FIRST LEGO LEAGUE

DUTCH DELTA 2016 - 2017

Index

We want to learn!
And now it is our turn!
To have fun and play the game!
Dutch Delta is our name!

1. Our team

History

The Libanon Lyceum is a comprehensive school (three types of secondary education) in the centre of Rotterdam, in the district of Kralingen. The school has existed for more than 100 years. It is a medium-sized school with about 1200 students, but because the school consists of two, rather nearby nice buildings, the students do not feel that the school is large and impersonal.

In the study year 2006 – 2007, during the ICT lessons, the first Lego robots were brought into the school. Then, groups of two students were assigned to build, with a Mindstorms RCX-set, a little robot that could ride along a square.
Some students found building and programming with the Mindstorms sets such great fun that they asked whether more could be done with Lego at school.

Study year 2008 – 2009, Climate Connections.
This year, for the first time the Libanon Lyceum entered the FLL finals in the Rijnmond region, unfortunately not very successfully: we found out that at the First Lego League, more was needed than just a funny little robot.

Study year 2009 – 2010, Smart Move.
This year, the students had got a better knack of building and programming and in that year, attention was also paid, for the first time, to research. A position in the Benelux finals was not yet achieved, but the hard work was awarded by a first position for the robot design.

Study year 2010 – 2011, Body Forward.
By that time, the team had gained a bit more experience. The research was tended out to a biology class and the technical group could fully concentrate on the robot. In the end, we became first in the robot design and in the overall ranking!
Therefore, in that year we were allowed to enter the Benelux finals for the first time. This proved to have quite another level than the regional final, the teams were obviously much better and more fanatical than the opponents that we were used to up to now. Despite the lack of experience, we still achieved a very neat 8th position overall and the prize for the best coach.

Study year 2011 – 2012, Food Factor.

Roughly the same team as the previous year, therefore students with a load of experience. The planning went easier and even before the regional final we had a pack of which we could be content. The girls did a nice research about the shelf life of eggs and the boys put all their experience in a new robot. Full of confidence, we went towards the regional final and for the second time in succession we won the first prize.
Not yet quite content about the robot, the team started to build a new one, which got his baptism of fire during the Benelux final. It did not yet go very well there on the playing field, we finished somewhere in the middle part. We did however finish in a high position on the overall list: 3rd place, later transferred into a wildcard for the OEL in Mannheim.

Study year 2012 – 2013, Senior Solutions.

This year we started with an almost completely new team. Two team members who had become too old to be allowed participation in the competitions, became junior coaches. At school FLL had becom a part of the curriculum for the “Technasium” classes, and te team helped to select which teams were allowed to go to the first competition. We did this by organizing a public selection tournament with the parents as public and our team members as judges.
The team itself built a new robot and examined how they could get an elderly lady knitting again. In December, the Rijnmond regional final was won for the third time in succession, but unfortunately, circumstances prevented us to make a good score during the Benelux final.

Study year 2013 – 2014, Nature's Fury.

This year we were off to a good start with all the preparations for the region final. A large part of the team participated in this contest over the past few years and with these experienced team members we have again, for the third time in a row, won the top prize.
With a list of points for improvement the team went to battle to prepare for the upcoming Benelux final. It went very well and to our delight we were awarded the first prize overall. We could also take part in the FLL World Festival in Saint Louis, USA. With weeks of preparations and hunting for sponsors our journey could begin. The team was pretty sure of itself because of the good preparations. But in the USA team found out that the level here is extremely high. Nevertheless, the team won a wonderful third prize for the robot design!

Study year 2014 – 2015, World Class

Several pupils who had been to Saint Louis have stopped this year. Some of them indicated that they would like to use their knowledge about the FLL to educate the new team members. And so they did, thus the new members have learned quickly about the software and how to tackle the investigation. Also, it was nice that this year we had girls in our team who like to work with the robot. It was even so that we to the regional final was played by a team with one boy and six girls!
On the regional final, we won the first prize, so again we could go to the Benelux final. That was very exciting. The robot didn’t function good in the first two rounds. But halfway through the day, we received the gracious professionalism ™ children's jury. And thankfully the last robot contest went fine. In the end, we won the third price overall, and we were quite happy with it.

Study year 2014 – 2015, Trash Trek

With a diluted team with many new members we started the school year. Fortunately, the old team members took the time to transfer their knowledge to the new students. We went to Kliko, a Dutch company that offers waste collecting solutions. They sponsored us with three mini-Kliko’s to build our prototypes we could use at the regional final. With the prototype and the research, we scored well and although the robot did not perform optimally, we went right through to the Benelux final.
On the Benelux final the robot unfortunately failed, after three robot-rounds it was already clear that we wouldn’t win an overall price this year. So, we were very happy to win the project prize!

Other activities with Lego

In recent years, the school has introduced the new Technasium education and asked the coaches of the First Lego league to put together a learning program. It was decided that the first-year students would participate in FLL during the R & D (Research & Design) program. The students are divided into groups that build and program the robot and groups that do a research project. A month before the region final there are qualifications at school. The students of Dutch Delta help with the judging of the robot missions and project presentations. The winners will form into four teams.
The school final is also selection used for the general school team (team Dutch Delta). This team is working after school time and has the advantage that the pupils have one or more years of experience. This team also has some more freedom regarding the design and some more Lego at their disposal.

During the open doors days are demonstrations of the various programmes given by team Dutch Delta. The Dutch Delta FLL team regularly gives demonstrations. For example, at meetings of LOWLUG (A Lego user group) and on Lego world in Utrecht, the Netherlands. In cooperation with the TU delft, our team has in the past regularly given Mindstorms classes in primary schools in our region. Also, we have participated in the MoonBots competition in 2014 and 2015 competition. Here we had to create a game board with mission designs and let the robot do these missions. Eventually, we had to present this to the jury via a video chat. in 2014, we won the third prize.

Season of 2016 – 2017

This year the Libanon Lyceam participates in FLL for the sixt time, with multiple teams:

Team Dutch Delta	The old team that has been participating for a couple of years now.
Team Libanon Duplo	Technasium students
Team Libanon Primo	Technasiumstudents
Team Libanon Quarto	Technasium students
Team Libanon Toolo	Technasium students

Each team of the Libanon Lyceum Rotterdam wears the same shirt in a different colour. Even the coaches walk in this shirt. Dutch team delta wears blue shirts. Our team is the only team of our school that is going International

Our team has a mascot named Bricky. He will encourage us in our contest shirt.

Last year, a large part of team Dutch Delta was new.
Two former students officially became coach. The team this year consists of many new students from the 2nd class. There are also students from the 3rd and 4th class participated last year with the FLL.
As in previous years, we started the robot group and the research group separately and some time before the region final they fused together again. There still is similarity and cooperation between the robot and research group: two students are in both groups, and there is great interest from the teams to the progress of the other group. Just like last year, there are many team members that have never participated in the FLL before. Therefore, it is a great challenge to reach a result that meets what is expected from our team.

We have a website: *DUTCHDELTA.WEEBLY.COM*

We can be followed on social media: *FACEBOOK.COM/DUTCHDELTA*
TWITTER.COM/TEAMDUTCHDELTA
INSTAGRAM.COM/DUTCHDELTA_FLL

Preparation and objective

Just like last year we also started this year with making a list of things that went right and wrong last year. We have noticed that the list of bad things gets smaller every year, and we can reuse more and more things from previous years.
These are the points to which we have devoted a lot of attention this year:

- clear objectives
- more structure in saving the programs
- consistently keeping a logbook
- look carefully at the rules and the Q&A the whole season
- read the judge's forms before the big day and see if we can score high
- print all documents out with enough time to spare before the big day
- next to the adult choaches we want to appoint one of us as junior coach. He or she can keep us focussed during the matches, we do not want our “real” coaches doing too much for us.

We have divided the season into the number of weeks still to go until the scheduled contest and what exactly we were going to do in those weeks. Every tuesday we discussed whether we had achieved the goals of the last week and if it was necessary to adjust the planning for the next few weeks .

Objectives for the whole team:

Above all have fun, learn a lot and get a little bit better every year

Every year we grow a bit. We learn more, the preparation is getting easier and we end up somewhat higher in the final standings. Because we have more and more experience the things that last year went well are getting easier and faster and we have more time to do things that went less well last year. We now have the feeling that we meet up to everything to be expected of an fll team. We have fun and we certainly have at least learned a lot over the past few years.

Introduce technics in our school education

This is actually an objective of the coaches, but we were also involved. The Libanon Lyceum is trying to stand out by focusing more on technological education. We have “Technasium” education introduced and participating in the FLL is integrated for the first year students.

Objectives for the robot group:

To build a sturdy robot that is not too heavy:

In previous years, we have learned that a robot that is not firm is unreliable. We do our best when designing the robot to be able to find a good balance between sturdiness and precision.

Changing attachments should be even faster

Last year we developed a 'clothespin' attachment. The changing of the attachments is going very fast. This year we are going to use this method again, but we try to minimize the number of attachments we need by doing multiple missions with 1 attachment.

Let the robot do its thing with minimal human intervention

To position the robot well every run this year we use frame. After the start, the robot itself will find its way with the gyro sensor and by the lines on the board.

Rewrite all excisting software (MyBlocks)

We work together as a team and use the base software that we have previously developed. We learn more about programming this way and we can share knowledge with each other. The downside is that our software has become ever more extensive. For this year, we have chosen to develop a new software, including all our MyBlocks

Bring more structure in the programs and filing:

If we write or modify software we give this a unique name with the date. That way, we can always fall back on the software version from the previous day. We have the program divided into several runs. The runs are my-blocks as part of the main program.

OBJECTIVES FOR THE RESEARCH GROUP:

A good research.

We want a good research. We want to research something that is interesting, amusing, informative and is a solution for a real problem. We also want to find a problem for which a solution is really needed in the society.

A solution that has been developed as far as possible.

We want our solution developed as far as possible, so that it can be produced at any moment

Good time distribution in the presentation.

We have a lot of information and other things to tell and to show to the judges. Our goal is a tight, short presentation with lots of information in a fun way.

Good cooperation within our team.

Another goal of our team is good cooperation. We want all members to work together and learn a lot, and try to solve our problems (if possible without our teachers or mentors). We believe it is important that everything is done together as a team

TEAM COMPOSITION

After the regional final, the team's composition has not changed.

Marjolein van den Berghe	Robot, Software
Kars Bebelaar	Robot, Software
Vincent Balk	Robot, Software
Storm Hoogstrate	Robot, Strategy, Hardware & Research
Hugo Polman	Robot, Strategy, Hardware & Research
Eriany van Deijk	Robot, Hardware & Research
Joris Hoogeweegen	Robot, Hardware & Research
Liselotte Schmitz	Research
Femke van Ette	Research
Harald Vijverberg	Coach
Karen Bebelaar	Coach
Anne Schmitz	Coach
Rory Rinck	Coach

Team get together

In team Dutch Delta almost everyone is in a different class at school and in many cases also in a different year. Because of this our bond was not so strong at the beginnen. We didn't know eachother that well.

On 29 November 2016, we had a get together without our coaches. We bonded by telling eachother something that we wouldn't normally just tell someone. Telling our stories to eachother was sometimes hard. To compensate we also did some nice games and had lots of laughs. Especially when we were playing charades!

Unfortunately, Joris was ill this day. But we the get together was very useful. Because we told eachother some hard things it is now easier to talk about things. It was a successful, emotional and fun afternoon that we would love to do again some time!

2. Core Values

What do the core values of the FLL mean to us?

We have assessed whether we could meet the standard of the 'core values' of the First Lego League. Actually, it was not that difficult, since we found out that we already aimed for most of those values:

We are a team

We are a team, but we have the problem that we are in different classes and we have to do everything outside school hours. Because the schedule and the use of the classrooms change a few times per year, this is not easy. In daily life, you always must collaborate, be nice to each other and help each other with problems. For example: At school, with a project in groups, you need to have good communication, collaborate and help each other whenever necessary. This should be done to prevent misunderstandings and to make sure that each of us does just as much and to achieve the best possible result.
Fortunately, we do have a fixed classroom that we may use during a few hours every week. Our playing field is there and the Lego can be stored there. When the robot group is practising, the team members of the research group often come by to go through some things. This way, each of us knows on what things the group is working and we can discuss what should be done next week. Things like the decoration of the stand are also organized then.

We do the work with the guidance of our coaches and mentors

Yes though, but less and less. One of our new coaches is also a pupil at the Libanon Lyceum, we can easily ask a question if we encounter her in the hallway on school. In addition, we now have several years of experience and the coaches need to do less and less. Though they provide biscuits and chocolate as we come together.

We are aware that our coaches and mentors don't know everything. We learn together.

Nowadays it happens more often that we have to explain to one of our coaches how we have made something because he or she does not understand. That was a lot different a few years ago.

We support the spirit of friendly competition

First of all, we try to do our presentations as well as possible, but other teams can always come to us for help. For example: we give the teams from the sophomore classes at our school tips on how they can prepare themselves well.

What we discover is more important than what we win

Of course, we want to finish as high as possible, but that's not our primary objective. First of all, we would like to have a great time with each other and we try to be a little better each year. In recent years, we have learned a lot about technology and a lot of other subjects. Even the team members who are doing the research now know a lot about the robot and the robot team members have learned a lot about the research. It's nice to win, but you don't need to be too fanatical. This would only create quarrels. You can see something similar, for example. In football.

We share our experiences with others

This year we have presented our research to interested parties in Sweden.
Also, the robot group likes to share its knowledge. Unfortunately, we could not go as a team to LEGO-World last autumn in order to present our robot and help in the Mindstorms stand. Three (old) team members did go to LEGO World for an entire day to demonstrate Mindstorms and wedo. Next year we hope to go back to LEGO-World as a team! During the open days of the school we always give a presentation of our research and the robot. Last year, we received a lot of new pupils at school who have chosen for our school because we do so much with the First LEGO league.

We show Gracious Professionalism in everything we do

That is what we are trying to explain right now. ☺

We have fun

We do, otherwise the old team members would not stick around and keep coming back to help new team members.

THE CORE VALUES OUTSIDE OF THE FLL

We have thought about how we applied the core values beyond FLL last year during the making of the core values poster and actually this was not that difficult. Below are some examples that would be applicable on our team:

“During the making of our prototype, we used tools I never had used before. When my father was doing some odd jobs last month, I was able to help him with because I had learnt that during the FLL.”

“Last week I had a fight with my sister. In fact, it was for no reason at all and suddenly I had to think about the competition and what we had learnt about Core Values during the season. Then I told my sister she was right and afterwards, we could make amends.”

“Learning together is always the thing at our school, which is why we are in a so-called world class. Teaching is not traditional there, but we work together and therefore also learn together.”

“Besides things with school, we also see the core values in things like a theatre group or sports activities, because of the teamwork that is required for these activities.”

“To us, the Core Values are not only a way to deal with the FLL, but we have started to deal with everything in our lives trying to follow the rules of the Core Values!”

3. Our examination

Problem indication

Theme FLL

This year the research question for the First LEGO League is: "*How can we improve the interaction between human and animal*"

The definition of interaction given by the FLL organisation is: "When human and animal affect each other's lives. This can be positive or negative."

We have chosen the reindeer. Reindeer are the cows of the north. They're bred for their meat, milk and fur. The reindeer have an owner, but they don't live on a farm like usual. They live in the wild throughout the whole year.

The two main problems during the interaction between human and reindeer are:

- **The people who keep the reindeer have to gather all of the herds together for maintenance. During this process, the reindeer are picked out per family and counted because all the reindeer in this area live together. Those countings are the most stressful for reindeer.**
- **When people with dogsleds enter the area, they can encounter the herds. The reindeer are scared of the huskies and are disturbed, which is not allowed.**

Research question

For the main problems, we've developed a research question with two sub-questions:

With what appliances are we going to improve the interaction between human and reindeer?

- **With what appliances are we going to make the counting of the reindeer less stressful or not even necessary?**
- **With what appliances are we going to make sure that the reindeer are not going to be disturbed by the husky drivers?**

During our research, we have discovered that there are more problems in the interaction between human and reindeer. Besides that, there are problems in the area that don't have a connection with the interaction between humans and reindeer. You can read about this in our examination. During the brainstorm session about a possible solution, we've tried to combine many problems with our solution. And we've done it!

Case history

Before we had the idea to use reindeer in our examination, we have thought about other animals. These animals were:

- Geese: they fly around Schiphol and cause trouble.
- Coral: it is threatened because of the human influences.
- Spiders: they get killed because people are afraid of them.
- Mosquitos: they get killed because people find them annoying.
- Forest animals: they die because of forest fires, which are started by (indirect) influence of humans in countries like Australia.

Due to the NOS news channel, we got the idea of reindeer. In the broadcast of 29 august 2016 you could see that because of lightning more than 300 reindeer died in Norway. We wanted to put a lightning conductor on their antlers to solve this problem. Unfortunately, we discovered that all reindeer lose their antlers every year. Because we think that reindeer are interesting animals and we know someone who visits Northern-Sweden often and has contact with the Samen - the reindeer keepers -, we have chosen to see if there are other problems with these animals.

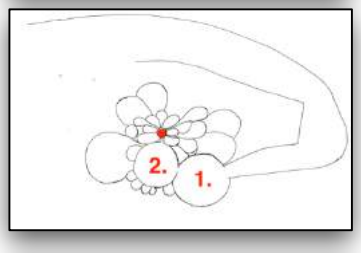
Problems between the Sami and their reindeer

The Sami are the original inhabitants of the north of Scandinavia. They're specialised in keeping the reindeer and therefore they're called "The farmers of the north". To know more about the interaction between the Sami and their reindeer we have skyped with Per-Nils Päiviö, a Sami from the reserve Saarivuoma in Sweden.

Per-Nils told us, among other things, that the reindeer are gathered together in a Coral a few times a year. Some reindeer get picked out for for example the slaughter and the calves get marked, so it's clear who's the owner. This puts the reindeer under a lot of stress, but it's unavoidable.

Once a year all the reindeer were counted for the taxes. From the big coral, the reindeer were gathered together in groups of 500 into a small coral. The reindeer walk closely spaced in the coral so the Sami can catch them by hand and separate them in different fences per owner. Those countings are so stressful for the reindeer, because they can't escape the small coral but really want to do so. According to Per-Nils it would be useful when you can see which reindeer is from which owner from a distance. Now, they use an expensive GPS-system for a few reindeer. This way they can localise at least a few reindeer. You can read more about this system later.

At the right, you can see a satellite photo and a schematical drawing from the coral in Järäma in the reserve Saarivuoma. The reindeer are gathered in a "trunk" and finally end up in the first or the second circle. By means of the countings they are gathered in groups of 500 to the small circle in the middle of the "flower". Out of this circle they are separated per owner in the "petals".



Problems between the mushers and the reindeer

Per-Nils told us that there are sometimes problems between the reindeer and the many companies that organise tours with dogsleds for tourists. For this purpose, we've talked with Jordana Widosuwito and Kent Gjöran Svendsen from Husky Tours Lapland. They are "mushers", the people who work with the dogs.

Jordana and Kent told us that the mushers would like to see where the reindeer are, so they can avoid them before they go on tour with the dogs and tourists. They want to avoid the reindeer because they encounter the herds which is not good for the reindeer, but it's also not allowed by law.

Besides that, they would really like mobile access in the area for when there is an accident with the tourists, the dogs and themselves. But they felt it was not necessary for the tourists to go on Facebook or other social media instead of talking to each other.

Program of demands and wishes

Based on the first information and the conversations with the Sami and mushers, we've drafted a few demands and wishes for our problem indication.

Demands:

Improve the interaction between human and reindeer, specifically:

- Prevent the most stressful countings by the reindeer
- Prevent that the reindeer are encountered and panic because of the Mushers with their dogsleds

Wishes:

- Prevent that many car drivers bump in crossing reindeer
- Prevent that the reindeer are killed or spooked because of the rockets that are shot by investigators of the Esrange Space Center in Kiruna
- Prevent that people with a sickness or an accident get help too late because there is no mobile access
- The solution must localise the reindeer easier and faster, so it's not necessary that there is a Sami in the area (in the wild) every time so you can know where the reindeer are
- Prevent that many reindeer starve: if many reindeer starve in one short period it's a sign that there is a sickness or a predator
- Prevent malnutrition by reindeer in a stern winter
- Help localise a gap in the fence between two reserves more easily
- Measure extreme weather so Sami and Mushers don't get unpleasant surprises
- Make it easier to count the reindeer for the taxes

Available solutions

Before we began thinking about a solution, we've investigated available solutions to the current problems.

The two main problems in the interaction:

Stress by the countings

At the moment, there are two solutions that could help:

- Cattle watch is a system whereby counters can see where their cows are. The system comprises a chip that's placed in the ears of the cows. With 4G and satellite connection the farmers can localise their cows. A disadvantage is that the cows are only connected when they're in a circle of approximately 150 meters and the system isn't useful as mobile help network for other users.
- A GPS-tracker can send the location of a reindeer. The big disadvantages of the system are the costs: the purchase is €350,- and every year you have to pay €300,- for the season ticket and battery. It's a system to localise a whole herd with one reindeer, very inaccurate without a doubt.

The encountering of reindeer

The only way to avoid the reindeer is that the mushers keep in touch with the Sami so the mushers can ask where the herds are. This doesn't happen very much, because the relationship between the Sami and Mushers isn't very good.

Solutions for two other problems

Car accidents

Navigation systems let the user see when there are reindeer on the road, but those signals aren't accurate. The warning gives a signal for over 30 kilometres, this isn't very useful anymore because many car drivers are going to ignore the warning after some time.

Mobile access

At the moment, there's little to no access in the reserve. It's a stretched-out nature area with actually only one road on the edge of the area. There's mobile access by the road, further there's only mobile access through some 4G points.

The available solutions for this are;

- Use a satellite mobile, a disadvantage is that they're very expensive.
- The SPOT communicator is a device that can send an emergency signal with GPS-coordinates. The disadvantages are that it's again very expensive and your access is limited. This is because the satellite is above the equator, but the reserve in the high north.
- Use the old NTW-network. You can only use this one on very old devices (around 1980). Some Sami do use this network.

Our solution: RenNät

After we've investigated the problems of the different groups, we've searched for available solutions. Based on this examination there isn't a good solution for all the problems. That's why we brainstormed for a good solution.

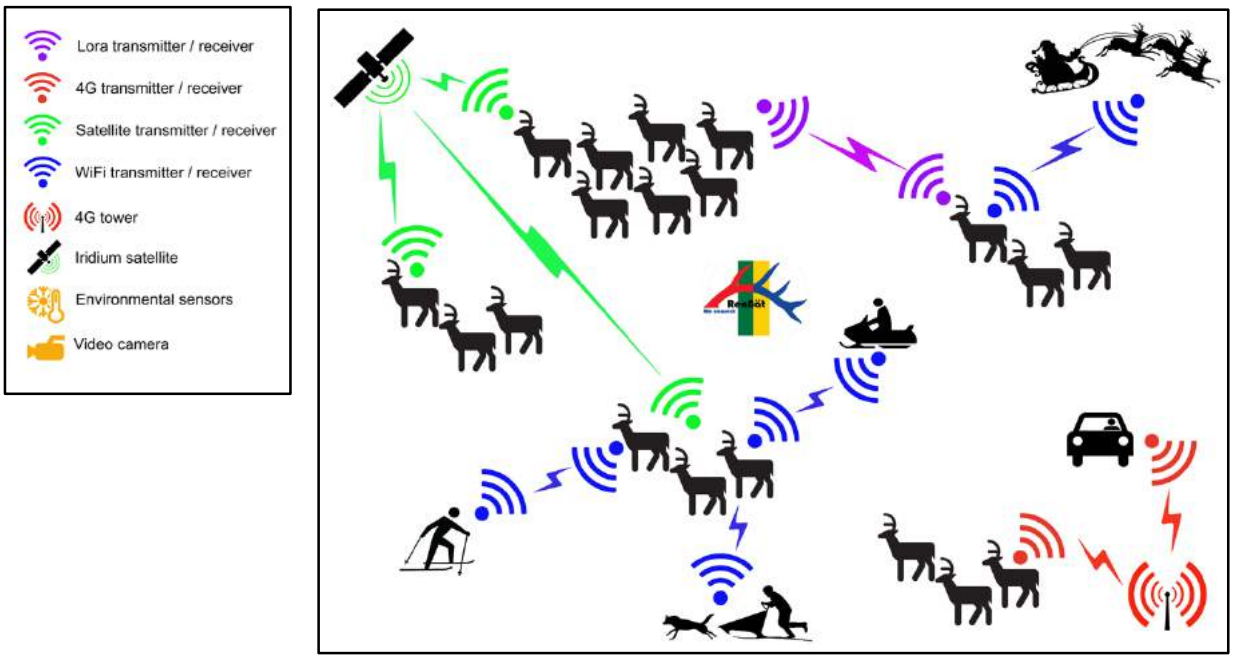
We've developed a system whereby the reindeer are electronically connected with a module that hangs under their neck. Most reindeer get a basic module, with which they are in contact with each other. Some reindeer get a special module, with a 4G and satellite transmitter and receiver. If those reindeer get in contact with the outside world with the 4G or satellite, all the reindeer -the one that has the basismodule and the ones in contact with the special reindeer- have contact.

With the network, the location of reindeers can be determined and it is clear which reindeer is from which owner. Besides, the people can use the internet connection in case of emergency.

We call our solution **RenNät**.
Ren is Swedish for reindeer and Nät means network. With our solution, we make a network out of reindeer and besides that the reindeer are connected to the internet.

The Network

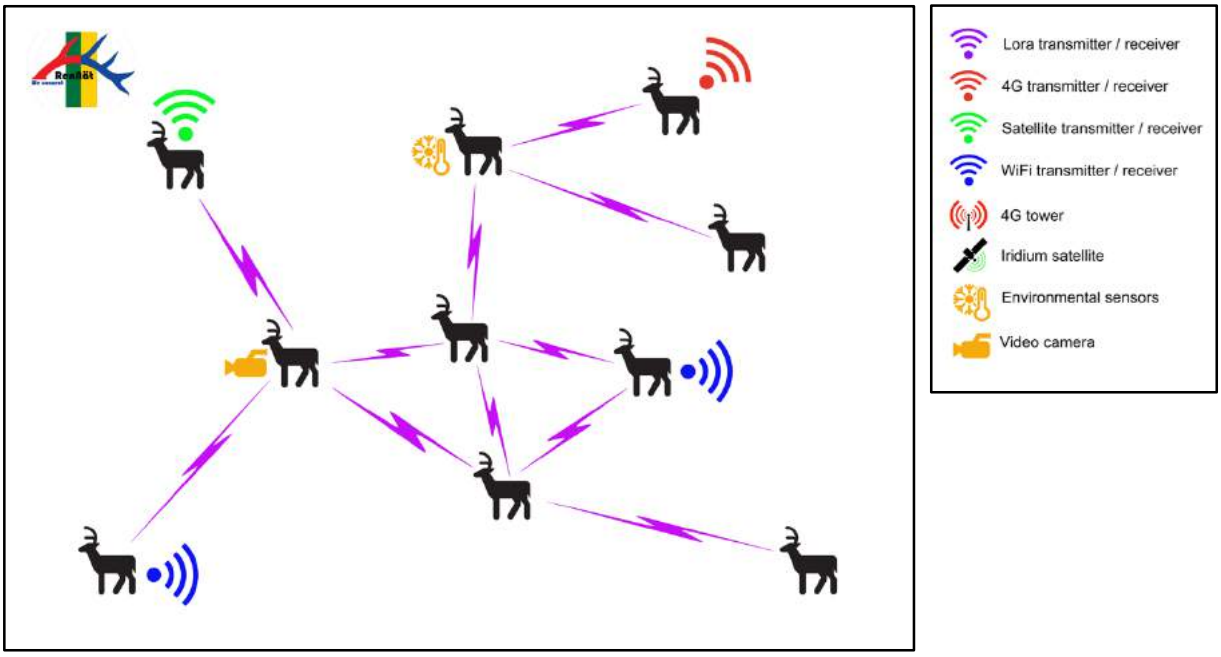
With a website, the Sami can see where their own reindeer are. By giving the devices some extra sensors they can see also the weather on one specific place for example. It's also a possibility that there's a photo camera added to some modules, so the photos can be used for for example documentaries. The mushers can use the website so they can see where the big herds are. Companies like TomTom and Garmin can use the information to give the car drivers more specific information.
We knew that it is possible to make networks like this. But because we didn't know much about the technique itself, we did much compounding research. For example, we've did research about chips and processors that are available and which can be used for our network. We've gathered most information ourselves, but we've also talked extensively with sir Pieter Venemans from TNO. He has told us a lot about digital networks. Thanks to sir Venemans we got an idea for the reciprocal connection of the reindeer to use the LoRa network instead of WiFi. This network can connect over 10 kilometres, that is much more than a WiFi connection. More information about the different networks you can find in the supplements.



Afterwards we've annotated how many reindeer are getting a basismodule and how many are getting a special one. For this we've looked to the average size of the herds that has connection with LoRa and made an annotated estimate. We assume that per 25 reindeer, there's one who has to make contact with the satellite and one with 4G.

Number in herd	How often does this number occur in a year in %	Mobile coverage in %
20.000	1	2
10.000	/	25
5.000	/	37,5
1.000	/	47,5
500	1,6875	48,75
250	3,375	49,5
100	6,75	/
50	12,5	/
25	25	/
5	50	50

In the chart, you can see in the left column how many reindeer there are in a average herd on a specific moment. In the middle column, you can see how often the average herd size that occur each year. This varied namely each season. Afterwards there's made, based on the LorRa network, an annotated estimate from the access in percents per herd size. If you read out the table you see that the herds of five reindeer happens the most. That means that in the biggest period of the year, there's the most mobile access.



Per 25 reindeer:

- 18 base modules
- 1 4G module
- 1 satellite module
- 3 wifi modules (to connect with your mobile phone)
- 1 photo or camera module (to take pictures of the reindeer in the area)
- 1 “weather station” module

Costs and gains

Based on the conversations with the sami and the mushers we’ve drafted a few demands about the appliance itself:

- The appliance mustn't weigh more than 250 g
- The appliance mustn’t cost more than €50,- per reindeer
- The costs of the network mustn’t cost more than €25,- per year
- The appliance must be protected for heavy circumstances.

Below you can see the table with the general costs. One module will be more expensive than another, conditional to the used technology. But calculated in groups of 25 reindeer, a module will cost approximately €23,-.

cost in €	Contents of module			
€20,00		LoRa	Processor	GPS
€25,00	4G	LoRa	Processor	GPS
€60,00	Satellite	LoRa	Processor	GPS
€25,00	Wifi	LoRa	Processor	GPS
€30,00	Camera	LoRa	Processor	GPS
€25,00	Weather	LoRa	Processor	GPS

This idea doesn’t have to be financed by the Sami only. Other groups who profit from our idea can pay too. Examples are TomTom or Garmin, because they will have more specific traffic information and mushers will see the location of herds. Tourists could maybe pay a little amount to get permission to use the network. Later we will calculate the costs of the website application, of course this will cost something too. Every year, an amount should be payed for connecting with the satellite and 4G. Because we’ve got a very big plan, the price will be less than the normal consumer prices.

Advantages and disadvantages of our system

Advantages:
Almost all the problems from our programme of demands and wishes will be solved.

Disadvantages:
- The LoRa network can send messages, but you can't use social media like Instagram and Facebook. It's meant as an emergency network
- The modules do need a battery and those can't last forever
- With our network, you still haven't got access everywhere. You only have access when you're close to the reindeer

The technology

Before we worked out our idea, we've investigated different kinds of technology like chips, processors, modules and networks. Below there's a short description. For more information, you can take a look in our supplements.

Processor
You need a small computer so all the chips and modules can function. This is called a processor. An example is Arduino. This processor is not meant for big projects like ours, but for "doing handcrafts", so this isn't a good processor for RenNät. For this we need a bespoke processor.

Networks
LoRa network
LoRa means Low Range Low Power. A LoRa network can send and receive little messages wireless, but doesn't need a lot of energy. This network is also on a very low frequency, which means that is can send messages over 10 kilometres. The Dutch company KPN has participated in designing the network. It even went a step further. KPN made it possible to receive information on your computer from a great distance.

Iridium network
This network is one of the most expensive and most used satellites. The costs are a big disadvantage, but mass customership can help fight these costs.

4G networks
This network is used by a lot of people on their mobile phone. It's not expensive, but you must be close to a mast.

Central server and website
If the information is sent to the outside world, it's received on a central server. This information can be transformed into a website or app for the Sami and Mushers. With different accounts for the Sami and mushers, the information can even be separated. How many reindeer a Sami has, is something that's only for the Sami. The information can be sent to others too, for example companies like TomTom and Garmin.

Sharing with others

We've shared our solution with the Sami, two mushers and an expert from TNO. They gave us their opinion on our solution and some advice so we can improve our idea, or find more information. Finally we've shared our idea with interested people during an evening at school where we told the Technasium about the FLL.

Interview with Per-Nils Païviö

To make the situation clear for us, we've talked with a Sami, Per-Nils, via Skype. He has a big reindeer herd and has worked with them for years. During this interview, we discovered that they don't know how their reindeer are doing. They see this with the countings and overhauls only. They told us that is would be very good if they could localize the reindeer so the gathering and countings go faster. Besides it would be very good if they could immediately know which reindeer is from which owner. They wouldn't be happy if everyone could see how many reindeer every Sami has, this is very personal in Lapland. They were also interested in the camera because they could sell the photos to film companies. You can find the whole interview in the supplements.

Interview Jordana Widusowito & Kent Gjöran Svendsen, Husky Tours Lapland

To identify the problem of the mushers, we've spoken to Jordana and Kent. They run a company where they go on tour with the dog sleds and the tourists. They told us that they were very interested in the location of the herds. They don't want to encounter the herds, but it's also not allowed by law. Some mushers make contact with the Sami to ask the location of the herds, but most of the time the Sami don't know it either. The mushers will profit from the mobile access too, because then it's safer to enter the area. You can find this interview in the supplements as well.

Conversation with Pieter Venemans, TNO

To get more knowledge about the technology, we've spoken to Pieter Venemans from The Netherlands Organization for Applied Scientific Research (**TNO**).
Mr. Venemans told us more about the WiFi network and told us we should use the LoRa network. More about this interview is in the supplements.
After the regional finals, we've spoken to him again. This time we talked about the database and the website. In other words, how we're going to present the information to the user.

After the regional final

After we won the regional finals in Delft, we went to work again and have examined a few things.

Battery

The modules need energy, that's a fact. That's why we investigated different kinds of energy resources. An example is kinetic energy, like you can find in some watches. Based on our examination this is the best solution. In the modules, there is going to be a light system that generates energy when the reindeer moves. A part of this energy is used immediately, the other part goes to a battery.

Other places

We've also looked for other places in the world where people could use RenNät. We've searched for places where there are animals who live in herds, but where there's limited to no mobile access. We saw possibilities for our system in Brazil, Australia and Canada with cattle breeding and stretched out places. But also in a country as Iceland, where the system could be fitted on the Icelandic ponies to make it safer for tourists to go into nature.

Database and example website

Further we wanted to develop RenNät more technically, because making a beautiful website is nice, but first we needed to investigate the technology of the database where all the information is collected. There are a lot of things that need to happen between information coming from the modules and it being displayed on a website. That's why we made a display model of a database and its information. After that we looked to which devices could be used and which user receives which information. In that way, we could sketch a website. Our expert made an example of this sketch for us

After the Benelux final

After the Benelux final, we decided to do a little more research on some topics to get more general knowledge. And we got the change to go to our local – but internationally famous – Blijdorp Zoo and visit the reindeer there. We could ask Jimmy, the reindeer caregiver, al kinds of information about the animals and we shared our research with him. Jimmy made clear that our module would not be too heavy for the reindeer, because they are used to having the heavy antlers, so their necks have a lot of muscles.

Jimmy told us that the clicking sound the reindeer make when they walk has the function of a gps. When there is a snowstorm and they cannot see a thing, the reindeer can still hear where the other animals are. That way they stick together. The sound is made by a tendant in the feet of the reindeer.

Jimmy showed us an antler and told us that the they have skin around them when they grow, which starts itching in the fall. The reindeer start rubbing their antlers against trees but also inside their cages. And in the moring it is sometimes really bloody in there! But the skin needs to come of and when the antlers are clean the reindeer men start competing and having fights to impress the female reindeers.

After we shared our research with Jimmy he took us outside to see the reindeer. There was a sort of fence that made us less visible for the reindeer. And they were a bit scared. But Jimmy gave them some food and then they came closer. We already knew that the reindeer in the zoo were a different kind than the reindeer that the Sami are keeping. The reindeer in the zoo are wild reindeer that originally come from a part of Russia. And now we could see that they really have much longer legs than the ones we had seen in all the pictures!

After we visited the reindeer Jimmy even showed us the giraffes, which we could feed. Because the zoo gets so many requests from students they normally do not help in this way. Lucky for us end of April the headmaster of our school announced that he had a new job. As the new managing director of the zoo…

We had a great afternoon! Unfortunately, we could not make a post on social media, because we had to be discrete about this visit.

Sources

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Professionals/contact persons:
Technical staff member TNO, Pieter Venemans
Sami, Per-Nils Païvö
Mushers, Jordana Widusowito & Kent Gjöran Svendsen
Reindeer caregiver at Blijdorp Zoo, Jimmy

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4. ROBOT HARDWARE AND SOFTWARE

PREPARATION

We started with an inventarisation of the benefits and the disadvantages of different types of robots. That is how we made a choice of what we wanted in our robot and what we approximately wanted him to look like. We started with selecting which type of wheels we would use for the robot.

A robot with four wheels is unstable. It is very imaginable that in a four-wheeled system one of the wheels would come slightly off the ground. Because of this the wheel wouldn't convey the movement and the robot wouldn't get to the desired location. That is why the choice became not to use four wheels and we decided to use either three wheels or a caterpillar track.

We wanted everybody in our team to get experience in building so we decided that everybody would build a robot of their own with three wheels. Subsequently were we looking for the advantages and the disadvantages of the robots. We payed attention to stability, compactness and ruggedness of the robot. All the robots with three wheels were too small to easily use appliances and slipped very frequently.

So, we continued with a robot with caterpillar tracks. The most important benefit of caterpillar tracks is the contact surface, with caterpillar tracks the robot has a lot of grip and so it doesn't have a chance to slip. We Also looked at the map of this year and the different missions. We concluded that a robot with caterpillar tracks was the best option.

We then started working in groups of two people on a robot with caterpillar tracks. We focused on keeping the robot small and light. The robot must not be too wide because of issues with manoeuvrability. The robot must not be heavy because then the maximum speed is too low. With those two points began with a new robot.

After the orientational phase we chose two roots to develop further. Because the amount of demands we set to our robots, the two robots looked a lot like each other. Based on that we have compared the benefits and the disadvantages and chosen for our current robot.

Requirements for the robot

The base
First, the sturdiness of the robot is very important, we don't want it to fall apart while driving. Frames give sturdiness because of their size and because they aren't able to come apart, like multiple smaller parts would. The opposite is true for beams. The construction of our robot prevents the robot from falling apart. Another important item is the symmetry of the robot. The robot will drive straight and it will improve its reliability.

Compact
Our robot is compact; we have built all parts as snugly as possible.

Bottom
We have built the bottom of the robot flat. Otherwise, the robot wouldn't be able to do the "Service Dog".

Placement colour sensors
The sensors are as low to the ground as possible. We have done this to prevent influence of light from the surrounding area.

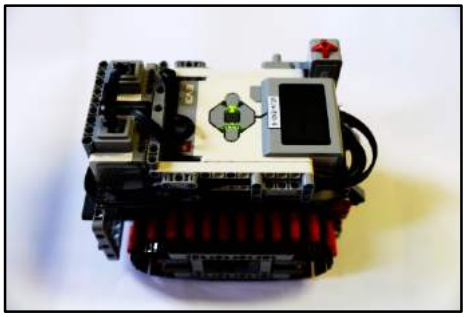
Placement gyrosensor and medium motor
There's space left below the intelligent brick. We placed the gyro sensor and medium motor there, so the robot wouldn't get bigger.

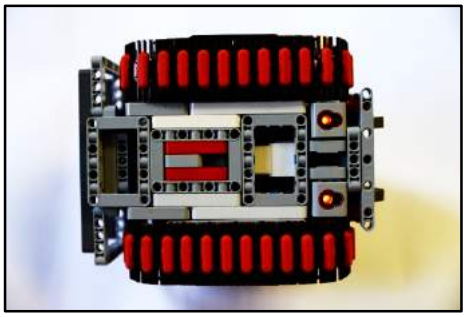
Drive motors
It's important that two motors are equal to each other. They are equal when they have the same pace and power. There could be a difference because of wear.
This is the reason we have tested six motors for their speed at four different paces: 25, 50, 75 and 100. One of the motors couldn't brake and another did stop to early. We continued with testing the other motors. We attached an axis between each two motors. When both motors start running at the same power and one of the motors is lifted, the motors aren't equal. After a few more tests we had two sets of motors left that were equal to each other.

Spot drive motors
The drawback of caterpillar tracks is the width of them compared with the width of wheels. For compensation, we placed the motors straight up.

Medium motor
We use two medium motors. They are very useful for missions and don't take much space. We use them to power the attachments.

Our robot





Our robot is using a gyro-sensor and two light sensors. The gyro-sensor is positioned under and in the middle of the robot, there it will work best. The gyro sensor is there because if it is on the side of the robot, it is far away from the turning point. That would for example mean that the robot is reading 50 degrees when it is turning 90. We have two light sensors in front of and under the robot. These are used to check for colours of the mat. With those sensors, we can follow a line, stop the robot perpendicular to a line and let it stop if it sees a line.

The robot has a bumper on the back of it. We can use this to make sure the robot is perpendicular to the wall when it starts. To avoid inconvenience with the cables we have tried to make sure the cables were as much out of the way as possible. With the attachments, the cables are not in the way.

benefits

- Compact, no open spaces in the construction
- sturdy, because of the tracks
- symmetric, and because of this it is more sturdy too
- a handy attachment system
- wires are tucked away
- the robot has two medium motors

disadvantages

- wide, because of the tracks
- slow, because the tracks are slower than wheels

Sensors

We use many sensors in our robot. We use them to select our run and make the robot more reliable and consistent. The robot can correct itself if it has a deviation. You can read more about that in Chapter 2: Software.

The gyro sensor

This sensor is not easy to use and we have had trouble using it in our robot. One problem for example is called 'drift'. If the robot stays in one spot, the Gyro sensor is supposed to start at 0 degrees, but sometimes it counts upwards without the sensor moving.

We did the following things to make sure we could use the Gyro sensor:

- Before we start our software, we reset and calibrate the Gyro sensor. If we would only reset it, the value would be set to 0, but the 'drift' wouldn't be solved. One condition is that we can't touch the robot while calibrating, or the sensor will not be calibrated right and the run will be guaranteed to fail.
- If we switch the measurement of the sensor from 'angle' to 'degrees per second' and the other way around, the sensor will do a small calibration on its own.
- The Gyro sensor has a built-in temperature sensor to make sure that the sensor compensates for differences in temperature. But if these are too large, the Gyro sensor will start it's 'drift' again. We've solved this simply by minding where we put the robot.

We still have trouble with the 'drift'. To compensate this, we have special my-blocks that use the measurements and convert them to usable data. We don't reset the Gyro sensor at the start of every run, but at the start of each round of two and a half minute. This is further explained in Chapter 2: Software.

The color sensors

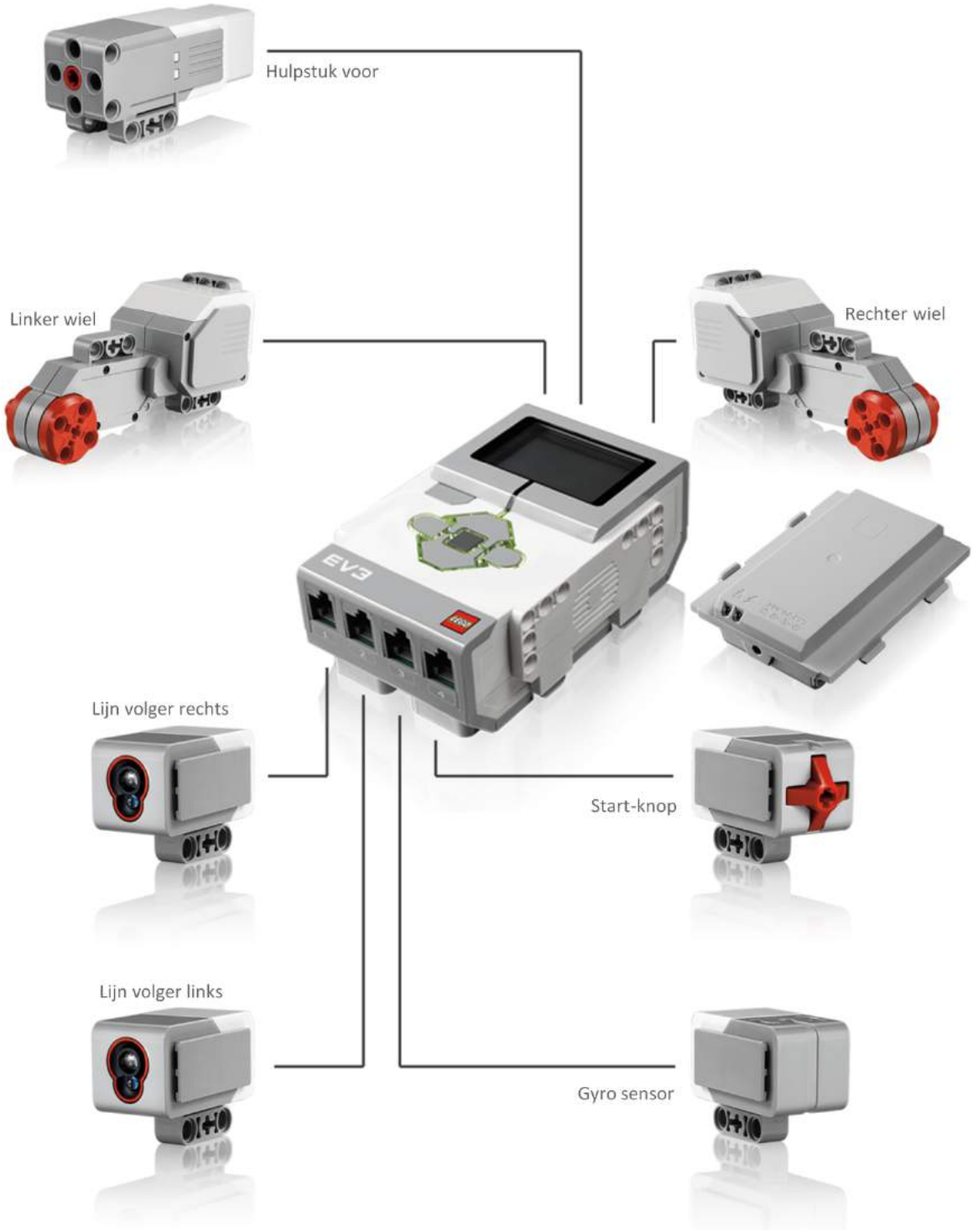
We have two colour sensors in our robot, we use them to see the colours on the field. We can follow lines, perpendicular ourselves on a line or stop when the sensor sees the line. We have two colour sensors for our myblock: line perpendicular and so the first one can follow a line and the other one can check for a line so the robot can stop following the line at the right moment.

The touch sensor

We use the Touch sensor so we can select a run in our selfmade run select menu. We do this so we don't move the robot to much after putting it on the right spot, so our runs start from the right position. Another advantage is that we can easily start runs if there is an attachment on top of the robot.

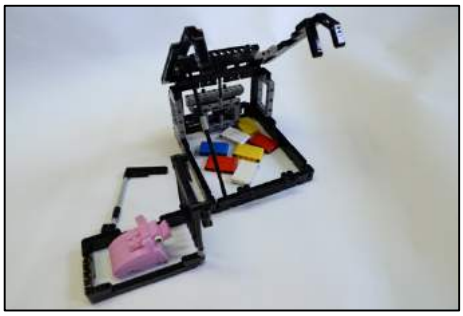
Overview of all EV3 hardware

These are all sensors and motors attached to our EV3 Brick.



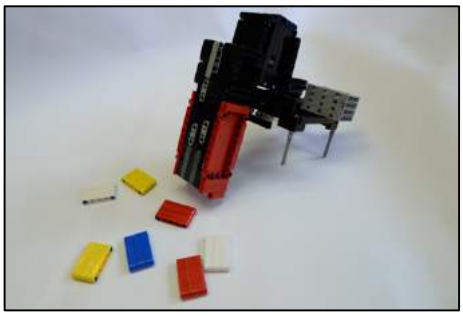
Our Attachment System

We use a convenient system for the use of attachments. An attachment is a structure that is confirmed to a (medium) motor and we use them for completing missions. We do this with loose parts that can be replaced between the runs, so there are multiple movements that can be created for different missions. On the front of the robot is a medium motor. We use this motor for powering attachments. Furthermore, we have a system to click the attachments on the robot easily. See the photos below.

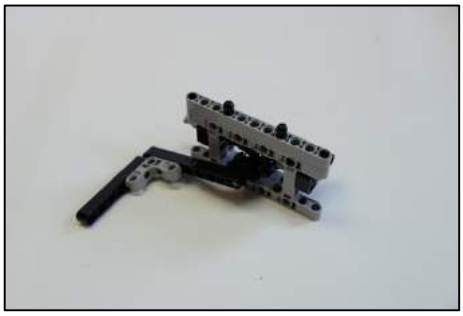


Food-Piggy collector: This attachment is used to collect the food at the fridge and pick up the pig and bring it to the base. (run 1)

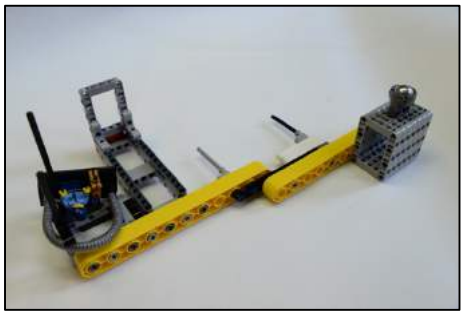
Shark Tank: This attachment is used to transport the shark. When we continue with the mission model with the 'Service Dog', the arm is pulled in so that it does not touch the dog. (Run 2)



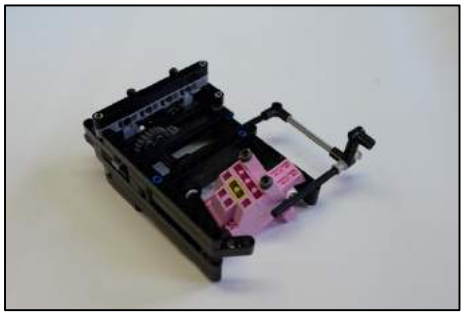
Food-Deliverer: This attachment is used to deliver the food to the animals. (run 3)



Animal Turner: This attachment is used to turn the 'Animal-conversation' making the animals switch sides. (run 3)



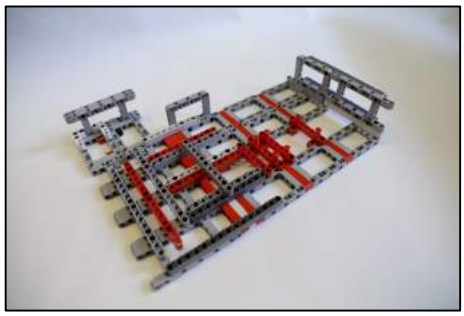
Scientific Lance: This attachment delivers the trainer, the zoologist and the manure to the training and research area. The dog trainer and the manure are in base already attached to the attachment. Along the way, it grabs the zoologist. (Run 4)



Piggy-Deliver: This attachment brings the pig with the prosthesis to the farm area. (Run 4)

The frame

It is hard to put the robot in the right place in the base during the match. That is why we use a frame to position the robot. The frame can be used in two ways, so we have multiple options for starting positions depending on the run.



New software

For a few years, our team used the same software, improving it and adding to it every year. But the more we added, the messier it got. This year we started from scrap with our software. We wanted a software like the old one, but less messy and easy to use for everybody.

Run Select

Every year, we use our Run Select. This has to do with the stress resistance of the software. What we mean by this is that, if you're really stressed at the table, you can still operate as normal. Because if you are stressed, you could move the robot even a little bit and your run could fail. We don't only focus on robot fail, but also make sure we don't fail at the table. To operate our Run Select, we use our Touch Sensor.

My-blocks

Here you can see some My-Blocks we have made and now use in our software:

Gyro-Drive

Drive, with use of the Gyro sensor, a straight line and compensate when the Gyro Sensor detects differences in degrees.

Gyro-turn

Turn the robot until it is at the desired angle.

AD-Motor

Easy way to control our Medium Motors, which are connected to port A and D, by degrees or seconds. The My-Block can calculate by it self how many degrees it needs to turn until it's at the desired angle.

Battery-Drain

This My-Block used the most Battery energy it can by using al lights and motors at once. We do this because we don't want the robot to be around 100% power. If the robot is full power, it will overdo all activities and won't perform as intended.

Fuzzy-Line follower

This My-Block makes an average light values. This makes the robot compensate more precise and fluently, for following a line.

Line-Perpendicular

This My-Block uses both color sensors and perpendiculates the robot on the line.

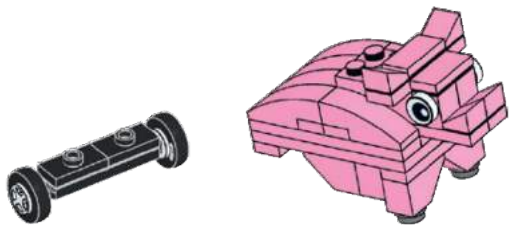
The Strategy

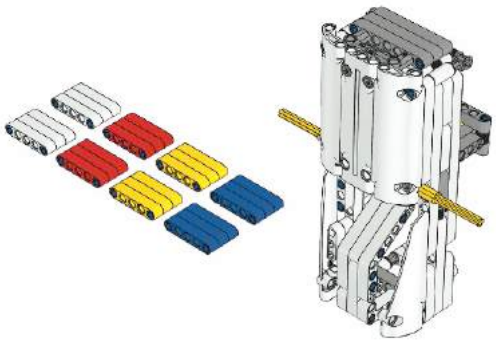
To establish our strategy for the runs we look at those missions that score a lot of points and are not to hard to complete. Examples are “Shark Shipment”, “Bee Keeping” and “Milking Automation.” We then combine as much of those missions as possible that are on the same route, those become our runs.

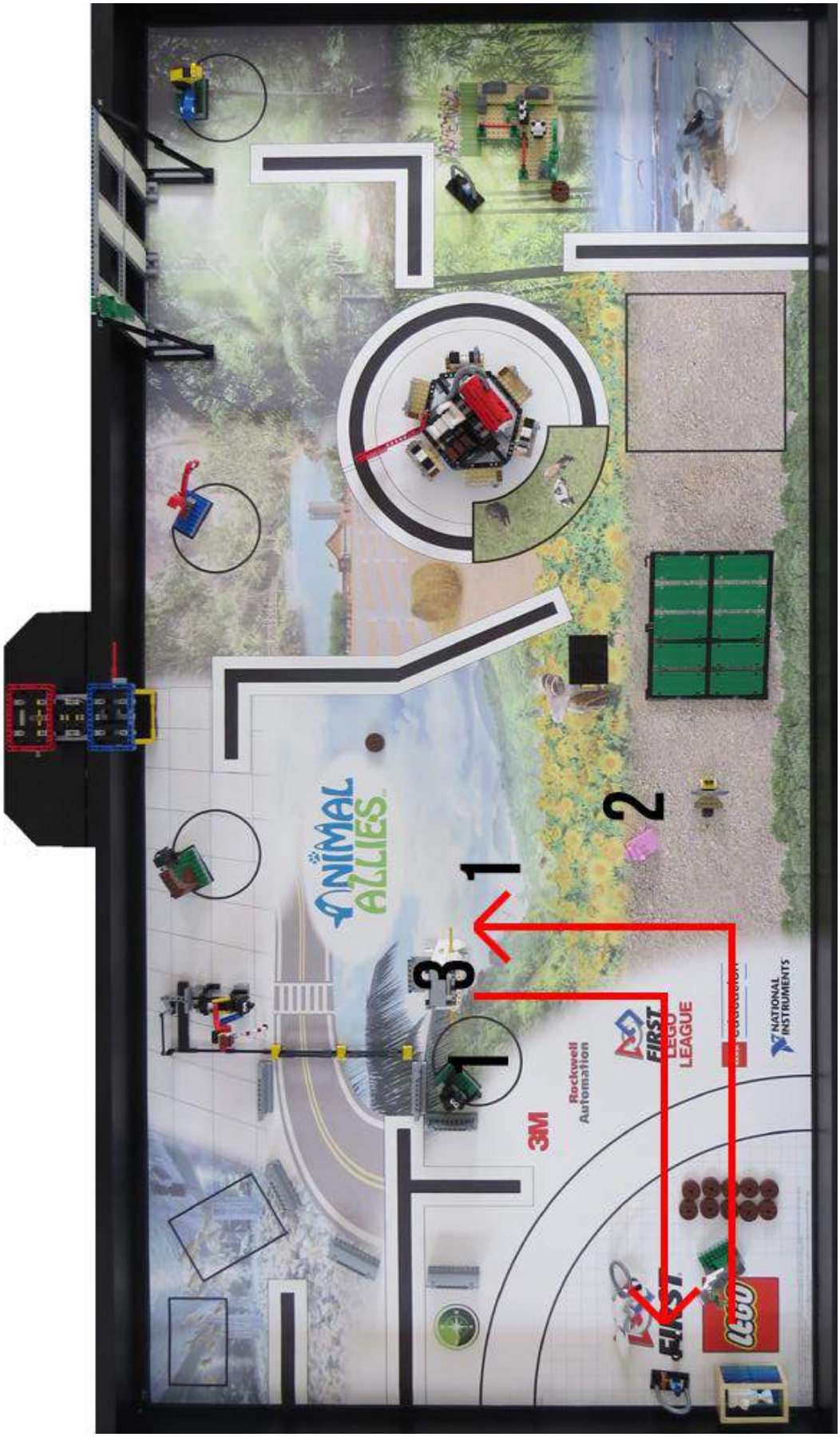
Run 1

Depending on the strategy of the other team we swap the Reindeer on the “Animal Conservation” mission for the two Frogs (because this will be worth more points.) We also have a built in possibility to disregard the whole Animal Conservation mission, in case the other team plans to do the same mission. (otherwise the animals would end up on the playfield they started in, making the completing the mission useless…)
The robot drives from the base to the refrigerator (1). On the way over there, the pig is picked up by the food collector (2). At the fridge, the food is taken out (3) using the food collector. The food is caught in the food collector and the robot drives back to the base (4).

Prostaethic for the pig	9 points
Collecting the food	0 points
Total:	**9 points**



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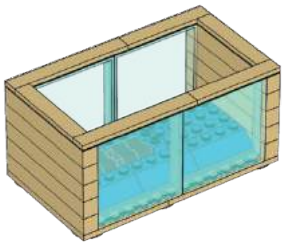
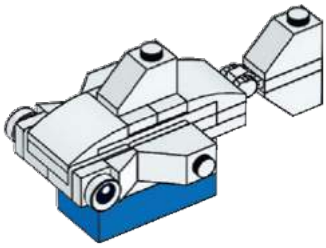
FIRST LEGO LEAGUE
NATIONAL INSTRUMENTS
FIRST
LEGO

RUN 2:

The robot drives straight out of the base (1). The shark stands against the attachment “Shark Tank” on the front from the robot and is pushed along. Then the robot drives through the bend and leaves the shark behind in the square plane (3). The robot brings up the Shark Tank and drives across the fence (4). It drives across to (5) and then reverses back through the bend and back to the base.

Shark Shipment	30 points
Service Dog Action	15 points
Total	**45 points**



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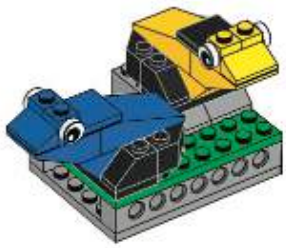
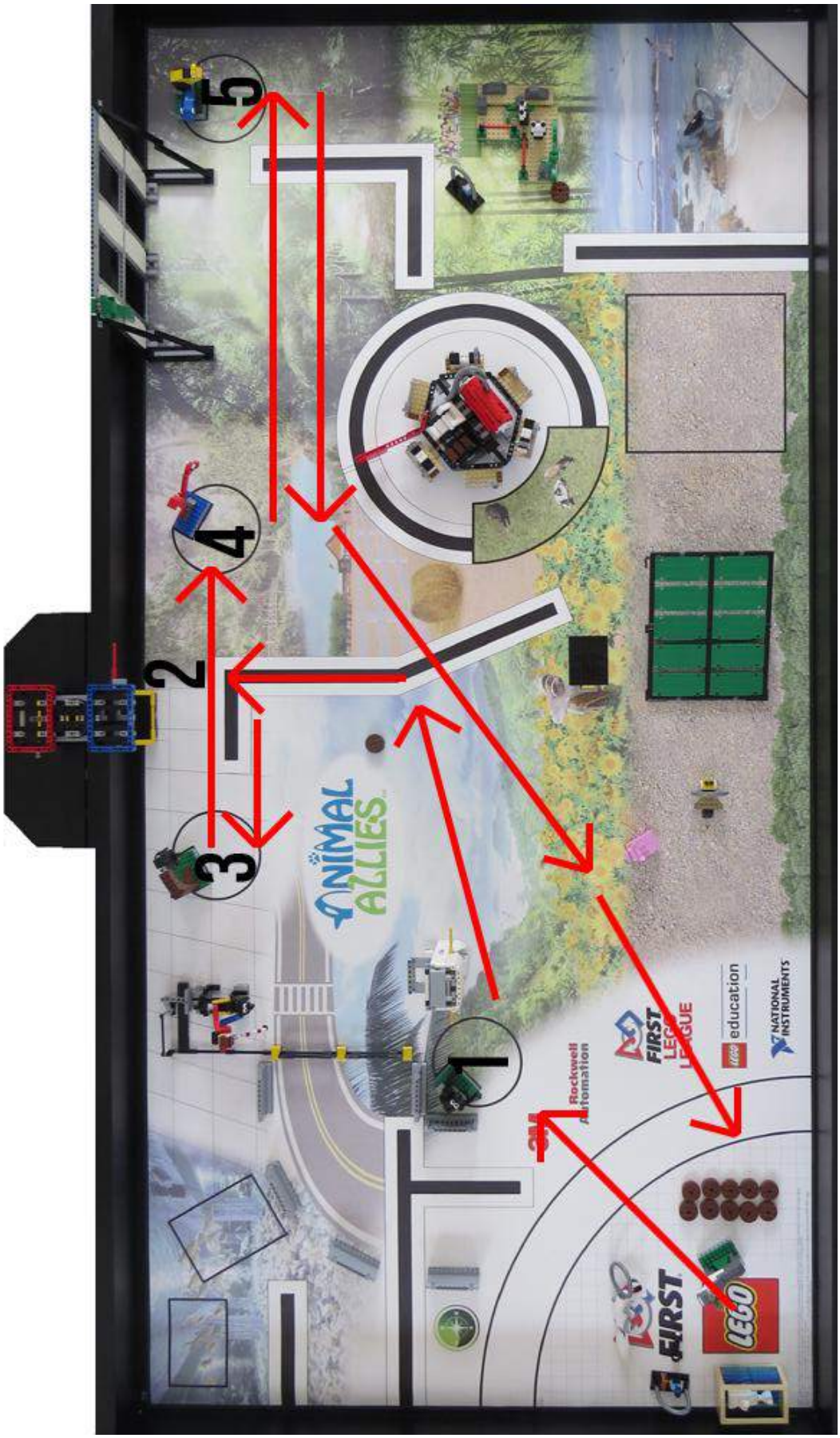
RUN 3:

From the base the robot drives to the gorilla where two pieces of food are left behind (1). Then the robot makes a turn to the black line and follows this line straight to the animal conservation (2). The robot makes the animal conservation turn around using its attachment. After that the robot drives backwards to the bat and drops two pieces of food (3). Then the robot drives forward to the black line and corrects itself on the line, after that the robot drives straight on to the flamingo and drops two pieces of food in the area (4). At last the robot drives to the reindeer (or the frogs) and drops two pieces of food in the area (5). Then the robot drives back to the base.

Feeding	80 points
Animal Conservation (our frogs, their reindeer)	60 points
Total:	**140 points**

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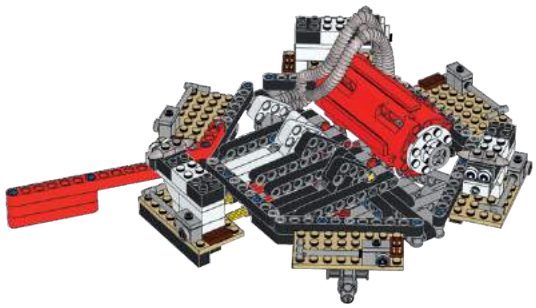
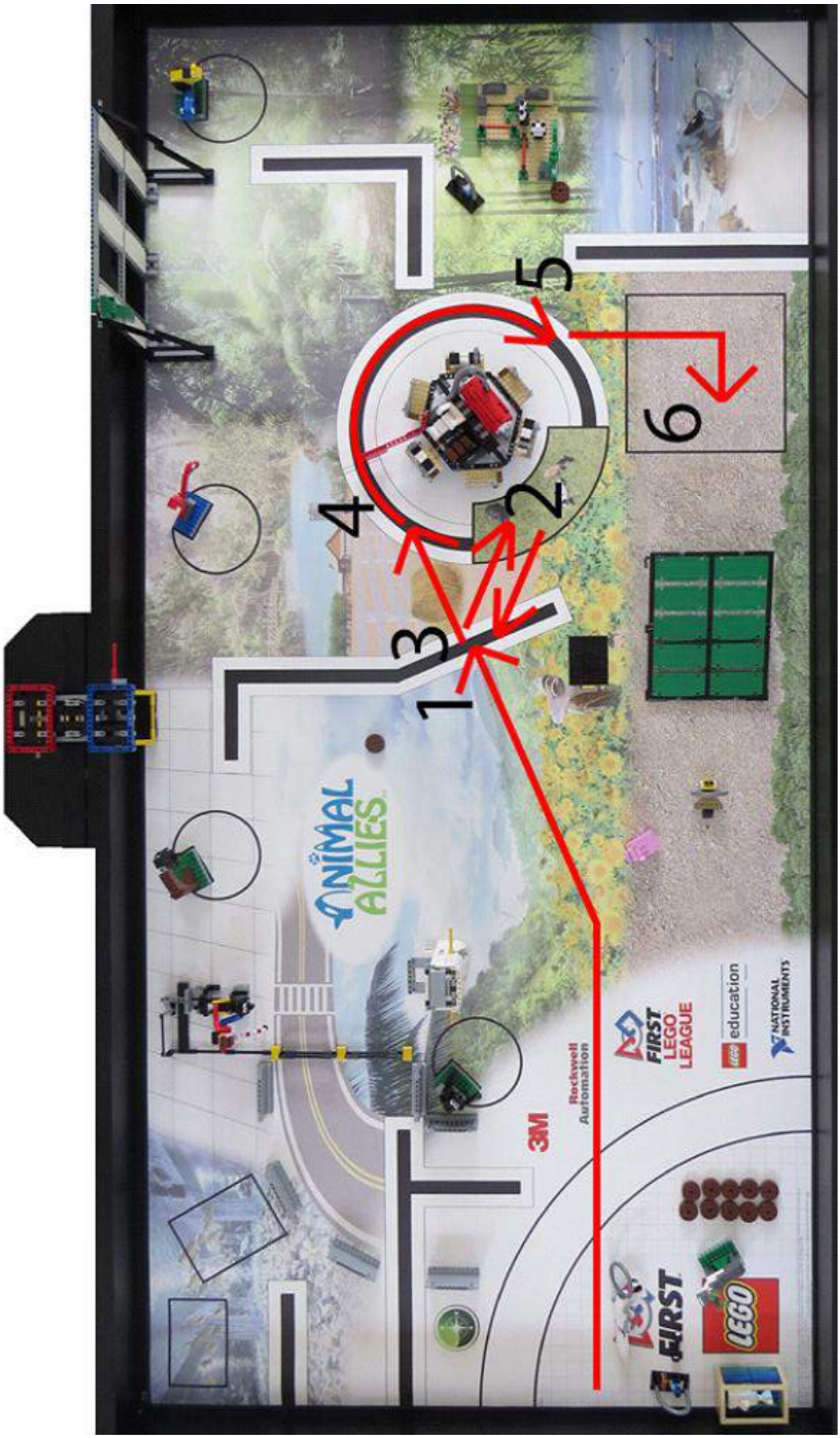
LEGO

RUN 4

The robot drives from the base straight to the black line and corrects himself on the line (1). The robot pushes the pig in the farm area with the Piggy Deliverer (2). The robot drives back and corrects itself on the line (3). Then the robot follows the line around the milking automation (4). Meanwhile he picks up the zoologist using the Scientific Lance. Then the robot stops following the line leaving only the milk behind (5). The robot ends in the training and research area (6).

Pig in farm area	6 points
Milking Automation	20 points
Training and Research	37 points
Total:	**63 points**




1
2
3
4
5
6
ANIMAL ALLIES
3M
Rockwell Automation
FIRST LEGO LEAGUE
LEGO education
NATIONAL INSTRUMENTS
FIRST
LEGO

After the regional finals

On the day of the regional finals, most things went well, and we won the first place. There were also things that didn't go well. Using those we tried to improve our robot, so that the highest amount of points would be scored at the Benelux finals

The missions

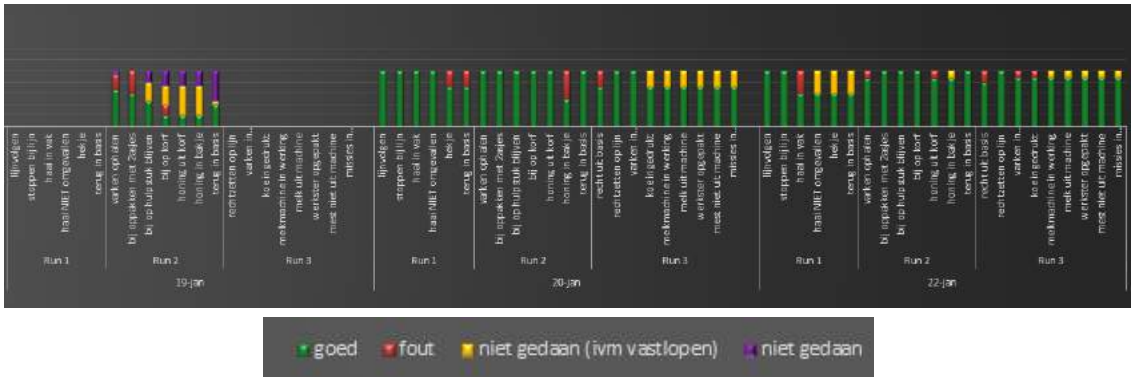
There were some things that went wrong with the missions causing us to miss out on some points. First the first corner in the old run 3 went wrong, because of that the cow could not be pressed into the milking machine. That is why the robot got stuck most of the time. We changed the programme so that the mission works well now. We also had some problems with the colour sensors, which we fixed for the Benelux finals.
At the final, there were some things that were forgotten at the preparation of the runs. Some mission models for example were forgotten. For the Benelux, we trained more so that nothing was going to be forgotten.

Tasks

Furthermore, the tasks during the competition weren't divided well. We forgot to bring some things to the presentations. To solve this have we made checklists. During the competition, someone is tasked to check off. We have also made a special checklist. All missions and points of interest that must be checked before the robot competition begins are on this checklist. An example of this is checking if certain mission models are placed on the table correctly.

Graphics

We have someone in our team that is very good with the program excel. This person has made a format for our list on which we tally mission results. This means every time when we start a run we note what goes wrong or not. Also, we note if the mission went wrong because of human mistakes or the robot made mistakes. With this list can we see which of the missions aren't consistent or which mission we must adapt. And we can also see where we ourselves can improve. We enter the information as numbers in excel and excel automatically makes a graph off this information that is easy to interpret.



After the Benelux Finals

After the Benelux Finals, we needed to prepare ourselves for the international competition. We needed to make sure that we were ready to play against the strongest teams. To do this, we changed a few things on our robot and in our software. We've also expanded our research a bit, but that was already strong.

We wanted to score more points in our two and a half minute, so we brainstormed about our strategy and the conclusion was that we could get many additional points by bringing the food to the animals. We've spent some time trying out new attachments and programmed some new runs which has greatly payed off.

We've also used graphs to tally the amount of runs that went well and runs that failed. We used this to see at what point in our run the robot fails so we can adjust that point in the software. This was a good and fast way to improve the reliability of the robot.

To improve the efficiency of the robot, we've added another medium motor. We use this one for the attachment that takes the food out of the fridge and the one that brings the food to the animals

We've made three new attachments, one that can take the food out of the fridge, one that brings the food to all four animals and one that can complete the animal conservation mission.

Supplement 1, background information research

The Sami and their reindeer

The Sami live in Lapland. They call the area Sápmi, what means: “Land of Lapps.” This area is for the biggest part in Scandinavia, the other part is in Russia. Lapland has a surface of 750.000 km². The Sami were a suppressed nation and they were forced to move. They moved more and more to the north and lived on the high- and coastlands. Unfortunately, it wasn’t only this, they were exploited. They had to pay high taxes over their fish and houses. In the 17th century, iron ore became more and more important in Scandinavia. In Lapland, there were many mines where they got iron ore, It’s the biggest iron ore area in Europe. Because of this discovery, the Sami changed lifestyles and a big part the nation became just Scandinavian.

There are only 20.000 Sami who are real Sami who speak Sámegiella. Samish is an official language in Norway, Sweden and Finland. There are different dialects in this language that’s not always understandable for another Sami. Their flag exists out of red, blue, yellow and green. Those are the traditional colours of the Sami. On the flag is a circle that’s half red and half blue. That red colour stands for the sun and de blue part for the moon. The flag is accepted by many governments and has to be used on typical Samish holidays. Former, the clothing of the Sami was made of reindeer skin. Through the years this is changed. The real traditional clothing is sometimes worn on Sundays, if the Sami go to the church and of course to a wedding. If you look to the clothes you can see from which village a Sami is.

Sami in the high north are specialized in breeding reindeer, the reindeer are very important for them. You can eat the meat and drink the milk. The skins are used to make clothes. The reindeer are also employed as a sled animal, but that was just in the past. Today the Sami use snow scooters. The reindeer who get beered are “tame” reindeer and the Sami see them as a pet (tamrein in Samish). A Sami can recognize his reindeer with the cut in its ear. The reindeer travel between the seasons from Sweden to Norway. Because of this traveling, the Sami were nomades. Today, they live in little villages.

A reindeer is a mammal that is family of the deer. The most special of a reindeer is that females as well as males have antlers, but the antlers of a female reindeer are smaller. In other deer species only the males have an antler. Reindeer live in the wild in north-Europe, the north of Asia and the USA (where they call them Caribou). In May or June the females are getting one calve after 210 until 240 days of pregnancy. Reindeer have special eyes for the antarctic winters. The females are smaller and clearly lighter than the males. The summer fur is brown and the winter fur is thick with long hairs, light-brown to white with light-grey manes on their throat. The reindeer mainly eat grass, herbs and moss, but also mushrooms.

Compounding research: chips, processors, battery and other areas

Chips and Processors:

Raspberry pi

To create a Wi-Fi network in the area, we have examined other chips that make this possible. This is the Raspberry pi. This chip is quite large. You can use it for simple or more difficult things. This chip is used by lots of amateurs. You can work with it very easily. This is because the printed circuit board has lots of different connection possibilities. There are different kinds of this. There are, for example, easier in use and more complicated ones. There is a big assortment for this. The prices can vary as well.

WifiDuino

The WifiDuino can also make a Wi-Fi-network. It's a smaller chip with a build-in Wi-Fi connection. You can add more sensors to this chip. All this information is sent to a hub. This is based on an Arduino platform but in contrary to the Arduino, this chip isn't larger than a penny and has less possibilities.

Cattle Watch

At this moment, this is the only chip on the market that helps you to have control over your cattle, like cows. The chips are put in the ear of, for example, a cow and can make a connection with the other chips. A few cows have a collar that can make connection with an Iridium satellite or a 4G mast. There can be a connection with the mobile phone or the computer of the farmer. Therefore, all cows are connected with each other. A big difference between Cattlewatch and RenNät, is that with RenNät you can use an emergency network too.

The battery of the modules

We have concentrated us on the battery of the devices after the regional finals. How is it used at the moment and how does it work? This question will be answered in this supplement.

Dynamos

Of course, you can make energy with the dynamo. You do this with a magnet and a spool. Due to the turning of the wheel, the magnet turns too and there comes a magnetic field of force. The conductor, the spool, is in the moving field, whereby tension originate. This tension is used, for example, for a light on a bicycle. There is a very big but in this story. The dynamo only generates energy if the spool is in the moving magnetic field of force. For our modules, this method is not practical

kinetic watches

These watches almost work the same as a dynamo, but the difference is that the movement is caused by a moving arm and not by a moving wheel. The other difference is that the energy is used differently: a big part of the originated energy is saved in a tiny battery in the watch, the other part is used directly for the ticking of the watch. This method will be more practical for our modules.

Smart material

At a university in Japan a new mix of metals is discovered. This metal can transform movement into energy, without needing anything else. There is a working prototype. When this idea is worked out, it might be used in RenNät.

Other places

We've looked for other places in the world where RenNät could be used too. We've searched for places where are animals live in herds, but where's no or less mobile access.

Brazil

Brazil has been the king of the cattle trade. They have sold a lot of meat of their cattle. They are still doing this. Our emergency network can be used on these animals and their farmers can control their cattle better. Further, the mobile access will be much better in Brazil.

Australia
Australia has a lot of farmers. Some of them have small farming fields and live in nearby cities. Others have huge farming fields, but live in the middle of nowhere. On the giant farms, it is hard to locate all of your sheep. It's also very strangely concentrated. At the shore, the inhabitants live very close to each other, but in the inland there are often many kilometres without cities or villages. In those places, it's very dangerous if you get in an accident, there is no mobile access.

Canada
Canada is the paradise for dairy farmers. The land is stretched out and the trade conditions are flexible. But because the land is very stretched out, it is too expensive to have mobile access everywhere.

Iceland
Iceland is a loved vacation destination for adventurous people. With a gide you go into the wild. But here's also no mobile access. At the moment, you go with cars, in this situation there is always someone nearby. Icelandic horses walk around in the wild on which our idea could be applied to.

Interview Per-Nils Païvö

Per-Nils is approximately 65 years and has lived as an original Sami when he was a little boy. Now he lives in Övre-Soppero. In the past, he has shown the tourists the area with his wife, but also told the children about the traditional Sami-life. That's how the Sami prevent that the culture get lost.

What does a standard day looks like?
Each day is different, we don't work with the reindeer every day. We've got other work next to our work with the reindeer, like busdriver.

Do you still live in the original traditions?
No, we're very modernized, but more in the tools of our traditional work. We go to the reindeer with snow scooters instead of skis and sleds. We do have still the same principles.

How big is the reserve?
Approximately 60 km wide and 250 km long.

How big is an average herd of reindeer?
That varies very much. Sometimes you see small herds of 10 or 15 reindeer and sometimes there are herds of 20.000.

What do you think about RenNät?
I think it's very helpful, for sure the GPS. Our work will be much easier without it our old traditions and principles will fade. Also, the new generation won't leave our villages much.

How do you know how the reindeer are, qua health?
If the reindeer are sick, we don't do anything. But when we count the reindeer, we check if they're undernourished. If that's going on, we can choose if we feed them more.

What are the dangers for people in the area, especially for people that are not familiar with the area?
Many people die in this area because of the surroundings. It is a real wildernes without any roads or paths and that is pretty dangerous. Many people that come here therefore have a sattelite phone.

How do you experience the period of the counting of the reindeer?
It is very stressful for the reindeer and very hard work for us. I would really like it to be more easy.

Would our solution make that you don't have to count the reindeer anymore or gather the animals in a coral?
No, unfortunately not. We have to gather the reindeer now and then. We need to check their health. And we need to brand the calves. We do that by marking their ears. And of course, we want to be close to our reindeer to sometimes.

How do you find out that the fence between the reserves is broken?
We patrol the fences regularly to see if the fence is broken, this takes a lot of time, because there are no roads. And often it is too late if we discover a broken fence. Some reindeer will already have escaped to another reserve. Then we have to collect them again. When the neighbours have a coral, we check if any of our reindeer are there.

How do most reindeer die?
The winter is the number one cause of death for the reindeer. A lot of reindeer are killed by predators too. If we spot predators in the area we need to move our herds. And of course, sick and wounded reindeer die too, we cannot do anything about that.

How do you keep an eye on the pregnant reindeer?
In spring, when we count the reindeer we check on the pregnant ones. We then know if we need to mark a lot of new calves later. But the reindeer give birth themselves, we don't help them with that.

Would you use our devices?
Yes, I would love to! But it shouldn't be too expensive, I cannot pay more than €50 for one module. We have a lot of reindeer and we are not too rich. It also needs to be light, so the reindeer won't notice it too much. It should not weigh more than around 250 grams.

Would it be beneficial to you if there was a camera in the device?
Yes, that would be nice, but then not in all modules. I would give 1:100 a camera. Maybe I could sell the images, any extra income is welcome.

Interview Jordana Widosuwito & Kent Gjöran Svendsen

Jordana and Kent life in Svappavaara and have a company called Husky Tours Lapland. They organize tours with sled dogs. They like to enter competitions with their dogs. One of these competitions, the yearly Tabacco Trail, passes Per-Nils' house.

Why do you leave with the huskies?
First of all because it's fun to do and as recreation. Second because this is our work.

What happens when you come across a reindeer herd
We try to avoid this, but we don't know exactly where they are. We can avoid smaller herds easier than bigger ones. When the herd is too big we turn around and search for another area.

How do you keep in contact with the outside world when you are in the reserve?
The area where our company travels around the most has a decent 4G connection, but when we go north we have no possibility to contact the outside world. For us this is one of the main reasons not to go to the north.

Would you use RenNät
That depends on the price. RenNät has a lot of benefits, but the keeping of the huskies is very expensive and we have to watch our spendings.

How would you use RenNät?
We would like to know where the bigger herds are before we live with the huskies. In emergencies, we would want to contact someone. If this could be possible with an app than that would work fine.

Do you have other comments?
Yes, I do. For us it is really enjoyable to be in the nature with a group of tourists. We get to learn the tourists and it's really fun. We are a little bit scared that the journee will be less intimate when everyone has 4G access and sits on the internet all day. Therefore, we would want the network to be closed.

Conversations with Pieter Venemans

To share our idea with an expert, we've talked to a contributor of TNO, Mr. Pieter Venemans. We've spoken to him two times.

For the regional finals, Mr. Venemans went to us to discuss about technical possibilities. He recommended us to use the LoRa network. He showed us different chips and told us what they do. Further he talked with us about the battery, like kinetic energy. Also, we've discussed the access of the different networks. Mr. Venemans showed us that too, because of the curves of the earth the signals can be broken. He has explained us that via satellites, but also with 4G balloons that are designed by Google, they can bridge bigger distances. With that information, we looked to RenNät very critical and changed some things. For example, we've chosen for the LoRa network instead of WiFi for the reciprocal connection. Mr. Venemans was very positive about RenNät before the regional finals and thought that the project was very interesting. Everything he told us was very useful.

After the regional finals, Mr. Venemans went to us again and this time we've spoken about the database and the website, or how we're going to present the data to the users. Mr. Venemans explained that we should make use cases first. This is used very much in the software development. He said that we should think up for example what a Sami would like to see if he's going to gather his herd together tomorrow. For example, he wants to know where they approximately are and what's the weather there. In this way, we could think of what the different users of our system would like to see and with that information we could think of what information out of the database is necessary.

Mr. Venemans liked our examination so much that he made an example of the relevant website. For this he used an already available lay-out that was easy to change.

The database

To get to know what data we needed, we've first looked to which users RenNät could have and which information those would have.

Sami (on smartphone or computer)

- Number reindeer
- How many reindeer he has altogether
- How many of his reindeer are in Sweden and how many in Norway
- Location of his reindeer
- Temperature per km²
- Does a reindeer live (heartbeat or moving in the past 48 hours)

Mushers and recreants (on smartphone)

- Location herds
- Temperature per km²

Government (just data)

- How many reindeer has an owner in Norway and Sweden

Road users (via GPS device)

- Location of a single reindeer at a distance of 50 m of the road
- Location of a herd at a distance of 100 m of the road
- Location of a single reindeer or a herd that moves with a speed of more than 10 km/h to the road at a distance of 500 m

With this information, we recessed into the database. The database is the place where all the information that comes from the modules is collected. A database is used as a bank of information where stuff is saved and changed easily. Each piece of information is saved in a "field" of the database. With information that comes out of the database you can show or change different things.
Some information is continual, those are in the system how they are and don't change. There also is variable information, this changes every time that there's a new signal from the module to the database. Finally, there are calculable information, information that you can calculate by specific data out of the database.

EXAMPLES OF DATA IN THE RENNÄT DATABASE:

Continual data:

- Number (from the module)
- Owner (of the reindeer)

Variable data

- Location of a reindeer
- Temperature
- Heartbeat reindeer

Calculable data:

- How many reindeer per owner
- How many reindeer are in Norway or Sweden per owner (with the location)
- Location of a herd (>50 reindeer in a hectare is a herd)
- Average temperature in a km²
- Speed of a reindeer (with speed changes in location)

Every time that a signal is sent out of a module, the variable data is changed in the database. Directly the computer calculates and changes that in the database too.

Some data is kept for a period. For example, the location. Because when a field with a location is overridden with a new location, you can't calculate how fast a reindeer moves.

The different users get entrance to to the database in different ways. The database can be connected to a website or app.

De Sami will use a special website. That site uses almost all data from the database, because they have an interest in all available information.
Mushers and tourists are going to use an app with which they can only see the location of the herds. They only get acces to that part of the data.
The government only gets entrance to the rough data about the amount of reindeer per owner and the data that shows where the reindeer are on a specific date, in Sweden or Norway? That's the only information that's relevant for the taxes. This data only has to be sent to the government once a year.
Companies who deliver navigation devices only get the data about the places and speed of a herd.

Our database could look like this:

A	B	C	D	E	F	G	H	I
unique ID	module	owner	time	latitude	longitude	temp	heart rate	distress call
1	1	1	2/4/17 10:35	68375389	21005659		56	10
2	2	1	2/4/17 10:35	68368959	20994692		48	10
3	3	1	2/4/17 10:35	68366641	20755213	-10	7	10
4	4	2	2/4/17 10:35	68366652	20894695		54	10
5	5	2	2/4/17 10:35	68368949	20994497	-3	0	0
6	6	3	2/4/17 10:35	68374389	21005736		70	10
7	7	3	2/4/17 10:35	68358949	21005682		74	10
8	8	3	2/4/17 10:35	68367632	20794478	2	54	10
9	9	4	2/4/17 10:35	68356640	20899546		50	10
10	10	5	2/4/17 10:35	68377637	20894341		49	10
11	1	1	2/4/17 10:40	68367632	20794478		56	10
12	2	1	2/4/17 10:40	68356640	20899546		48	10
13	3	1	2/4/17 10:40	68377637	20894341	-9	7	10
14	4	2	2/4/17 10:40	68374389	21005736		54	10
15	5	2	2/4/17 10:40	68358949	21005682	-3	0	10
16	6	3	2/4/17 10:40	68366652	21005659		70	10
17	7	3	2/4/17 10:40	68368949	20994692		74	10
18	8	3	2/4/17 10:40	68375389	20755213	3	54	10
19	9	4	2/4/17 10:40	68368959	20894695		50	10
20	10	5	2/4/17 10:40	68366641	20994497		49	10

The green columns contain the information that does not change. The blue columns contain the variable information. Every time the module sends new information in, this will be added below. This is the base from where all the calculations are made and where information is connected to.

An example of the part from the database with calculations:

A	B	C	D	E	F
unique ID	grid 1,1	grid 1,2	grid 1,3	distress	dead?
1	0	1	0	10	1
2	0	1	0	10	1
3	1	0	0	10	1
4	0	1	0	10	1
5	0	0	1	0	0
6	0	1	0	10	1
7	1	0	0	10	1
8	1	0	0	10	1
9	0	0	1	10	1
10	0	0	1	10	1
11	0	1	0	10	1
12	0	1	0	10	1
13	1	0	0	10	1
14	0	1	0	10	1
15	0	0	1	10	0
16	0	1	0	10	1
17	1	0	0	10	1
18	1	0	0	10	1
19	0	0	1	10	1
20	0	0	1	10	1

SOME EXAMPLES ON WHAT COULD BE DONE WITH THE DATA:

herds

	1	2	3	4	5
1	1,1	1,2	1,3	1,4	1,5
2	2,1	2,2	2,3	2,4	2,5
3	3,1	3,2	3,3	3,4	3,5
4	4,1	4,2	4,3	4,4	4,5
5	5,1	5,2	5,3	5,4	5,5

The map of the area is divided by the computer in squares of one hectare. These squares get a number. All the number are put in their own column. With help of the GPS-location that is collected by the devices the calculation is made in which square the reindeer is.
In the database, we will work with a sort of binary alphabet. When a reindeer is in a specific hectare, that square will get a 1. In all the other hectares, it will say 0. After this the calculation is made if a column (a certain hectare) has more than 50 reindeer. When this is the case all the reindeer will be clustered to a herd.

No.	grid 1,1	grid1,2	grid1,3	grid1,4	grid 1,3000	grid 1,5000
0	0	0	0	0	1	0
1	0	0	1	0	0	0
10	0	0	0	0	1	0
11	0	0	0	1	0	0

0	Aanwezig in ha
1	Niet aanwezig in ha

Data per owner

It is easy to calculate how many reindeer an owner has and where they are with the data from the system.

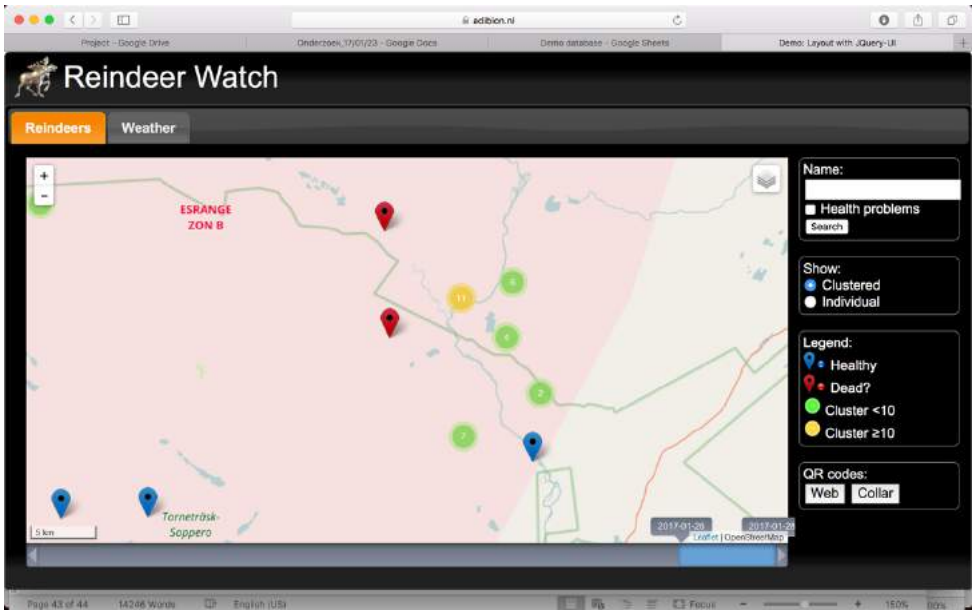
Owner	Owner ID	Total	Sweden	Norway
s1	Per-Nils	500	450	50
s2	Johan	450	370	80
s3	Isak	600	510	90
s4	Elin	530	500	30

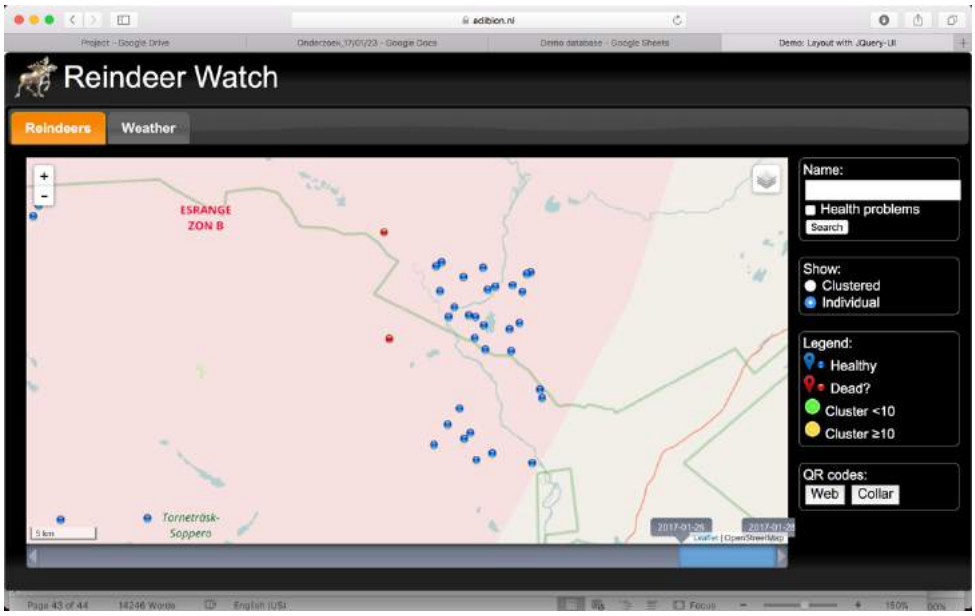
Much more is possible with the database. And if RenNät would be further developed, much more thought and research is needed on the structure and data. That is something we wouldn't be able to do ourselves.

A DEMO WEBSITE

We have spoken with mr. Venemans about the information that we now have. We have explained him how everything is going to look and what information should be presented to the people. He has made a website based upon these ideas that the Sami could use. The website is a “dummy”, because we don’t have working modules hanging on reindeer. The information that you can see in the database is chosen randomly. Yet, it is fun to see how it would really look like. *When we saw the picture of the website we have noticed that we haven’t explained the difference between a moose and a reindeer well enough...*

Below you can see screenshots of the website with the matching explanation:

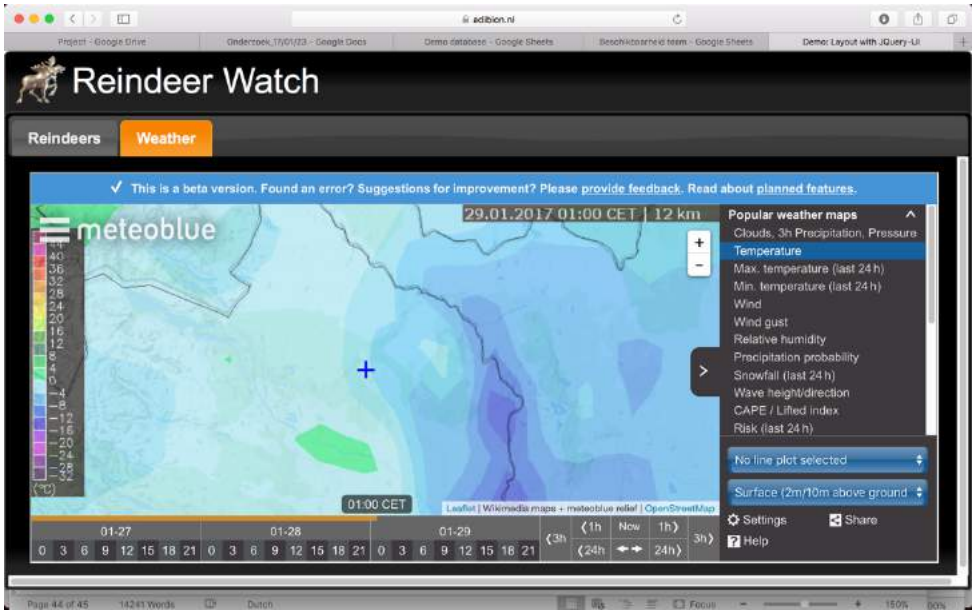




Based upon the information in the database a balloon on the right location will appear. When there is more than a specific number of reindeer on a specific square kilometer, there will appear a cluster with the number of reindeer that are located there. Below the map there is a timeline you can drag to see how a reindeer has moved. When a reindeer is not moving for a longer period it is probably dead and it’s balloon will turn red.

The weather is shown in another tab. This is the information of a meteorological office. The information that the reindeer collects are included to make the data collected even more precise.


Reindeer Watch
Reindeers
Weather
This is a beta version. Found an error? Suggestions for improvement? Please provide feedback. Read about planned features.
meteoblue
28.01.2017 13:00 CET | 12 km
Popular weather maps
Clouds, 3h Precipitation, Pressure
Temperature
Max. temperature (last 24 h)
Min. temperature (last 24 h)
Wind
Wind gust
Relative humidity
Precipitation probability
Snowfall (last 24 h)
Wave height/direction
CAPE / Lifted index
Risk (last 24 h)
No line plot selected
Settings
Share
Help
Övre Soppero
Back to Zoetermeer
20:00 CET


Reindeer Watch
Reindeers
Weather
This is a beta version. Found an error? Suggestions for improvement? Please provide feedback. Read about planned features.
meteoblue
29.01.2017 01:00 CET | 12 km
Popular weather maps
Clouds, 3h Precipitation, Pressure
Temperature
Max. temperature (last 24 h)
Min. temperature (last 24 h)
Wind
Wind gust
Relative humidity
Precipitation probability
Snowfall (last 24 h)
Wave height/direction
CAPE / Lifted index
Risk (last 24 h)
No line plot selected
Surface (2m/10m above ground
Settings
Share
Help
01:00 CET

How to be a reindeer…

There is a nice option in the website. With a QR code you can become a reindeer yourself. You can put information in, like body temperature, heartbeat or name. When you send the information, you will be added as a 'reindeer' in our database and you will be seen on the website. This way you can see for yourself how the system works.

Supplement 2, software prints