Technology Innovation Award Submission

"To Encourage Development of Technologies Through Sharing"

Thruster Fans: Propelling Us Towards the Future

Purpose:

The *FIRST* 2009 Competition, entitled *Lunacy,* was specifically designed to resemble the lunar moon surface. The moon has approximately one-sixth the amount of gravity found on Earth. To simulate this lack of gravity, a majority of the game floor was covered by a slick, white material called "REGOLITH" or "Glasliner FRP$_{tm}$," Regolith is a gel-coated, fiberglass-reinforced, polymer material, which aided in simulating the harsh land conditions faced by lunar robots while driving on the moon. To further encompass the effect that the moon has on gravity and control, each robot needed to incorporate new wheels that were covered with a hard white plastic for this year's game challenge.

Traction to the floor is a very important facet in this year's game, and was very challenging for many teams. Increasing the number of wheels would, in turn, increase the contact area, but did not change the coefficient of friction, nor aid in a more swift control system. Due to robot interaction during the game play, the floor wears causing coefficient of friction changes. A quick check showed that a 120 pound robot would start to slide and lose control with approximately 14 pounds of force exerted upon itself. Since control is an essential component of this year's game challenge, traction played a major factor in robot design.

Several ways to reduce wheel slippage on the floor have been discovered, tested, and implemented. One effective change is to monitor the wheel speed to the command speed, and then reduce the rate of acceleration until minimal slippage occurs. The scientific term for this process is known as traction control. Such a device would require custom circuitry and delay in movement. Another solution, which is much simpler and reliable, is the implementation of induct fans. Air force generated by these fans would assist the acceleration of the robot, thereby increasing the drive system control, and better completing the game task at hand. An airplane taxiing away from the gate at the airport is a perfect example that demonstrates the effective use of induct fans.

Scope:

1. To move air by induct fans that would give a reactive force to help accelerate a 120 lb. robot, thereby creating better overall control of the robot.

2. Materials used would have to meet *FIRST* rules of material and cost.

3. Total current consumed by the induct fans would have to be less then 40 amps at 12 volts DC (according to *FIRST* guidelines). Note: This can be achieved with different gear ratios to the motor.

4. The fans would have to fit in the envelope of 28"x36"x 60" (as stated by *FIRST*)

5. The weight of the fan would have to be included in the maximum weight for the robot--120 lbs.

Experiment:

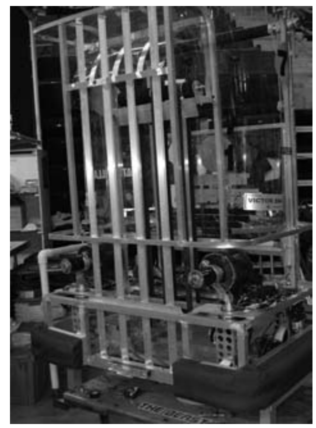
After completing extensive research regarding induct fans, we discovered model airplanes have used inducted fans as a source of power to fly. A company named Aero-Naut makes a Turbo-Fan 8000 that is made out of a very light electric carbon fiber material using extreme precision, efficiency, and embodies structural integrity. The combined weight of the impeller and case is only 11 oz. These fans have the capability to rotate at 30,000 RPM, with an output force of 30 lbs. Team 71, as well as other *FIRST* teams, would never be able to achieve this speed with the regulated *FIRST* kit motors and reducers. However, by using the CIM motor from the kit (which has 5300 RPM), and gearing it up with a XRP gear reducer, we were able to run the gear reducer in the opposite direction. This resulted in a much faster speed. To achieve the desired effect, a round adapter was machined to the diameter of the CIM motor and adapted to the XRP gear reducer. The adapter was then mounted to the CIM motor with the impeller also mounted on the output shaft. By incorporating this technique, Team 71 was able to engineer a very slim and aerodynamic design.

The first initial test with the induct fans had a 4 to 1 ratio that would result in 5300 x 4 to1 ratio = 21200 RPM calculated /actual 20,000 rpm, because of the efficiency of the gear reducer. This resulted with a current of 57 amps, which is well over the deign criteria of the robot.

Our second trial run used a 3 to 1 ratio that would result in 5300 rpm x 3 to 1 ratio = 15900 RPM calculated/ actual 14300 RPM, resulting in a current of **32 amps, which would be the desired current.** This test proved successful.

Team 71 now has the induct fan assembly running at 32 amps and having a total weight of 4.1lbs. We needed to measure the actual thrust, in pounds, that would assist the robot in acceleration and control. To measure this, we strapped the thruster fan assembly to a small roller chair with a battery attached for power, as shown in the left picture below. Measuring with the fish scale, we have approximately 5 lbs. of thrust. By incorporating two induct fans on the robot; we would be able to achieve 10 to 12 pounds of total thrust.

Basically, the hard part of the design was complete, except for mounting. Planning ahead, we did leave some room and weight to accommodate the additional weight from the thrusters' fans. We proceeded to mount the thrusters on the top of the crab steering, which is the control system that drives the robot around the playing field. This position of the thrusters was effective, because the induct fans follow the way the wheels turn, aiding the robot to accelerate in the direction commanded. After the fans were mounted and wired, they had the look as if they were designed to be there, as shown in the far right picture.



With two thruster fans, we were able to achieve:

Thruster Fan	Force	RPM	Current Amps	Force of Two
Original	15 lbs.	30,000	85	30 lbs.
4 to 1 Ratio	10 lbs.	20,100	57	20 lbs.
3 to 1 Ratio	5 lbs	14,300	34	10-12 lbs.

Conclusion:

Thruster fans (also referred to in the report as induct fans) that have been incorporated into our 2009 robot design have assisted the robot in acceleration. The manner in which they were mounted on top of the drive wheels enabled the fans to set their force in the direction of driving set by the operator. This unique design also has a second benefit when it comes to your opponent trying to score moon rocks, this year's game pieces. If a team is trying to score in your cart (that is, the goal being towed behind you), acceleration of your robot allows the Thruster fans to blow air, blowing away and redirecting the moon rocks from being scored.

This added benefit occurred because of the air flow of the fans. In our opinion, Team 71 won the St. Louis Regional not only with the help of our alliance partners, but also due to our innovative thruster fan design implementation.