

# Robert E. Lee

Coach: Ronnie Pundt

Contact Information: (210) 667-3975

LEE STEM NESA ISA

Powering the Future.

TEAM 57



[leebestrobotics.com](http://leebestrobotics.com)

“Bladerunner”  
2014



About Us .....	3
Section 1. Engineering Design Process .....	5
1.1 Problem Statement and Analysis .....	6
1.2 Manufacturing—Staff Training .....	6
1.3 Brainstorming.....	7
1.4 Scheduling.....	8
1.5 Programming.....	8
1.6 Analytical Evaluation of Design .....	10
1.6.1 Wheel Design.....	11
1.6.2 Chassis and Turntable Design.....	11
1.6.3 Gearbox Design .....	12
1.6.4 Arm Design.....	13
1.6.5 Manipulator Design .....	13
1.7 Offensive and Defensive Evaluation.....	14
1.7.1 Solo Strategy: 397 points .....	14
1.7.2 Newly Established Partner: 478 points .....	14
1.7.3 Experienced Partner: 747 points .....	15
1.8 Test, Refine, and Evaluate .....	15
1.8.1 Extended Storage Area .....	16
1.8.2 Trailer Hitch.....	16
1.9 Safety .....	17
Section 2. Research Paper.....	18
2.1 Research Paper Bibliography.....	21
Section 3. Marketing.....	22
3.1 Outreach, Promotion, and Recruiting .....	22
3.3 Mentors .....	25
3.4 Consultants.....	26
Section 4. Appendix.....	1
<b>Figure 1: Drive Chassis</b> .....	2
<b>Figure 2: Arm</b> .....	2
<b>Figure 3: Wheel</b> .....	3
<b>Figure 4: Arm Gearbox</b> .....	3
<b>Figure 5: Robot</b> .....	4
<b>Figure 6: Safety Lesson</b> .....	5
<b>Figure 7: Practice Safety Test</b> .....	6

## About Us

We are the 2014 Robert E. Lee High School Robotics Team. We are very diverse because of our three magnet programs on campus: ISA (International School of the Americas), NESAs (North East School of the Arts), and STEM (Science Technology Engineering and Mathematics) as well as the local students that attend Lee. Our team is open to anyone who wants to join. Participation is important to us, especially since this year we are required to fundraise more than previous years in order to support the further development of our organization.

Lee has participated in the BEST competition for the past 20 years. We strive to support and incorporate the BEST values into our everyday learning environment. Our team teaches all the aspects of the engineering design process when working on the robot. In addition, we educate the members on how to make important decisions and design choices in the real world. These concepts are used to aid our marketing decisions, which fosters the skills and values that it takes to proceed into the engineering work force.

While following the criteria and constraints presented by BEST, we use the six-week allotted time to develop, manufacture, and test a robot to complete the task at hand. We have the utmost confidence our robot will be capable of competing in the upcoming BEST competition.

We have two team coaches and we are supported by several adult mentors. Most of the adult mentors are parents of team members with the exception of two mentors that work on teaching the programming and building aspects of the team. These two mentors are members of the community who have an interest in robotics, and have been with our team for the past five years. In addition, to them as mentors, we have returning alumni to help mentor

and pass down their experience from previous years. The parent mentors have many talents that they use to help guide the students in becoming a well-oiled machine.

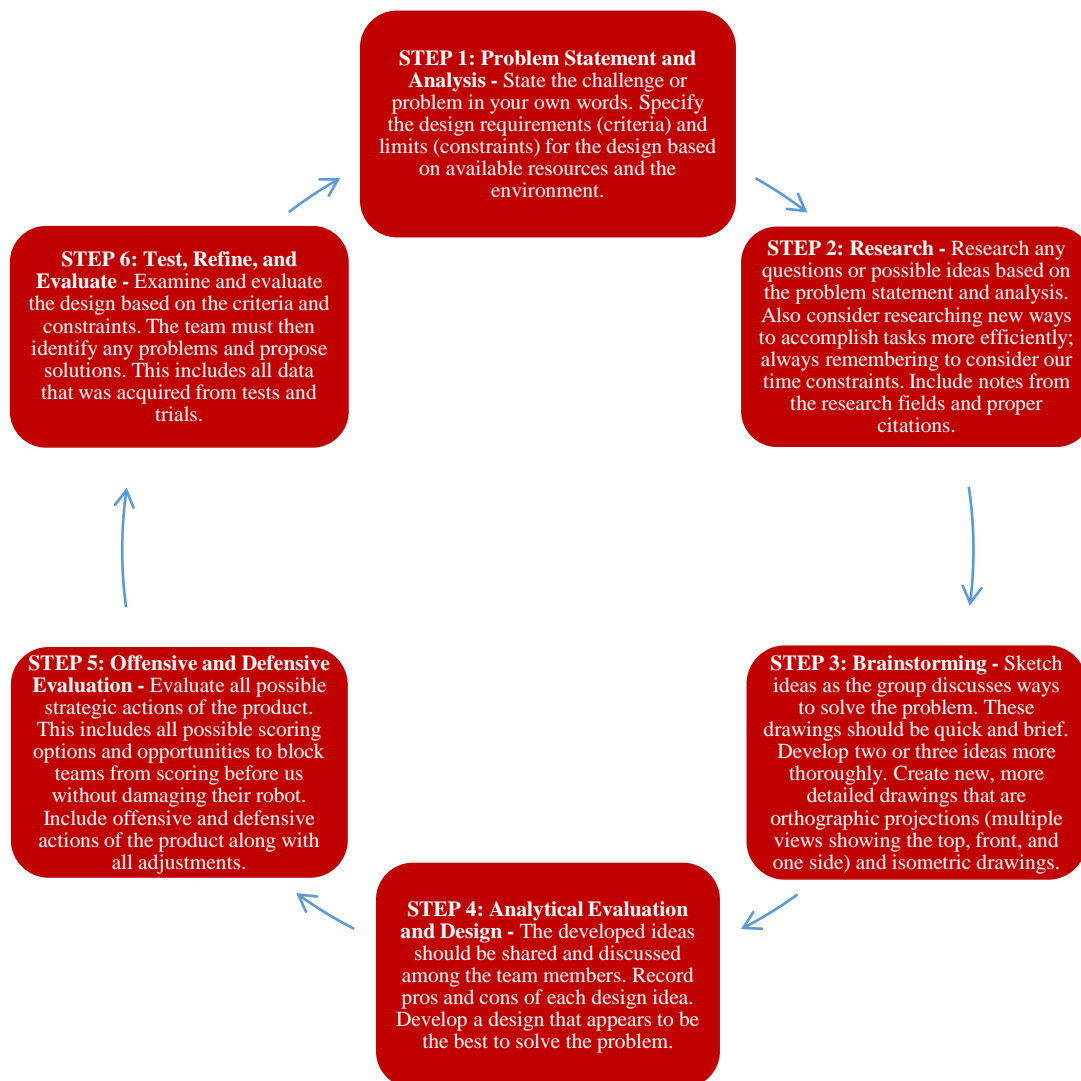
Our team focus is on our students. We have several new members who are juniors and sophomores. The remaining students from last year are now team leaders. These team leaders teach the new members the game and how to use their skills to accomplish goals. We have a lot more students with diverse qualities than in previous years. These students excel in areas that were lacking in past years.

This year, we are glad to say we are continuing to grow our website and glad to have a few team members experienced in designing websites. We have been hard at work over a hot keyboard compiling pictures and information. We are thankful to have a professional website this year. Along with that we hope that many people visit and read up on our team and our robot. If you would like to view our website you may visit us at [www.leebestrobotics.com](http://www.leebestrobotics.com).

Another very important goal for our team this year is getting more involvement and support from the students and staff at Robert. E. Lee High School. More members means more opportunity for spreading information about the competition via word of mouth. In addition, we advertised the robotics competition, as well as our fund-raising efforts, on the morning announcements and teacher email. Our primary school fundraiser was a concession table set up during Lee-ESTA. This is a community parade to celebrate the diversity of our school. We also used the opportunity of the parade to promote our team and the BEST competition.

## Section 1. Engineering Design Process

The engineering design process involves a series of ordered steps that lead to the development of, in this case, a robot. In this process, students are to complete each step and document this work as they manufacture the final product. By following this process we are able to maximize our efficiency and productivity. Productivity is crucial as we are limited to only six weeks to design and manufacture a fully functional robot. The Engineering Design Process is as follows:



## **1.1 Problem Statement and Analysis**

In order to design a robot to be successful. We first need to understand what the robot is supposed to accomplish during the challenge. Our members are that will design a robot to construct a wind turbine by, in order, several stages. To begin creating a functioning robot as well as satisfying the client, we must first construct it based on the challenges below:

- Fit within a 24” x 24” x 24” cube
- Maneuver with agility
- Be able to lift heavy game components of varying weight and size
- Include a rotating arm
- Include a multi-function manipulator
- Be precise in the scoring of game components

From this list of tasks, we have determined that our problem statement is “We are to design and manufacture a robot that can complete a multitude of predetermined tasks in order to assemble wind turbines in six separate three minute matches”.

In reference to the content above, we then based our robot design and strategy on these criteria and constraints. We constructed all aspects of our robot to fit the problem statement, and by understanding all of these aspects we were then able to better understand build and strategy concepts and have a broader understanding of the game.

## **1.2 Manufacturing—Staff Training**

This year our team has the privilege of having two CNC machines at our disposal. The acronym CNC stands for Computerized Numerically Controlled, and refers specifically to the computer control of machine tools for the purpose of repeatedly manufacturing complex parts in aluminum and other materials. The program is written in a notation conforming to the EIA-

274D standard, commonly called G-code. The CNC machine was developed in the late 1940s and early 1950s by the MIT Servomechanisms Laboratory.

We sought outside help from one of our mentors who has a large CNC machine. He was willing to teach us how to write G-Code, along with allowing us to manufacture some of our robot parts on his larger machine. A team member and one of our coach's travelled over to our mentor's shop to write the G-code for the machine so it would precisely and accurately cut our parts. Our parts fit together easily and have less friction because of the accuracy of the machining in comparison to what the human hand can produce. A number of us have now learned enough about CNC machines to be able to teach other students we mentor in the future.

### **1.3 Brainstorming**

At the start of the season, we got together and had a brainstorming session. We decided that we would take ideas from our past robots, change them, and incorporate them to make new components to create a robot suited for this year's competition.

We took the drive train off of our 2010 robot. The drive train consisted of just a direct drive from the motor to the wheel. The reason we chose the direct drive was that it had the strength to carry our robot and the game pieces. It also has the speed to move the robot around the field in a timely manner to complete our strategy. We changed the wheel diameter from 12" to 10" because we did not need that big of a wheel. Our team had to worry about the size constraint, but also we are trying to save materials to make a large chassis this year.

We took the turntable from our 2012 and 2013 robots as it allowed an efficient and wider range of movement. We changed the gear ratio of the turntable from 7:17 to 5:13.

This year we had to design a new manipulator that will be able to hold on to the eyebolts that are on most of the field pieces. On the back of the robot there is an area to hold on to the large blades so that we can take all three blades over the bridge at one time.

## **1.4 Scheduling**

Our coaches have been involved in the BEST competition in San Antonio for 10 years. Specifically the experience we need as a team to keep on track and complete this competition in the allotted time. As a precaution, our coaches have helped the team make realistic schedules that they think we can accomplish in the allotted six week time period.

## **1.5 Programming**

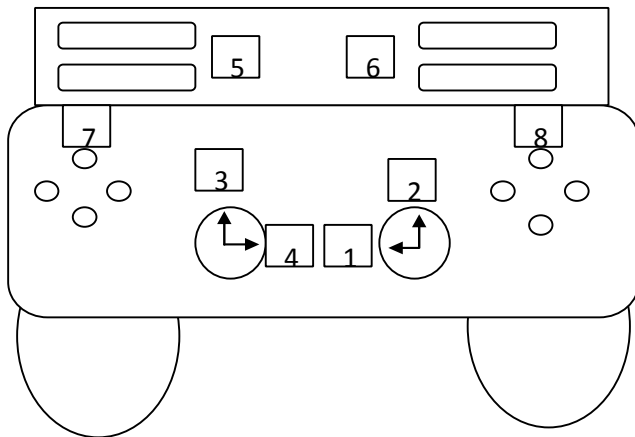
We tested all the motors and the potentiometer after we received our kit, to make sure they worked properly, although we did not end up using the potentiometer. After testing the controller we recalibrated the joysticks. Our drive team wanted to try driving our 2010 competition robot, over the bridge in order to see if the motors would be powerful enough to get over the bridge without gearing. For this we wrote a simple tank drive (driving the robot using two joysticks) program. The next thing we did was program our robot to use an arcade drive, driving the robot with only one joystick. The drive team wanted to keep driving on one joystick because we had two different things that should be controlled using joysticks. We ran into problems at first because EasyC is built in arcade drive block which caused the robot to turn in the opposite direction of the joystick. To fix this, we had to look up the algorithm used for arcade drive and program it manually, instead of using EasyC's built-in function.



When we began the writing this year's program. The code had 4 different sections. They are; the arcade drive, the turntable, arm motion, and the code which opened and closed the servos. We decided to completely start over instead of copying segments of last year's code which did similar tasks, because the code would be more readable if we started from scratch and fully incorporated our own style of writing code. The robot was not fully built when writing this year's code, so we could only write the basic structure of the program. We had to fine-tune after the robot was constructed (ex: which position on the claw's servo between -127 and 127 corresponds to the close position). Once the robot was fully built and could be tested (see Table 1.1 for details).

We tested the preliminary program to ensure that the controls were programmed correctly. Everything was correct on the first try and there were no problems. Once the robot was built, we had to change the parameters for the open and close positions for our claw and nacelle hitch. Our programmer had to decrease the range of the claw in order to remove servo strain and double the range of the nacelle hitch so that it could move down far enough to grab the nacelle.

The drivers also decided that it would be useful to be able to slow down the turntable because sometimes it would turn too fast. In order to fix this for them, we added a button which would toggle between full speed and 50% of full speed for the turntable motor. Finally, the drivers decided that they would be able to move the robot with greater ease if they used a tank drive driving system rather than an arcade drive so the programmer changed the program so that the 2 joysticks were each used to control a wheel and the controls for the turntable and arm were moved to the back buttons on the controller.



1. L – Turntable left  
R – Turntable right
2. U – Arm Up  
D – Arm Down
3. U – Drive forward  
D – Drive backward
4. L – Left turn  
R – Right turn
5. Not Used
6. Not Used
7. Not Used
8. U – Not used  
D – Trailer Hitch Open/Close  
L – Not used  
R – Manipulator Open/Close

*Table 1.1: Controller Layout*

## 1.6 Analytical Evaluation of Design

In order to score competitively, the team has developed a strategy that will try to score as many points as possible in the three minute time constraint. This strategy is based on the experience and expertise of our personnel. The team this year is composed of a fairly even spread of veteran and new members. Because of this, we were able increase the difficulty of our strategies in order to stay above the competition. In addition to considering the relative capability of the team members, the team also had to consider time and space constraints. The fact that our drivers have a very limited time to practice coupled with our shop’s confinement to a particular set of capabilities keeps the team aware that the strategy cannot be too outlandish.

The team has designed the robot around the strategy to ensure success. We began with determining the speed of which the robot must travel to be efficient in gameplay. You can read more about this in the section 1.7 Offensive and Defensive Evaluation.

### **1.6.1 Wheel Design**

Designing from the ground up, the team first had to fabricate the wheels. The wheels this year are three separate layers of quarter inch plywood and 3/5 inch plywood milled with a CNC machine to ensure accuracy. The two outer layers of the wheel are simply rims that add thickness and support to the inner layer, which is a spoked wheel attached to the mounting hub. We spoked our wheels to decrease the overall weight of the robot. We drilled holes through all three layers in a circular pattern along the entire rim of the wheel during the same instance, again with a CNC (See Figure 3 in the Appendix). These holes are threading points for the rubber tubing that is wrapped around the wheels to add traction. Additionally, we milled mounting holes lined up with the center of the spoked layer for ease of access when constructing the robot. Next, all three layers were indexed to ensure the layers were in the correct orientation when we glued them together. Later, after the glue had dried and the team checked the overall quality of each wheel, the rubber tubing was twisted and threaded through all of the holes to make the required treading.

### **1.6.2 Chassis and Turntable Design**

In previous years, our robots included a turntable that consisted of the Lazy Susan and a ring gear milled into the base of the robot that allowed the arm of the robot to turn in all directions (See Figure 1 in the Appendix). The team saw this design element as something that would benefit this year's robot in its operation. We attached a drive motor to the base of the arm that has a mounted gear that paired up perfectly with the milled out ring gear. We used a 5:13 gear ratio for this gear pairing that allowed the entire system to fit within the size constraints of the Lazy Susan and robot chassis. The drive gear used in the turntable also functioned as the

mounting hub. We milled the gear out of the half inch block of aluminum and drilled a set screw hole into the side of it, effectively eliminating the need for a separate mounting hub.

In the same milling instance, we also made pockets in the bottom of the robot chassis. These pockets don't cut the entire way through the base of the robot, and serve only as weight reduction. We placed these pockets such that they do not get in the way of any other components of the robot or reduce the rigidity of the chassis.

An upright storage rack with slots cut into it to hold the large blades is mounted to the back of the chassis. The strategy that the team is using involves carrying three large blades at the same time. The storage rack allows the robot to hold three large blades in addition to other game components. This reduces the number of trips the robot must make to the parts storage area.

### **1.6.3 Gearbox Design**

The challenge this year includes many components that are heavy in comparison to previous years. To compensate for this, the team designed and constructed a gearbox that drastically increases the strength of the motor at the price of its speed. In two stages, we increase the torque of the motor from 9.49 inch pounds to 132.86 inch pounds with a gear ratio of 20:1. However, because of the 20 inch length of the arm, the mechanical advantage is canceled out. Essentially, we used the gear-box to overcome the moment at the end of the arm due to the arm extending so far beyond the base of our robot. In the first stage, a five toothed gear hub is paired with a 20 toothed gear. In the second stage, a 6 toothed gear, mounted to the 20 toothed gear from the first stage, is paired with a 16 toothed half gear. Finally, the arm of the robot is mounted to the flat side of the half gear (See Figure 4 in the Appendix).

In the construction of the gearbox, we had some trouble getting the axles to line up with the holes on both sides of the gearbox. To fix this, we simply bored out the hole which allowed

the axle to slide freely and properly into the bearings on either side of the gearbox. Next we added the wooden spacers that separate the two walls of the gearbox to the correct width to hold all of the necessary components. After we had all of the gears mounted on their corresponding axles and correctly spaced, we had to add in axle spacers to keep the gears in place. We used a hole-saw to cut out 18 wooden spacers from quarter inch plywood. Once we installed the spacers, we installed the outside wall of the gearbox and the gearbox construction was complete.

#### **1.6.4 Arm Design**

For this year's challenge, the team decided that a simple, single stage arm would perform better than a more complicated, two stage arm. The body of the arm is made of 1" PVC that attaches to the half gear that is mentioned above. We used PVC because we have an abundant supply due to the fact that we don't use PVC anywhere else on the robot, and it provides the strength required to lift the game objects. We cut a flat spot into the round body of the PVC arm that allows the arm to fit properly against the flat edge of the half gear (See Figure 2 and 4 in the Appendix). At the opposite end of the arm, we cut a DADO notch the width of the manipulator to secure the manipulator to the arm itself.

#### **1.6.5 Manipulator Design**

Our manipulator is made out of four layers of quarter inch polypropylene plastic bolted together. There are two outer layers that help enclose the entire assembly, a middle layer composed of a fixed jaw and a pivoting jaw, and a support layer that holds the actuator servo, all milled by CNC for accuracy. All of the layers, except the support layer, have a semi-circle cut out that allows the manipulator to pick up the large turbine blades (See Figure 2 in the Appendix). In addition to these four layers, a bent aluminum rod is attached to the side of the

manipulator. This rod is perfect for the collection of game pieces that have an eye bolt. We inserted the rod into a slit cut into the fixed jaw and held in place with a screw. We connected the manipulator to the robot via the notch cut into the end of our arm large enough to hold the manipulator in place with two screws. The servo wire is threaded through the body of our arm to our cortex so it cannot get caught during any sort of arm movement.

## **1.7 Offensive and Defensive Evaluation**

At kickoff we received the game for this year, “Bladerunner”. We noticed that the game had similar characteristics of past games. For example, the assembling of structures on the field in “2008 Just Plane Crazy.” After we made a rough idea of our strategies we went into a brainstorming session.

We made several strategies that each highlight different possibilities. For example, we have a strategy for when we work alone, for when we work with an experienced partner, and for when we work with a newly established team.

### **1.7.1 Solo Strategy: 397 points**

- Leave the start block forward
- Move the bridge chicken
- Place chicken by OSOW permit
- Grab 3 large blades and store
- Get small turbine blade assembly
- Get small nacelle
- Cross bridge
- Insert nacelle
- Insert small turbine blade assembly
- Open blades
- Place large blades
- Spotter aligns blades

### **1.4.2 Newly Established Partner: 478 points**

#### Team to the left:

- Get OSOW permit
- Move 2 prairie chicken habitats to safe zone without knocking any over

### Our Team:

- Move chicken habitats out of the way and open the bridge gate
- Pick up 2 large blades and store
- Get small nacelle
- Cross bridge
- Get partner's large blade
- Get partner's small blade assembly
- Insert nacelle
- Insert partner's small blade assembly
- Place all 3 large blades
- Spotter aligns blade

### **1.7.3 Experienced Partner: 747 points**

- Move chickens out of the way
- Open bridge gates and get OSOW permit
- Grab 3 large blades
- Put 2 blades on ally tower (stage 1)
- Ally puts 1 blade on (stage 1)
- Ally pulls tower upright
- Ally puts blades in position (stage 2)
- Grab nacelle
- Transport parts over bridge
- Ally grabs our small turbine blade assembly
- Ally puts small turbine blade assembly on their nacelle
- Ally pulls tower upright
- Ally expands small turbine blades
- Put nacelle on our small tower
- Place 1 large blade
- Ally places 2 large blades on our tower
- Pull large tower upright
- Put blades into stage 2
- Grab allies small turbine assembly
- Place small turbine blade assembly
- Pull small tower upright
- Expand small turbine assembly

## **1.8 Test, Refine, and Evaluate**

After constructing our robot, we were able to make several test runs. During these test runs, our drivers found several problems with our design that had to be fixed. Below are explanations of the problems we encountered and how we overcame them.

### **1.8.1 Extended Storage Area**

The original large blade storage area was made of a fixed unit on the base of our robot. We found out after a few practice runs that the arm reached past the storage area and therefore, wasn't going to work. We started brainstorming other ways to store the large blades on our robot and came to our current solution by combining the best aspects of the designs we came up with. The first idea was to use a bungee cord to spring an extension panel holding our original storage area into place slightly farther away from the arm. The down side to this was that it was impossible to remove the large blades from the original slots after placing them. The second idea was to store the large blades vertically rather than horizontally. This meant using several sections of three inch PVC piping as cups with slots cut into the sides that would hold the large blades vertically.

### **1.8.2 Trailer Hitch**

While testing we discovered that our robot could move the nacelle over the ramp better while the robot was driving backwards then forwards. We put stop/indexing blocks on the sides of our extended storage area that corralled the nacelle and kept the nacelle from moving side to side. The stop/index blocks were cut at a slant so they could fit within the size constraint. We also had the problem of the nacelle rolling away from us when we drove forwards. To fix this, we mounted a servo in between two of the aforementioned PVC cups. A lever arm was attached to the servo horn and a dowel was attached to the end of the lever arm. When the lever arm was placed in the down position, the dowel would be forced down and act as a hook on the captured nacelle. With this addition, we were able to move in all directions with the nacelle without losing control of it.



## 1.9 Safety

Safety is of great importance to our team. To instill strong safety awareness in all our members, we implemented a system of safety checks.

First, we require all students working in the shop to pass a general safety test. A copy of this test is attached (See Figure 6 and 7 in the Appendix). Each test must be passed with 100% mastery. In addition, if a student wishes to use any power tools or hand tools, they must pass a “Tool-specific Test” with the same parameters.

Second, we created a set of ground rules for all team members to follow, including, but not limited to: wearing safety glasses, tying back long hair, closed toed shoes, and peer reminders. This list is a requirement for any person present or working in the shop. Peer reminders are an effective way of always being safe. Any member can remind the whole team of safety rules at any time.

Lastly, all team members must participate in cleaning the shop at the conclusion of every work night. Some jobs include: sweeping, de-cluttering, and organizing the work area. We also have a designated tool manager. This member has the responsibility of checking to make sure that all the tools have been put in their correct spots and that everything is in order before leaving each night.

## Section 2. Research Paper

The name of this year's game is Bladerunner. The goal is to transport and construct wind turbines from pre-made parts. To better understand how to accomplish this feat, our team must first know about real-world wind turbines, their history, structure, and function. The environmental impacts of wind turbines are also important to this task.

To begin understanding the workings of a wind turbine, we must learn about its past and what inventions led to it. The earliest records of humanity harnessing wind power are in Ancient Egypt. Around 5000 BCE the Ancient Egyptians would use the wind to propel their boats up and down the Nile River. The first use of propellers and wind energy was in China and the Middle East around 200 BCE. Basic windmills helped pump water and mill grain for farming.

Windmills stayed popular for a very long time. A little over 1,000 years after windmills showed up in the Middle East, they diffused their way east to Europe. While it was used all over Europe, it was most famously used and adapted by the Dutch. With their borrowed technology, the Dutch modified the windmills to drain bodies of water. During the Industrial Revolution, electricity became one of the main uses for windmills. All over Europe, they were used to power a variety of different machines.

Later on towards the end of the 1800's, wind power made its way to America. It was used for all the same purposes as they were in Europe, but with one small difference: how they changed them. Once the windmill was improved in America, it was made bigger and better by a variety of people. Pushing into the 1900's, simple windmills had become electricity making behemoths. These wind plants were then scattered about the country.

World War II is when people really started calling these contraptions turbines. It is also when they became a popular energy source. Turbines were used commonly up until the 1950's

when oil became a cheap and easy energy source. From that point on, there has been a battle between wind turbines and oil, each one's dominance fluctuating depending on the others price at the time. For example, an oil shortage, such as the one in the 1970's, would cause turbines to become popular, but an abundance of oil would make wind energy seem fiscally irresponsible.

By the end of the 20th century, oil beat out wind, as reflected in the fossil-fuel-driven electrical market today. Still, wind power is being used a great deal, especially in Texas, and will very likely come back to being a major energy power.

From the outside, a modern turbine seems similar to its ancient predecessors. Inside, it's a different story. There are two main parts of a turbine, which contain the other parts. The parts are called the rotor and the nacelle. The rotor includes the propellers and what they are attached to; the nacelle is what the rotor is attached to. Finally, there is the tower, which is the pole that attaches the main part of the turbine to the ground. The pole is used to raise the turbine high enough to minimize turbulence that is often present at ground level.

A few other components of turbines are generators, gearboxes, and controls. Generators are what make the turbine able to convert wind to energy. It converts the mechanical energy made by the movement of the blades into electricity. The gearbox, as its name represents, is a box of gears. These gears turn the slow movements of the rotor into more rapid rotations by transferring it through a series of gears until it reaches the generator on the other side. The controls make sure all of this is working efficiently and sends reports to engineers.

These many parts come together, to create a wind turbine: a machine that harnesses the power of the wind and makes energy that is available for human usage. Wind blows into the blades of a turbine and spins the entire rotor. The spinning of the rotor begins turning the gears in the gearboxes, which in turn spins the generator. The generator turning makes the electricity.

Wind turbines are transported in parts, because of their size. The blades are transported together, as are the towers. These are the longest parts, which makes transport complicated.

As technology improves, so does the length of the parts. This increasing size is making it harder and harder to transport them easily. Only certain roads and bridges will allow cargo of the size and weight wind turbines across them. This reduces the variety of routes for transportation, forcing the convoys to use rural and bumpy routes.

According to the American Wind Energy Association, Texas is the country's leader when it comes to wind energy. There are 7,986 utility-scale turbines in the state producing 12,755 megawatts of electricity. The majority of these turbines are in windy West Texas.

Beyond saving coal, wind turbines do a lot to help the environment. Most of these benefits come from what wind turbines don't do, compared to other sources of energy. Compared to fossil fuels, wind power does not pollute air, water, or land. Nothing is released as a consequence of wind power either, unlike greenhouse gases from coal. Also, the land that wind turbines are on can be used for other purposes at the same time the turbines are in use, even farming at some times.

On the other hand, sometimes wind turbines hurt the environment. These tall sticks with propellers can distract many animals. Bats and birds have died, mistaking the turbines for trees on many occasions. Even the transportation of the parts endangers land bound animals, such as the prairie chicken.

Every machine needs a designer and a builder. In the case of wind turbines, this job goes to the wind energy engineers in the world. These engineers design the turbines along with how the entire wind farm will be plotted out. While these are the main people on the job, other

engineering specifications help. For example, civil, mechanical, and electrical engineers are some of the main types.

The existence of wind turbines is very important in the past, the present, and the future of electricity. To know its background and how it affects the earth is very important not only to the world but to this team. This knowledge will help us better prepare for facing this years' challenge.

## 2.1 Research Paper Bibliography

- Anatomy of a Wind Turbine*. (2013). Retrieved 10 2, 2014, from AWEA:  
<http://www.awea.org/Resources/Content.aspx?ItemNumber=5083&RDtoken=29819&userID=4379>
- Fortner, A. (2013). *Transportation and logistics impact wind project costs, turbine engineering*. Retrieved 10 2, 2014, from AWEA:  
<http://www.awea.org/Issues/Content.aspx?ItemNumber=5035>
- Gupta, A. (2014, 5 27). *How do Wind Turbines Benefit the Environment?* Retrieved 10 4, 2014, from Bright Hub: <http://www.brighthub.com/environment/green-living/articles/68454.aspx>
- History*. (n.d.). Retrieved 10 4, 2014, from Wind Energy Foundation:  
<http://www.windenergyfoundation.org/about-wind-energy/history>
- How Do Wind Turbines Work?* (n.d.). Retrieved 10 3, 2014, from Office of Energy Efficiency & Renewable Energy: <http://energy.gov/eere/wind/how-does-wind-turbine-work>
- State Wind Energy Statistics: Texas*. (2014, 4 10). Retrieved 10 2, 2014, from AWEA:  
<http://www.awea.org/Resources/state.aspx?ItemNumber=5183>
- Wind Energy Development Environmental Concerns*. (n.d.). Retrieved 10 4, 2014, from Wind Energy EIS: <http://www.windeis.anl.gov/guide/concern/index.cfm>
- Wind Energy Engineer*. (2013). Retrieved 10 3, 2014, from Troops Energy Jobs:  
<http://www.troopstoenergyjobs.com/energycareers/engineer-wind.php>
- Improving Lesser Prairie-Chicken Habitat* (n.d.). Retrieved 10 6, 2014 from USDA

## Section 3. Marketing

BEST does not only consist of building a robot that can compete the specified task, but also a marketing and development portion. With this, we show our spirit and sportsmanship through shirt design, a booth display, and presentation, all of which tie into the year's competition.

### 3.1 Outreach, Promotion, and Recruiting

Our team works hard to promote BEST outside of the competition setting. We have compiled a list of events that we have participated in order to promote BEST and the values it advocates.

<b>Time of Year</b>	<b>Event Involving Team or Members of Team</b>
May 2014	Promoting at a NEISD Event to Spread Robotics to Schools
April 2014	Outreach to other clubs/organization at Robert E. Lee
August 2014	Promotion of BEST to STEM Freshman
August – September 2014	Team Brainstorming and Member Recruiting
September – October 2014	Promotion to Parents and Sponsors
September 2014	Fundraising at STEM Game Night
September 2014	S.A. BEST Kick-Off
September 2014	San Antonio Youth Code Jam
October 2014	Robotics Team Fundraising at Lee-esta
October 2014	Promotion of BEST to Robert E. Lee High School Staff
October 2014	Promotion to Robert E. Lee Community – Lee-esta
October 2014	Promotion to STEM Staff and Clubs
*November 2014	Outreach to the Church of Reconciliation
*November 2014	Outreach to Northern Hills Elementary School

As big supporters of the BEST competition, we went out into our community to promote BEST and talk to students about what they need to do to get involved in robotics at a young age. We spoke about past competitions and our experiences to get them excited about robotics and the BEST values.

### 3.2 Sponsors

# Bill Miller Bar-B-Q



Pfitz. Public Relations  
Ultimate Air Systems, Inc  
River City Credit Union  
Star Wholesale  
Turner Family  
Warmowski Family  
Scheffer Family

Strader Family  
Pundt Family  
Emma Orta  
Erica Juarez  
Dr. Melissa Alcala  
Richard Canales







### 3.3 Mentors

After 20 years of BEST, our team was excited about a 21<sup>st</sup> with the new Bladerunner game, but we definitely could not have done it all without the help of our mentors. Not only have our mentors helped to instill in us the values of the BEST competition, but they also ensure that we stick to the plans we made. Our mentors have helped each and every one of us to accomplish things that we had no clue we could do with just a bit of guidance. These mentors have given us the momentum and the direction to accelerate into the future.

Ron and Louann Pundt have worked side by side for years to help students accomplish the seemingly impossible. They have been both mentors and coaches of BEST teams for the past 11 years. They have continuously changed the lives of their students, encouraging them to do well in school to continue into higher education, and giving them an organization to empower themselves. They are dedicated to their team and have donated hundreds of hours to allow us to compete. They go above and beyond.

Rudy Pena is a mentor who helps us with both strategy and construction. He was very involved in robotics when he was in high school. He has been our mentor for six years.

Fred Safstrom is our mentor who helps us with programming. He is originally from Sweden, but is now a United States citizen. He is employed with IBM in San Antonio. He has been teaching our team members about programming for the past six years.

Jody Turner donated tremendous amount of time and food for our hungry team members. She was instrumental in assisting our spirit group by helping to make banners and noise makers. This is her second year on the team. She has devoted a lot of her time to finding us sponsors. Also, as a goal of the team, it was very important for us get team members parents involved in the meetings and at the competition. So, gracefully, Mrs. Turner took up the job of keeping all

parents informed about the team and how we were doing and if we needed help with providing meals for the team at our late night team meetings.

Erica Juarez is our mentor who is a past team member. She has been working on this team for the last four years, but as of now she is a mentor for the marketing and notebook departments for our team. She is a great writer and we are lucky to have her mentoring our team so we can all succeed in professional writing and our marketing categories.

Elizabeth Muire is an English teacher at Robert E. Lee and assists us in the revising and editing of our engineering notebook. She is new to the team this year and has been an amazing help.

Janine Warmowski donated countless hours of her time to assisting our team throughout the season. She helped our spirit and exhibit team tremendously. Additionally, Janine donated food that helped our team members put in the long hours required for this competition.

### **3.4 Consultants**

Consultants are individuals or companies that assist our team with information or knowledge without directly mentoring the team. Below is a list of this season's consultants and the information they provided to the team.

- RES America – Information on wind farms used in the research paper and our exhibit
- Jeff Bonner – Information of prairie chickens used in the research paper and our exhibit
- Daniel Joaquin – Design tips and marketing information

We greatly appreciate all of the information provided to us by our consultants. With this information we have bettered our knowledge of the game theme and the real world.

# Section 4. Appendix

*Bladerunner 2014*



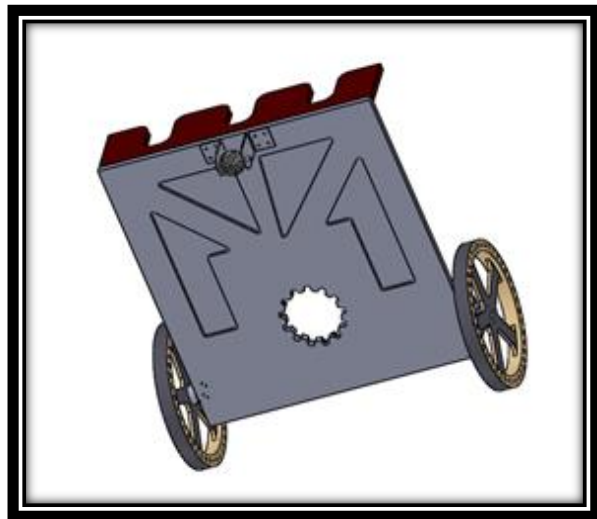
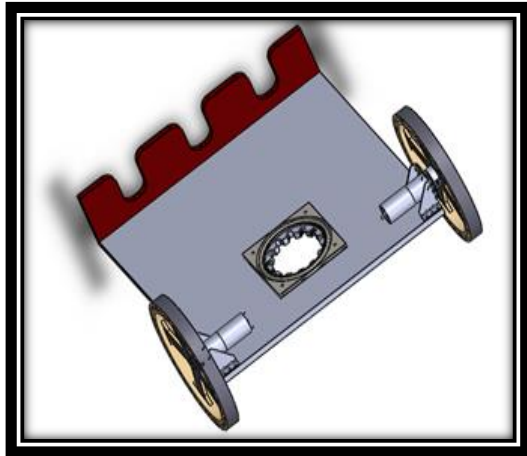
*Boosting Engineering, Science, and Technology*

leebestrobotics.com



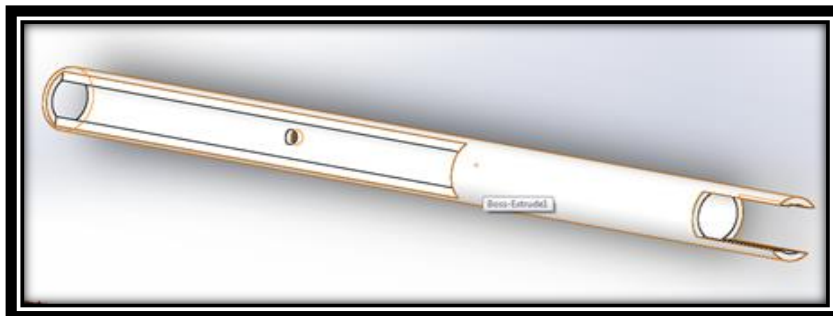
Powering the Future.

**Figure 1: Drive Chassis**

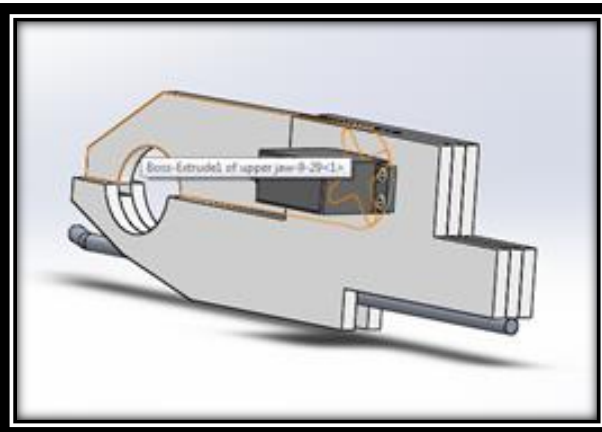


The drive chassis is composed of two main wheels and the rear wheel is composed of a golf ball on an axle.

**Figure 2: Arm**



The arm is composed of two parts. First is the arm which holds the wiring, and the manipulator which does contain a hook.

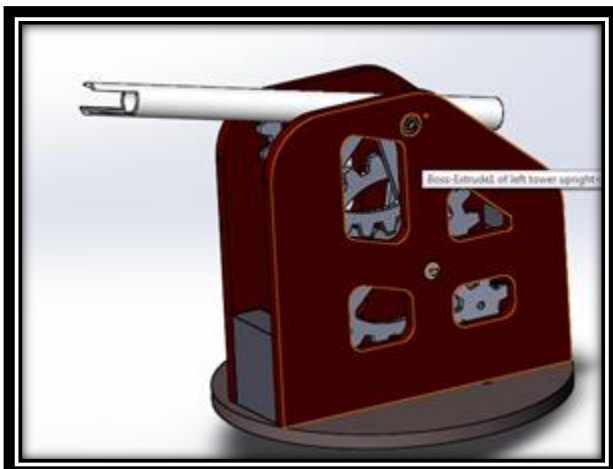
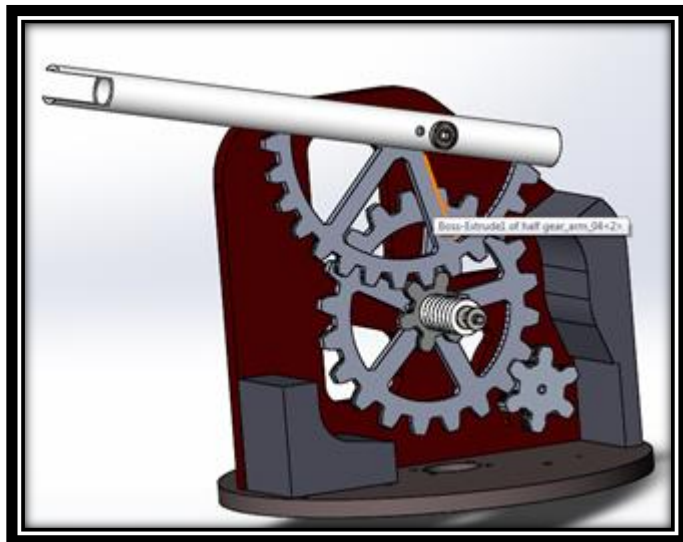


**Figure 3: Wheel**



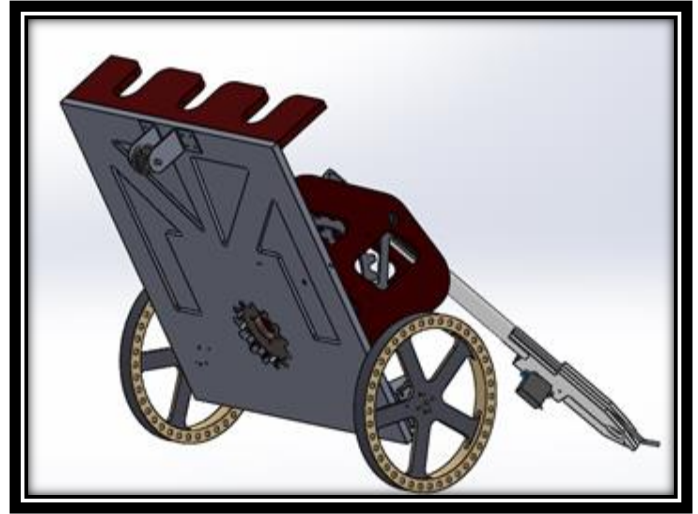
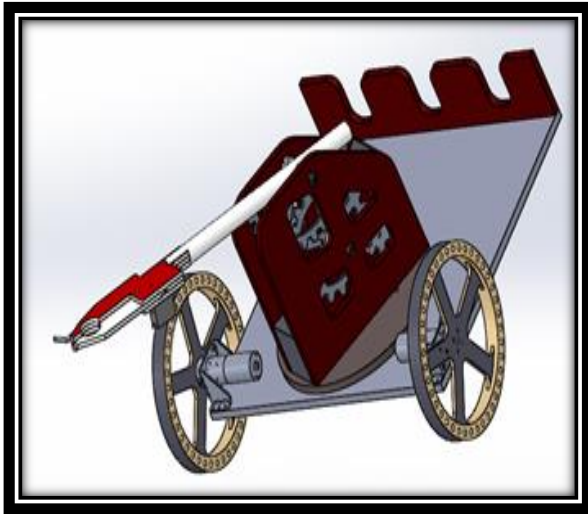
The wheel has holes drilled throughout the rim, which are evenly distributed.

**Figure 4: Arm Gearbox**



The arm gearbox contains the mechanisms that control the arms movement. On the bottom is contains a part that will be the turntable.

**Figure 5: Robot**

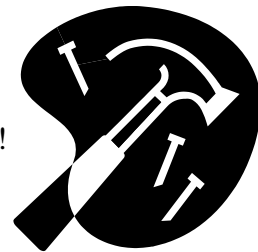


This is the complete robot put together with all of the main compents of the robot.

## Figure 6: Safety Lesson

1. Pay attention to your surroundings and your teacher!
2. Always wear your safety glasses!
3. Know where the emergency turn off buttons are on machines and in the shop!
4. Don't leave a mess! Pick up after yourself! Sweep up a workspace after making a mess. If you don't, this can cause people to slip!
5. Wear the correct shoes; no open toes in the workshop!
6. No running in the workshop!
7. Please keep long hair tied back!
8. Don't wear overly loose clothing in the workshop!
9. Clean up immediately after you're done-don't procrastinate!
10. Please report all hazardous, unsafe conditions and work practices.
11. When in the construction zone, please wear your hard hat at all times!
12. Only use tools and machines for their intended purpose.
13. Only qualified or suitably trained personnel may use equipment.
14. Never distract the attention of another staff member when operating equipment and never indulge in horseplay.
15. Always seek instruction before using an unfamiliar piece of equipment.
16. Always put away tools that you take out of the storage rooms.
17. Please do not leave machines on when not being used.
18. Know exactly where emergency items are in case of emergency.
19. Please keep all guards in place to ensure safe use of machinery in the workspace.
20. Think safe, be safe! If you think safety, you will work safely!
21. Keep food and drinks out of the work room!
22. Cut away from yourself.
23. Don't ever carry tools in your pocket!
24. A metal edge can be as sharp as the tool you use to cut it!
25. When carrying sharp objects, carry them next to you with the sharp end down.
26. Store tools vertically with the sharp or heavy ends down.

**Think Safe!**



## Figure 7: Practice Safety Test

**Question 1.** Yes or No: Is it ever okay for anyone to carry sharp tools in their pockets?

**Question 2.** NEVER, EVER use a machine without its \_\_\_\_\_ in place. Choose one answer.

- a. pulleys
- b. widgets
- c. safe guards

**Question 3.** Always wear your \_\_\_\_\_ whenever you are in the shop even if you aren't doing anything, but others are. Choose one answer.

- a. dark shades
- b. ear protection
- c. safety glasses

**Question 4.** Always cut \_\_\_\_\_ yourself when using chisels and other edged tools. Choose one answer.

- a. against
- b. towards
- c. away from

**Question 5.** Carry sharp and pointed tools \_\_\_\_\_ your body with the point's \_\_\_\_\_. Select the correct answers to fit the blanks. Choose one answer.

- a. away from, bent
- b. next to, down
- c. towards, up

**Question 6.** Store tools and materials \_\_\_\_\_, with the points and heavy ends \_\_\_\_\_. Select the best answer group. Choose one answer.

- a. vertically, down
- b. horizontally, up
- c. vertically, up

**Question 7.** A metal edge can be just as \_\_\_\_\_ the tools that cut it. Choose one answer.

- a. dull
- b. rounded
- c. sharp



**Be Safe!**







## BEST Team Demographics - 2014

Submission of this completed form is **required** as part of the **Project Engineering Notebook** submitted at the local hub competition. We request that it **be completed just prior to submission of the notebook for judging.**

<b>School Name:</b> Robert E. Lee High School		<b>City/State:</b> San Antonio, Tx	
<b>Most correctly describes school location:</b> <input type="checkbox"/> Rural <input checked="" type="checkbox"/> Urban/City <input type="checkbox"/> Sub-urban			
<b>Type of school (check the box):</b> <input checked="" type="checkbox"/> Public <input type="checkbox"/> Private <input type="checkbox"/> Home school <input type="checkbox"/> Other:			
<b>Type of school (check the box):</b> <input type="checkbox"/> Middle/Jr. High <input checked="" type="checkbox"/> High School <input type="checkbox"/> K-12 <input type="checkbox"/> Other:			
<b>Which most appropriately describes the total student population at your school:</b> <input type="checkbox"/> 1 to 399 <input type="checkbox"/> 400 to 799 <input type="checkbox"/> 800 to 1199 <input type="checkbox"/> 1200 to 2000 <input checked="" type="checkbox"/> greater than 2000			
<b>Number of students on BEST team by grade:</b> K - 5 <sup>th</sup> :    6 <sup>th</sup> :    7 <sup>th</sup> :    8 <sup>th</sup> :    9 <sup>th</sup> :    10 <sup>th</sup> : 3    11 <sup>th</sup> : 8    12 <sup>th</sup> : 5			
<b>Number of students on BEST team by race (optional):</b> African-American:    Asian American:    Hispanic:    Native American: White:    Other:			
<b>Total number of students on BEST team:</b> Number of males: ___ 10 ___    Number of females: ___ 6 ___			
<b>Total number of students who worked on the robot: ___ 11 ___</b> Total male: ___ 9 ___    Total female: ___ 2 ___			
<b>Total number of students who worked on the BEST Award: ___ 16 ___</b> Total male: ___ 10 ___    Total female: ___ 6 ___			
<b>Approximate number of students on your BEST team likely to pursue careers in engineering, science, math, or technology:</b> Total # of male: 9    Total # of female: 4			
<b>Total number of adult mentors assisting your BEST team (NOT including teachers): 6</b>			
<b>This year, is BEST being integrated into any STEM (Science, Technology, Engineering, Math) curricula at your school?</b> X YES <input type="checkbox"/> NO			
<b>As a direct result of participation in BEST, has your school adopted/developed an engineering course(s) or curriculum?</b> <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> N/A (our school does not offer engineering courses/curr.)			
<b>Of the software provided by BEST Robotics, our team/school used the following (check all that apply):</b> <input checked="" type="checkbox"/> SolidWorks <input type="checkbox"/> MathWorks Simulink <input checked="" type="checkbox"/> easyCv4 <input type="checkbox"/> RobotC <input type="checkbox"/> Mathematica <input type="checkbox"/> HSM Works <input type="checkbox"/> InspirTech (SolidWorks Training)			