0.1 Brainstorming (21.09.15)

Time frame: 22.09.2015 17:00-21:00
Preview: Since this year FTC rules were published, every member of our team had carefully read them. Today we gathered together to discuss all the aspects of this year gameplay and think of how to get on with the most significant features of the game.

General aspects:

Features	Solutions	Label
Moving to the ramp is essential to achieve high score.	Robot's wheel base should be good at moving on the ramp.	chassis
Space between each two bars in 3-rd zone is wider than the standard TETRIX wheel diameter.	Using tracks or 3-4 wheels from each side of the robot will prevent robot from getting stuck.	chassis
It will take a lot of time to climb to the 3-rd zone of the ramp.	It is possible to deliver debris to the highest goal with elevator standing on the 2-nd zone instead of climbing to the 3-rd.	elevator
Goals for debris have a very little capacity.	It is more preferable to collect cubes than balls. That's why we need mechanism to prevent balls from collecting.	gripper
Pulling up costs 80 points. It's not difficult to realise then.	At least 1 DC motor should be reserved for pulling up. It is possible to grasp the pull-up bar with hook and lift to it by reeling the cable.	pull up
Moving over the inclined plane and pulling up require high moment on motors. However, the number of motors is limited.	Robot should be light enough to decrease the moment required for moiving and, as a result, increase speed of moving.	weight
All the zones of red alliance are the mirror reflection of blue alliance's zones.	Robot should be symmetrical and capable of playing on both sides of field.	concept
Robot can grip 5 debris at once, when the maximal capacity of one bucket is 24 cubes. So, to fill one bucket robot has to repeat collecting and taking cubes to the goal 5 times per 1,5 minutes	Gripper for debris should be at the front side of the robot and extractor for scoring elements - from the back side. It will allow robot to go to the ramp backwards, so it won't need to turn around on the ramp before going down to collect debris. It will save some time.	concept
It's quite unconvenient to exchange ramps with your ally during the game.	We will negotiate with our ally about spheres of influence before each game. Additionally, there should be two autonomus programs for climbing onto both ramps.	strategy
This year autonomus period has no difficult tasks. The only hardness is that both robots in alliance have to fulfil the same tasks at the same place. Furthermore, robots can start autonomus period form different positions. So, it's difficult to predict how the another robot in our alliance will move.	A number of different programs for autonomus period are needed for easier adjustment to the ally's strategy.	strategy
It's not restricted to collect debris in autonomus period.	It will be useful to realise automatic collection of 5 cubes in autonomus period. At the conclusion of autonomus period the robot will remain on the ramp with 5 cubes and we will put them to the goal immediately	strategy

The main conception of engineering process: FTC rules have a various number of heterogeneous objectives. Some of them are simple, while other are quite challenging. The quality of performance in same tasks depends on laboriousness of realisation of mechanisms.
In these conditions, we made a decision to develop two versions of robot:

1. a simpe, but reliable one, to startup and perform in regional competition

and

2. a high-quality one, which will take a lot of time to design and assemble to perform in further competitions.

Detailed explaination:

1. As we know from our previous FTC seasons experience, there are strict constraints for wheel bases can be used for climbing mountains. Firstly, omni and mechanium wheels are completely not suitable, because mechanium wheels can ride only on plain surface (when 2-nd and 3-rd zones have cross hurdles) and omni wheels have ability of undependable movement on small rollers so they behave very unstable on mountain. Various conbinations of standard and omni wheels can't be used too, as in the 2-nd zone there are obstacles which can cause some wheels lose contact with ground and if the rest of wheels will behave differently, the whole robot would be unstable. In conclusion, we can use only standard wheels or tracks.
   Additionally, wheel base should be symmetrical against central axis for stable climbing to the mountain. If we decided to climb 3-rd zone with standard wheels, we will have to put 3-4 wheels at the each side to avoid getting stuck on hurdles (the space between two hurdles is for about 14 cm, when the diameter of big TETRIX wheels is only 10 cm).

Рис. 1: possible wheel bases

2. To score in high zone goal from 2-nd zone robot should have a mehanism for delivering debris to the distance of 40 cm or more. Shooting debris is entirely unsuitable approach, because it's impossible to realise enough accuracy for stable scoring cubes and especially balls. Another way is elevator. There are three types of lifts which familiar to us: they're crank lift, scissor lift and retractable rails.
   Scissor lift is not suitable for this year competition, because despite it's main advantage - the ability of extracting the longest distances of all - it's too difficult in development.
   Crank lift allows to vary the angle of turning of each segment. However, it requires at least one DC motor of strong servo for every joint.
   Retractable rails can only move along one axis. However, they require the least space and can be equipped by one DC motor (as all the motors are connected to the only reel, which winds the cable).

Рис. 2: types of elevators

3. The parameters of the box are $9 \times 5.75 \times 6.25$. So, it can contain at most 24 cubes (4 in length, 2 at width and 3 in depth). As for balls, there can't be scored over approximately 10 of them because of their unconvenient shape and ability of top balls to roll out of the box (especially from the upper box, which is turned on 50° from horisontal position).

This is the reason to implement mechanism for separating debris into cubes and balls. However, there are only 50 cubes on field (12.5 for one robot), so they will run out quickly, so the ability of collecting balls is required as well.
Additionally, we need to think of how to put cubes into boxes gently so as they will settle down in straight lines. It will allow entire filling boxes with cubes.

4. Solid constructions for pulling up will be too bulky because they have to be strong enough to withstand full weight of the robot. The more reliable and simple solution is steel cable with hook for grasping the bar on it's tail.
   In second case the most difficult objective is to deliver hook to the bar, which can be solved by creating secondary lift for it (the main one is a lift for debris). Mechanism for shooting hook towards the bar is not suitable as it can be dangerous for operators and spectators (if the it will be accidentally activated during the match).

5. The main weight of the robot goes the battery and motors. The weight of the battery is 570g. We have two types of motors: standard TETRIX motor (207g) and "NeveRest 40"motor by AndyMark (334g). The complete control system (phone + controllers + power distributor) weigh about 700g.
   Therefore, total weight of essential components varies from 2926g to 3942g (with 8 motors). With several beams (166g the longest), wheels (117g each) and other construction elements robot will weigh from 6 to 10kg.
   In our primary calculations robot's weight will be accepted as 10kg. However, it is preferable to make robot as light as possible.

6. Wheel bases which are good at climbing mountains are usually less manevrous, than carriages with omni and mechanium wheels. This way, the less robot will turn, the more effective it will compete.
   Accordind to this, it will be more convenient to realise construction that will allow robot to score debris without turning around. Robot can collect debris with gripper on it's front side while moving forward and then go backward to the ramp and score debris with the mechanism on it's back side.
   Furthermore, it will be useful to attach one robot to one ramp in order to prevent them from commiting extra movement. Although it seems that two robots can fill the top goal together two times faster, in fact they will just interfere with each other. So, it will be a good tactical step to negotiate with our ally before the mach which robot will operate with each mountain.

7. This year field is symmetric with respect to the diagonal. It means that all zones of one alliance are the mirror reflection of another. Consequently, the gameplay depends on which alliance you are playing for.
   So, the robot should be capable of executing equal tasks playing for each alliance. The major unconvenience cause releasing alpinists, as it requires two similar mechanisms from both sides, that will take 2 servos instead of 1. Mechanism For scoring debris should be summetrical to provide filling boxes from both sides of the ramp. Besides, autonomus program should be twoside as well.

Additional comments: For the next meeting we need to think of two issues:

1. which tasks our robot should be able to execute without loss of efficiency
   and
2. to set the priorities of performing tasks during the game.

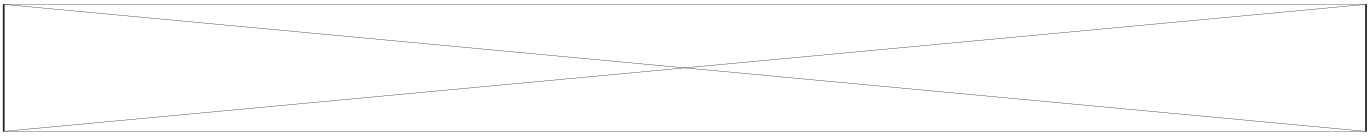
0.2 Strategy discussing (22.09.2015)

Time frame: 22.09.2015 17:00-21:00
Preview: Today we put the priorities during the building of the robot and performing tasks of the game.

Detailed explaination:

1. The tasks which robot must complete (We assume that robot can do everything. Tasks located in order of priority) :
   1.1. Autonomous period:
      1.1.1. Push the button and score climbers. It give 60 points (20 - button 10x2 - climbers in autonomous 10x2 - climbers in tele op).
      1.1.2. Ride to opposite mountain and collect balls and bricks. It help us to save a time because when start tele op we already have 5 bricks.
      1.1.3. Go to middle or high zone of the mountain. It give 40 (or 20) points. Additionally, we start driver control period near the top box. So we can put 5 bricks there immediately.
   1.2. Driver control period:
      1.2.1. Put elements that we collected in autonomous period to the top box.
      1.2.2. Go from the mountain and collect 5 bricks. We decided to collect only bricks because the balls take up much space in the box. So if we collect only bricks we can put more elements to one goal and get more points.
      1.2.3. Put 5 bricks to the top box. After that the top box most likely will be full. So we won't be able to put another five bricks.
      1.2.4. Collect and put 5 bricks to the middle box.
      1.2.5. Start moving to the crossbar and score climbers.
      1.2.6. Turn "all clear"signal.
      1.2.7. Pull-up.
2. Implementation of robot that can perform following tasks (tasks are in order of priority)
   2.1. Stable scoring to the middle box. This task is very simple and give a lot of points.
   2.2. Scoring to the high box. This task is more complex but gives more points.
   2.3. Releasing the climbers on the rope in driver control period. We can do it very fast and get 60 points but for scoring the top climber we must be able to climb to high zone.
   2.4. Scoring climbers in autonomous period. It is very easy task that give 40 points (as 4 bricks in the middle box).
   2.5. Riding to the high zone. It can give 40 points in autonomous period and 40 points in tele op.
   2.6. Pulling up. This task give the most number of points.
   2.7. Turning "all clear"signal. It gives us 20 points and our opponent lose 20 points.
   2.8. Pushing button. This task is difficult in terms of programming and gives only 20 points.

Additional comments:Task for the next meeting: to elaborate concept of the robot.



0.3 Concept discussing (24.09.15 - 27.09.15)

Time frame: 24.09.15 - 27.09.15
Preview: The main purpose for current session was to figure out how the modules of simple robot should look and how they will be developed.

Modules:

Modules	Conclusive solutions	Label
Wheel base	We will use 8 standard wheels with 6 DC motors.	chassis
Elevator for debris	We will use the crank elevator with one degree of freedom.	elevator
Bucket for debris	We will create bucket with turning cover which will close entry inside the bucket to prevent scoring elements from accidental falling out	bucket
Rotating blades	We will put axis with 2 rotating blades ahead of the bucket for grabbing debris	gripper
Slopes for collecting debris	We will put slopes on both sides of the bucket to increase collecting area	gripper
Heaviness	We will build as light robot as possible to afford gear for speed 2:1 on drive motors.	wheel base

Days inside session:

0.4 Concept discussing (24.09 - 27.09)

Time frame: 24.09 - 27.09
Preview: The main purpose for current meeting was to figure out how the modules of simple robot should look and how they will be developed.

Modules:

Modules	Conclusive solutions	Label
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Slopes for collecting debris	We will put slopes on both sides of the bucket to increase collecting area	gripper
Heaviness	We will build as light robot as possible to afford gear for speed 2:1 on drive motors.	wheel base

Detailed explaination:

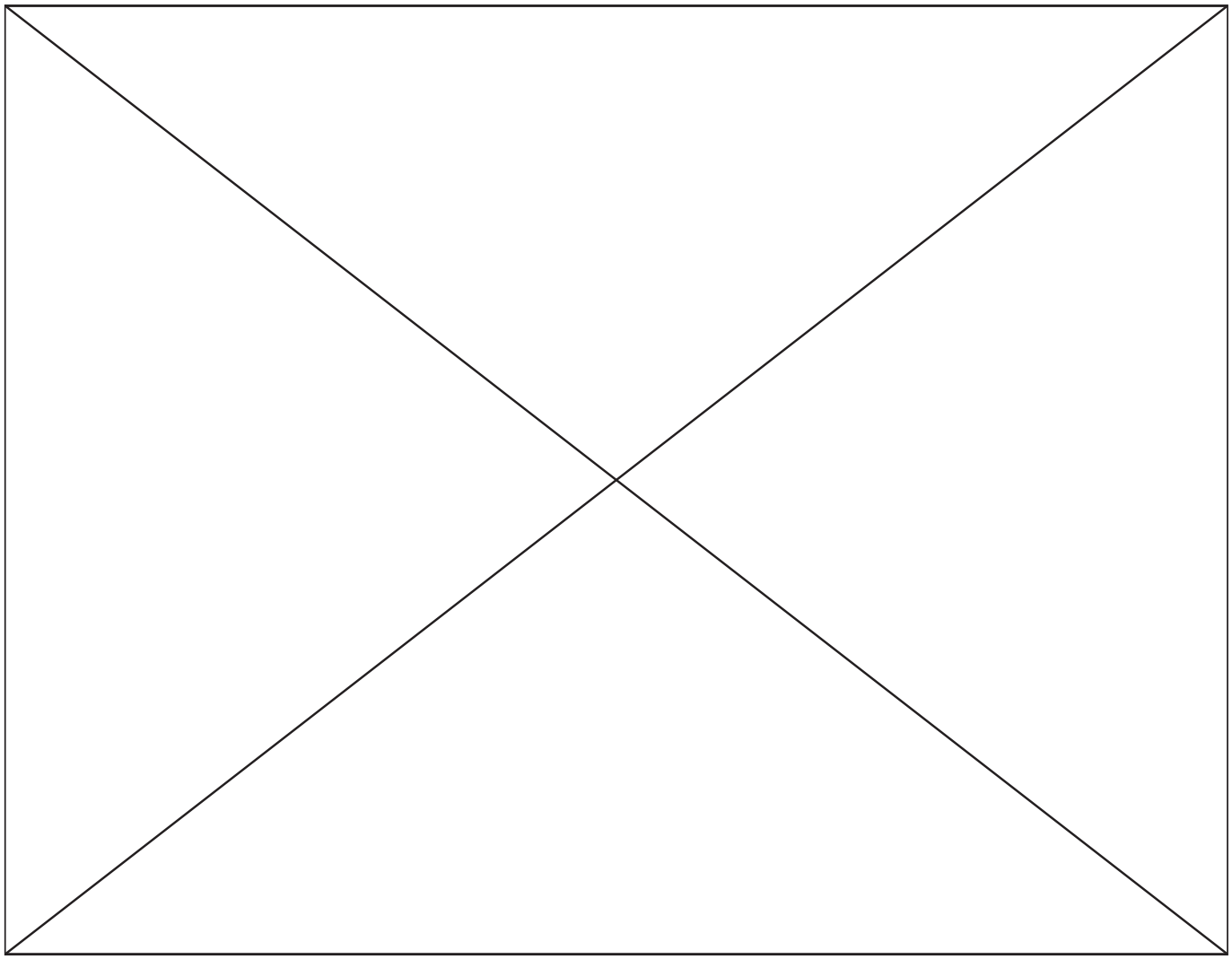
1. Detailed explaination of robot...

Рис. 3: robot

2. Detailed explaination of program...

Рис. 4: robot

Additional comments: For the next meeting we need to consider the high-quality robot's modules.



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

Tasks for current meeting:

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. 5: robot

2. Detailed explaination of program...

Рис. 6: robot

Additional comments:

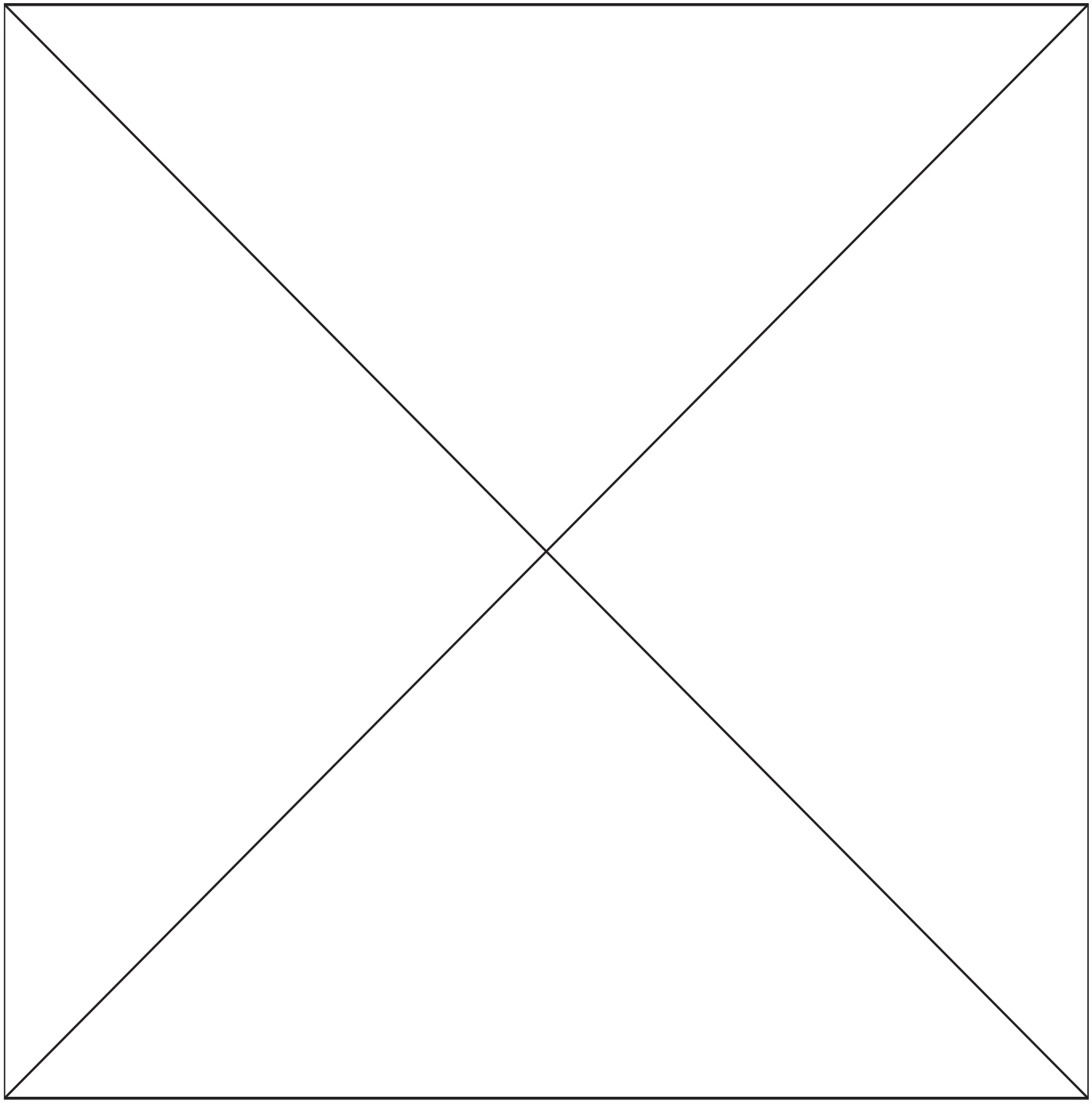
Ideas we invented	Resourses to realise	Label to the result
To build robot	We built robot	robot
To write program	We wrote program	program

The events of the day:

1. Today we met guys from Pikalevo...

Рис. 7: robot

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



1 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