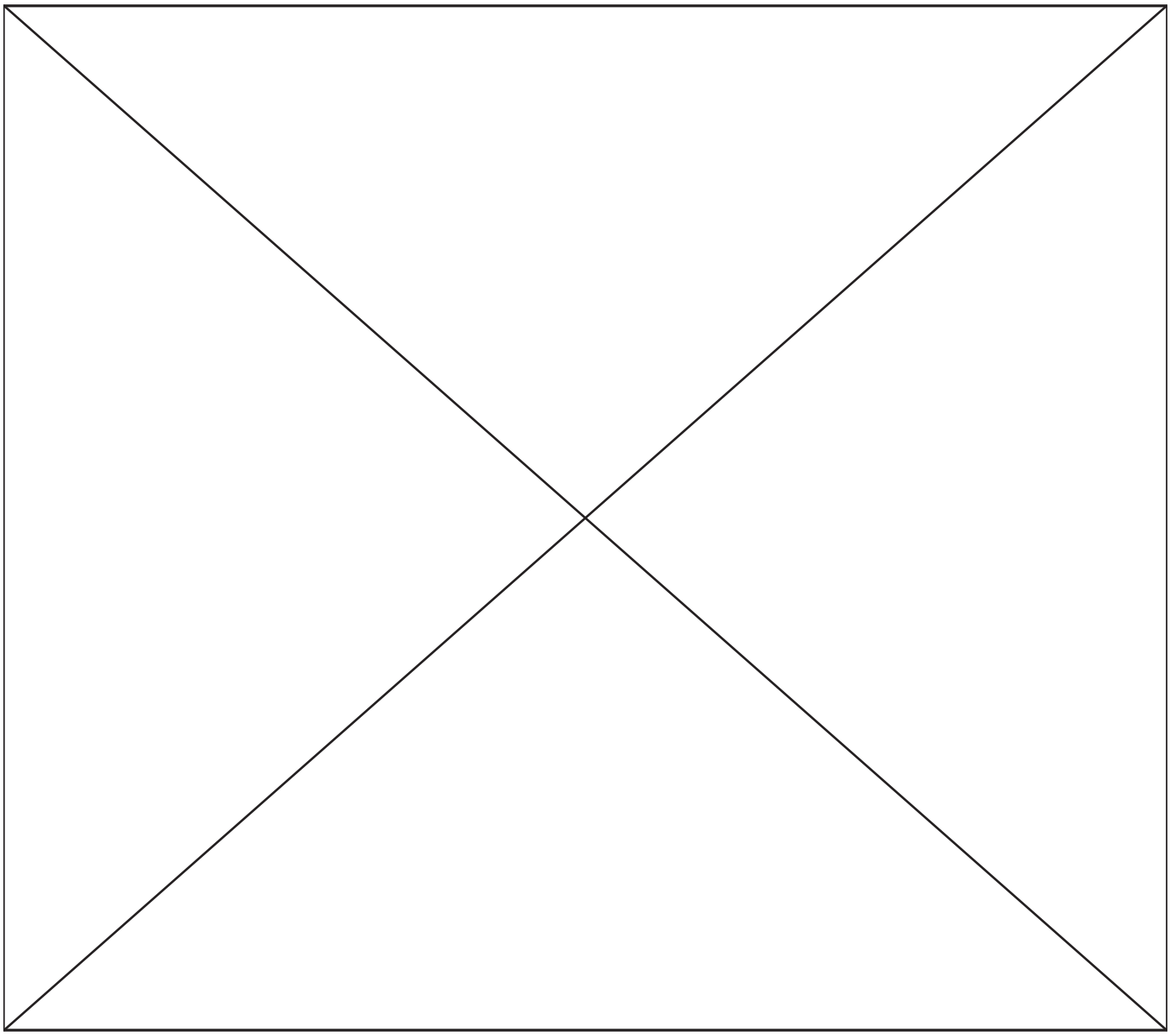
4.2.3 Driver-controlled period - final

1. Fill the central basket with balls.
2. Place maximum possible number of mobile baskets on the ramp.
3. Call the robot to the ramp.



4.3 Planned steps for creating of the robot

1. Creating a wheel (or track) base of the robot.
2. Writing a program for controlling the wheelbase through one (1) joystick.
3. Creating a system of goal control.
4. Writing a programm for robot control through two (2) joysticks.
5. Writing a programm for the autonomous period.
6. Creating additional decorative elements.
7. Installating protection elements on the robot to prevent damage during an accidental collision.
8. Trainings (alone or with another robots).
9. Making improvements on the based on preformance in first competition.



4.3.1 1 Meeting

Time frame: 00.00.2015 16:00-21:00
Preview: The main purposes for current meeteng were making robot and writing program...

Tasks overview:

Tasks	Solutions	Label
To build robot	We built robot	robot
To write program	We wrote program	program

Detailed explaination:

1. Detailed explaination of robot...

Рис. 1: robot

2. Detailed explaination of program...

Рис. 2: robot

Additional comments:

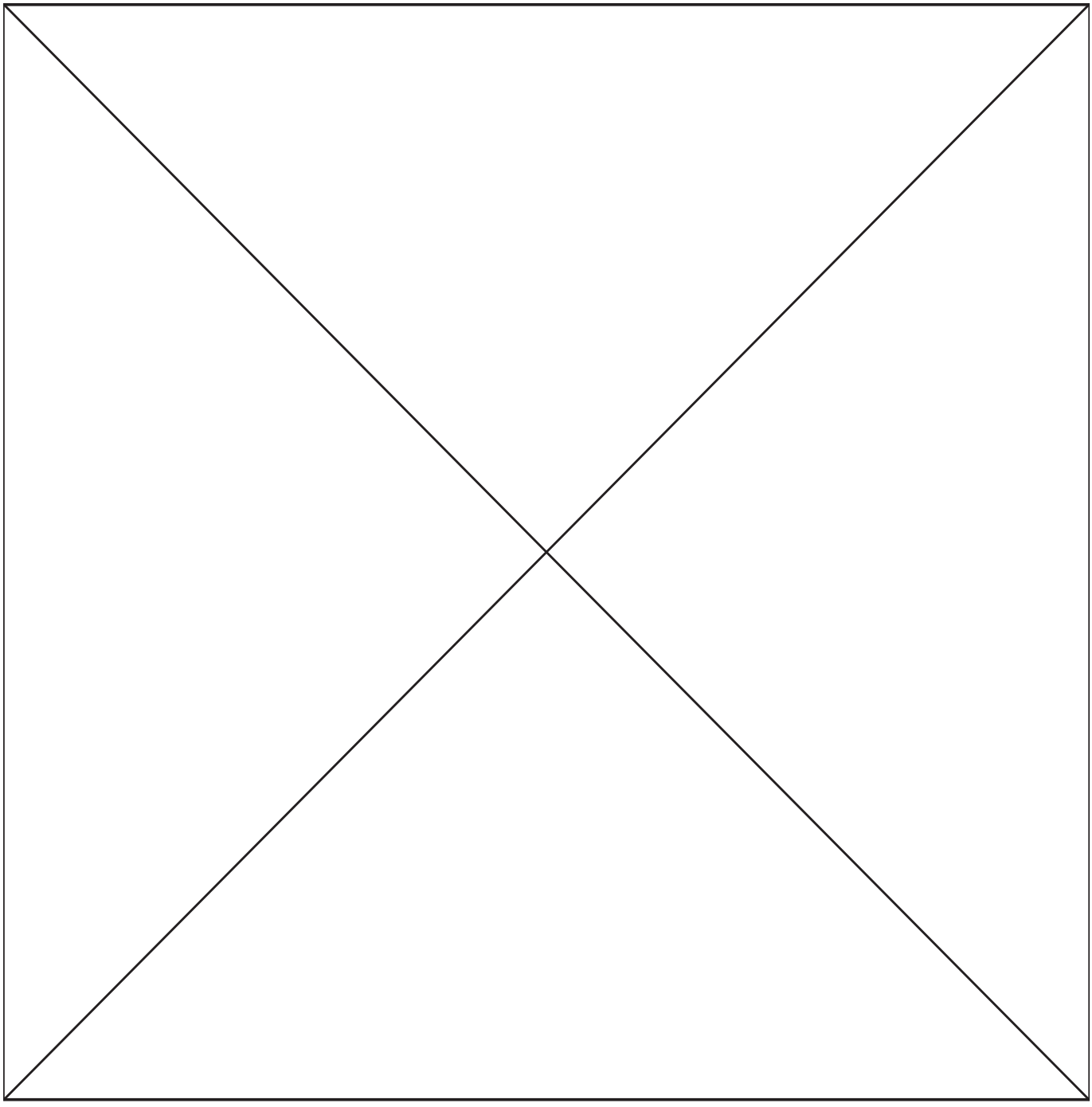
Ideas we invented	Resourses to realise	Label to the result
To build robot	We built robot	robot
To write program	We wrote program	program

The events of the day:

1. Today we met guys from Pikalevo...

Рис. 3: robot

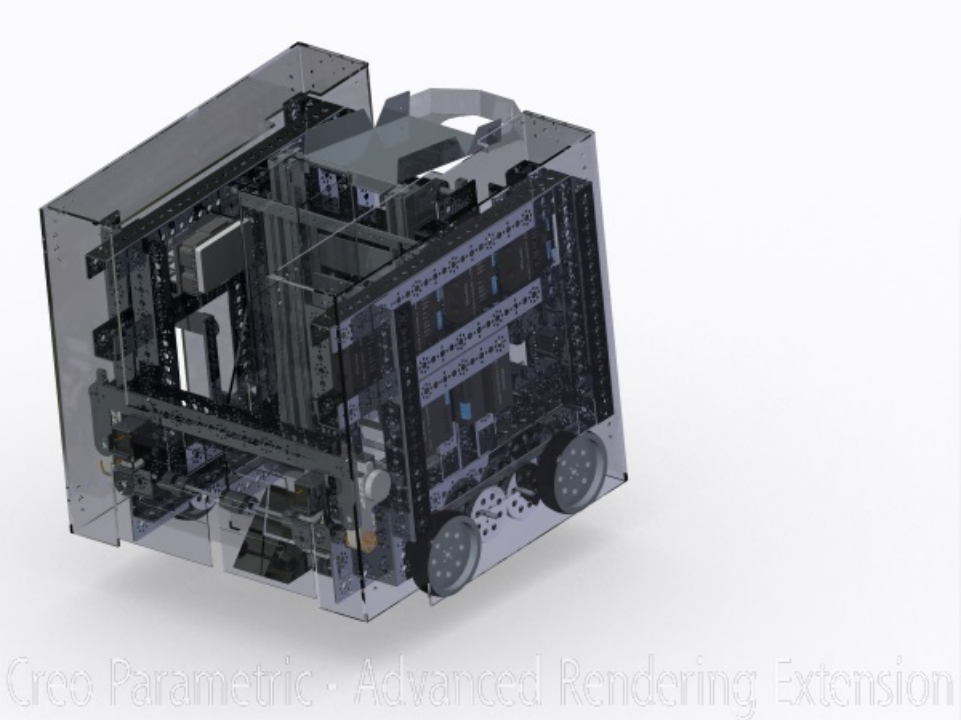
2. Today we also visited Geoscan (label..)...

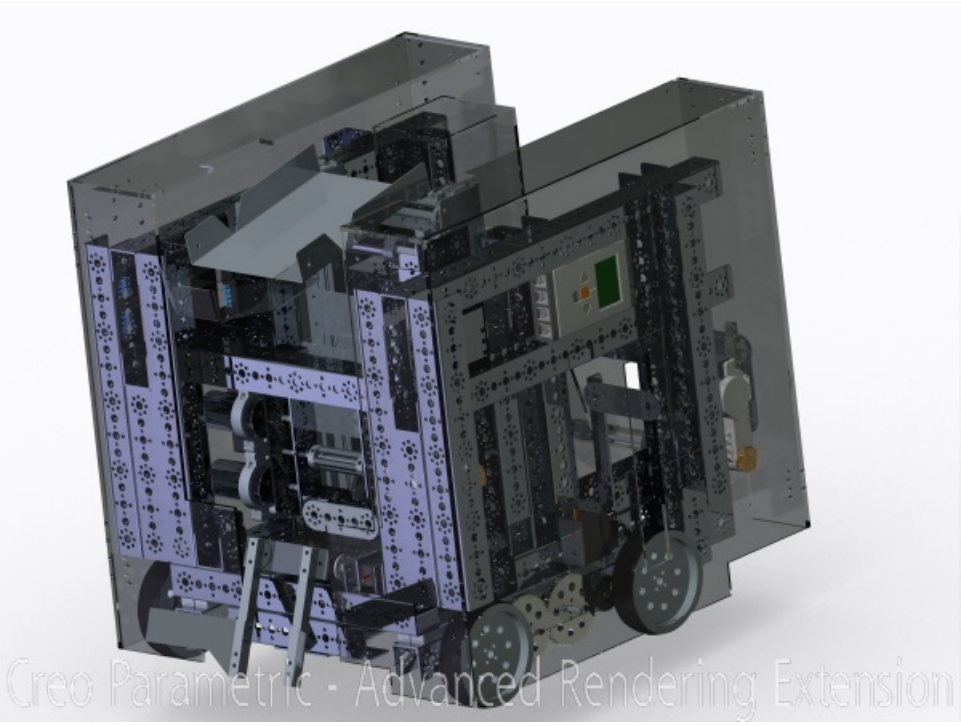


5 Key summary

5.1 Model

The final version of the model of the robot made in Creo Parametric 3.0:





5.2 Strategy

Our strategy is very flexible, so we can adjust to any ally.

6 Thanks and prospects

We enjoyed working on a custom and non-standard project, which, besides its technical aspect, included working with new people who shared our values of friendship and mutual understanding.

Our team is planning to continue doing robotics, setting new goals for ourselves in order to improve. This is our first year taking part in FTC and we will participate next year as well. If we don't realize ourselves this year, we'll look at all our mistakes, correct them, and preform a lot better next year.

In any case, we are ready to learn new things, improve ourselves and expand our skills.

None of us know for sure what we want to do in the future, but we are certain that our experience will be very valuable to us.

Our thanks go to the company FIRST for organizing this competition, which we are very happy to be participating in. We appreciate this wonderful opportunity to test ourselves and learn something new and wish them success and growth in their future endeavors.

Also we thank our sponsors: company PTC and it's Russian representative "Irisoft"and charitable foundation "Finist"for their support. Also we thank Physics-Mathematics Lyceum 30 and it's director Alexey Tretyakov for providing comfortable conditions for preparation to competition.

Team PML 30 φ

7 Appendix

7.1 Programm

Program of driver control period and two versions of autonomus period with brief explanations.

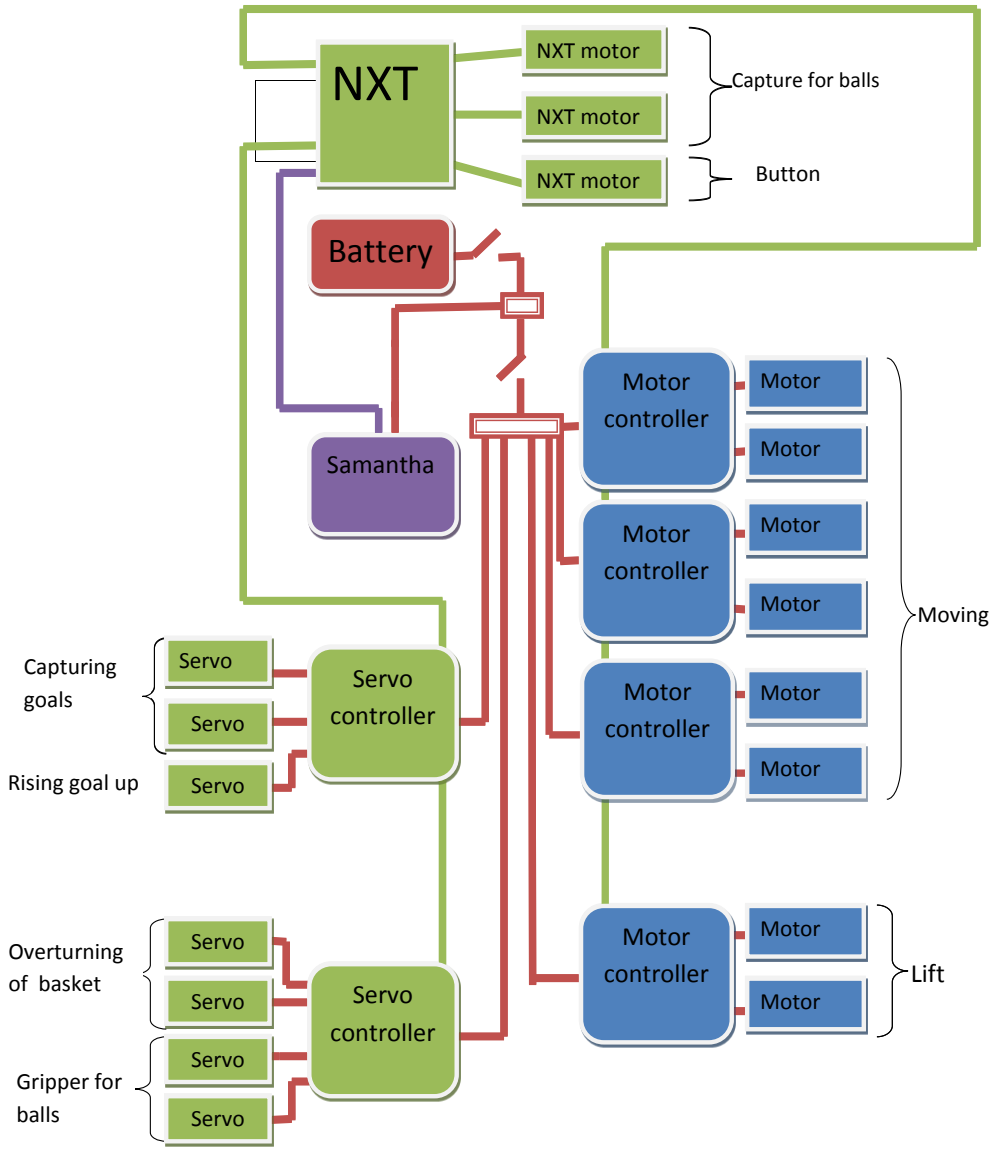
7.1.1 Driver control period

7.1.2 Autonomus period from the parking zone

7.1.3 Autonomus period from the ramp

7.2 Electical scheme

The final version of the scheme of electrical components of our robot:


NXT
NXT motor
NXT motor
NXT motor
Capture for balls
Button
Battery
Samantha
Motor controller
Motor controller
Motor controller
Motor controller
Motor
Motor
Motor
Motor
Motor
Motor
Moving
Capturing goals
Servo
Servo
Servo
Servo controller
Rising goal up
Overturning of basket
Servo
Servo
Servo
Servo
Servo controller
Gripper for balls
Motor
Motor
Lift

7.3 Supplementary materials which were used in the robot's construction

1. Aluminium axis 1m x 8mm. 2 pieces.
2. Steel axis 3m x 8mm. 1 piece.
3. Aluminium strip 2m x 50mm x 2mm. 1 piece.
4. Aluminium strip 1m x 40mm x 3mm. 1 piece.
5. Aluminium profile 1m x 10mm x 10mm. 1 piece.
6. Furniture slats 30cm. 2 pieces.
7. Furniture slats 35cm. 4 pieces.
8. Belt 2,5m. 1 piece.
9. Plastic clamps.
10. Plastic bottle. 1 piece.
11. List of PET 1 m x 80 cm. 1 piece.
12. Hot melt adhesive.
13. Tape.
14. List of plexiglass 3m x 2m (cut). 1 piece.