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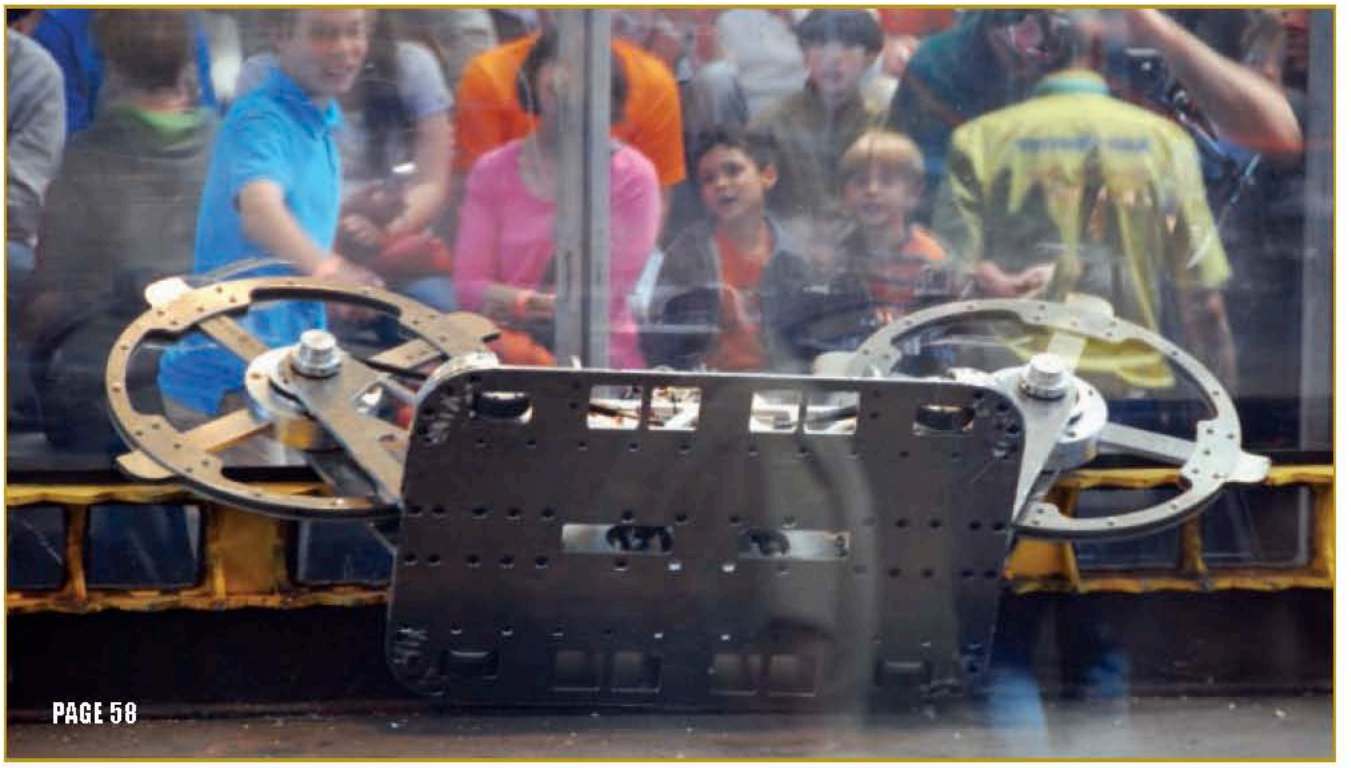

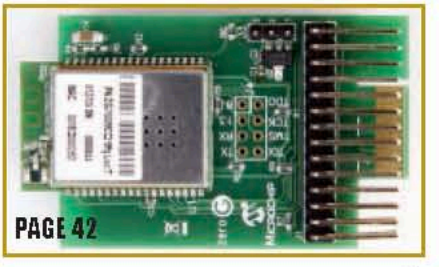

From Brazil to San Francisco

By Marco Meggiolaro

FIGURE 1. RioBotz at RoboGames 2006.

Our Incredible RoboGames Experience

Our combat robot team RioBotz can be divided into two timelines: B.R. and A.R. – Before RoboGames and After RoboGames. We have been competing with combat robots since 2003, starting with a lousy (though beloved) middleweight named Lacraia, that had an "amazing" 1 mm thick aluminum armor (so as not to go over the weight limit). This all started when a few of my college students asked me to help them build a combot. I had built robots before, but never to be sent into combat or to have a strict weight limit. This was new to both me and my students. After a lot of learning, broken parts, and reading all available books on combots, we achieved our first significant result the following year, winning the Brazilian nationals with the middleweight spinner Ciclone.

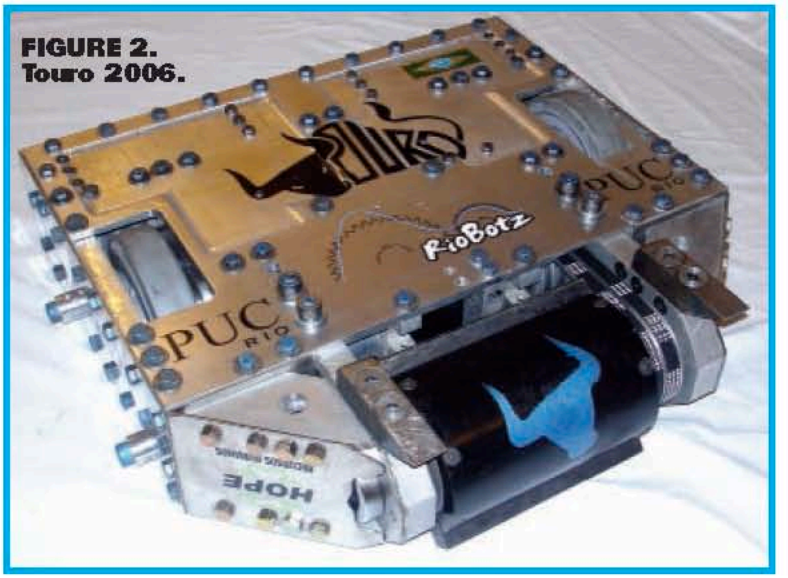

FIGURE 2.
Touro 2006.

Back then, Brazilian competitions were very different from today. Most robots weren't powerful enough to inflict any major damage on adversaries. The rivalry was very intense, not only among teams but also between the various states around Brazil. The cheering was sometimes too passionate, resembling a street fight crowd. A few teams insisted on covering their robots in the pits (as if, during the competition, there would be time for competitors to modify their robots to take advantage of any obvious weak spots). The competition was fun, but there was not too much sharing of information.

Things changed after Paulo and Thacia, the organizers of Brazil's largest combat event (the Brazilian equivalent of Dave and Simone), attended RoboGames 2005. They had a wonderful experience — completely different from the Brazilian events back then. Not only were the combots more powerful and destructive, but the builders were much more mature and friendly. Paulo and Thacia gathered a lot of information about building combots and pit etiquette, and shared it with the Brazilian community on their return.

They also shared several videos from RoboGames 2005 which inspired many teams to attend the event the following year (especially our own RioBotz). But the combat videos were scary! Most Brazilian robots were not even close to that level! Our relatively unstable middleweight spinner Ciclone would be flipped over for sure against any well-built wedge, and its 1/4" thick, low-grade aluminum structure would be cut like butter by powerful spinners.

FIGURE 3. All Brazilians competing in 2006.

This was when there was a huge upgrade in the RioBotz robots. RioBotz had been winning most Brazilian events with a middleweight robot that was not invertible and whose weapon energy was the same as the one from our current featherweight. We were lucky – we never had any major damage inflicted on us. In fact, you only learn your robot's limits when something breaks. Our spinning bar broke once in Brazil, which led us to improve the weapon system. Unfortunately, our armor was still lousy by RoboGames standards. To change that, we started designing Touro in late 2005. It would be an invertible middleweight combot with a powerful spinning drum. We also designed and built our first beetleweight combot, Mini Touro, to compete at RoboGames 2006.

Figure 4. Front armor.

Our sponsors didn't have the money to send the team to RoboGames 2006, so all the students who attended had to pay for their own ticket and hotel room. This is pretty much how it still is today, since it's not cheap to compete overseas – but

Figure 6. Touro vs. Sub Zero.
(Photo by Brian Benson)

it is well worth it! **Figure 1** shows the RioBotz team at RoboGames 2006 — only seven of the 15 students on the team could afford to travel with us. Due to final exams just before the trip, we had to finish the robot at the San Francisco hotel. (I do not recommend that! But at least it was fun.) There was a "mechanical systems" hotel room and an "electrical assembly" room. All grinding was done at the hotel parking lot. **Figure 2** shows Touro on our hotel bed, having finally been completed. Other teams from Brazil attended RoboGames 2006 as well, and are shown in **Figure 3** during a welcome party.

RoboGames 2006 was a blast. It was the first time ever we watched live heavy and super heavyweights fight. At that time there were just middleweights in Brazil. We were very well received by all the teams in the pits. We were pleased to see everybody showing their robot's details, even when we would be facing them next. We gathered a lot of information on motors, mechanical parts, speed control tweaks, and so on. It was a crash course in robotics for sure!

We also learned from our mistakes. For instance, in the 2006 Touro vs. Ice Cube match, one of our two battery packs failed due to a broken solder that occured right after the first impact. Touro finished the round very sluggish, costing us the match. Since then, we've only used battery packs with flexible copper braid instead of rigid tabs. We highly recommend this.

We also learned a lot from our next match against Mortician. Even though we won the match by KO, it took us eight hours to fix the bot afterwards. We still used hex head bolts back then, and many were sheared during the fight. Mortician hit our thin titanium front armor plate on a surgical strike exactly where it was not supported by the aluminum structure (**Figure 4**); this almost destroyed our weapon system. Since then, we've used thicker armor plates there, and only flat or round head Allen screws.

The whole team was excited to watch the other competitions. There was so much to see and learn that the three days were just not enough. This is when the A.R. era began.

The whole experience was so enlightening that I started writing the RioBotz tutorial as soon as I was back in Brazil. There are several great build reports, forums, books, and tutorials showing how to build combots, however, there was nothing written in Portuguese (translated excerpts from my tutorial have been printed here in *SERVO's* Combat Zone). My idea was to not only write about building combots (including all I had learned at RoboGames 2006), but also to describe the great experience I had there. I wanted to tell Brazilians that robot competitions are not only about robots and winning, but also about knowing people and sharing knowledge. There is a whole chapter about RoboGames and pit etiquette which has had a huge impact on the Brazilian community.

In the first six months of putting my tutorial on-line, there were 10,000 downloads! I believe every Brazilian combot builder became aware of RoboGames and its friendly environment. The following year's Brazilian competitions were noticeably different — hardly anyone was hiding their

Figure 5. Touro Light 2007.
(Photo by Brian Benson)

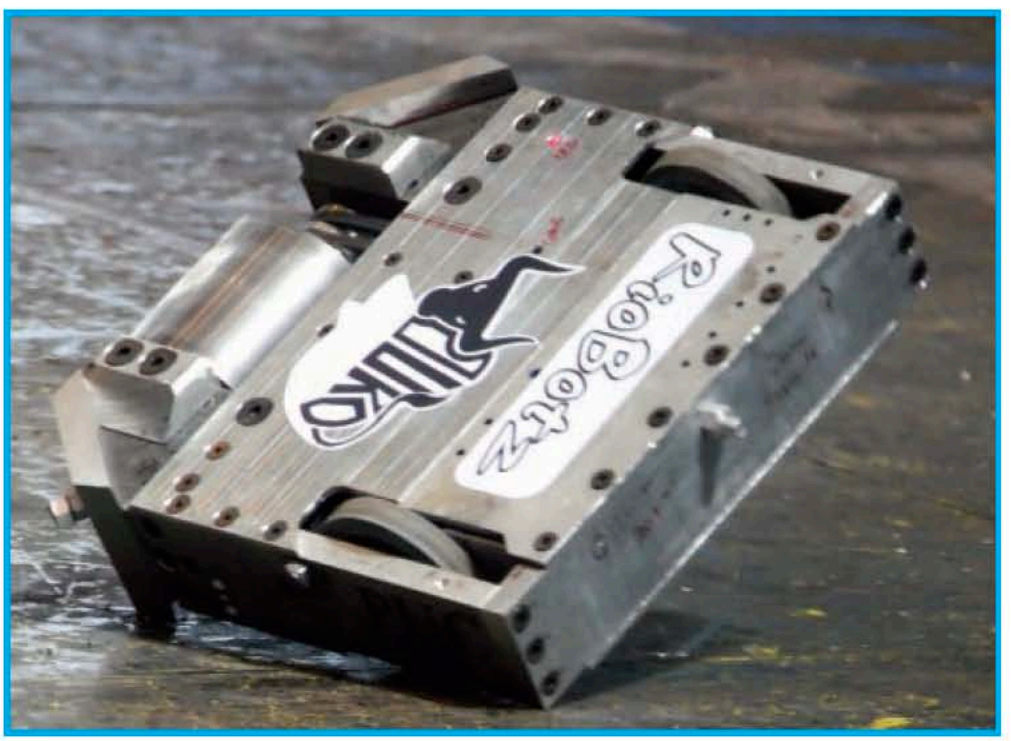

Figure 7. Touro vs. Mortician 2009.
(Photo by Brian Benson)

robots under covers. People were proudly showing their bots in detail, and many teams were helping each other fix their robots. This was uncommon before 2006. I also believe the tutorial helped to increase the number of Brazilian teams who compete, not only due to the technical tips, but also due to the description of our wonderful experiences at RoboGames. Finally, the fact that we won both a gold and bronze medal in 2006 also had a great impact. It showed other teams that it was possible for a Brazilian robot to win, even in such a tough event.

RoboGames also had an influence on the number of categories in Brazilian hosted events. Since our attendance at RoboGames, we added hobbyweight combat in 2007, featherweight combat in 2008, and then followed by 3 kg Sumo and hockey in 2009.

Since 2006, we've attended RoboGames every year. For RoboGames 2007, we increased the speed of Touro's drum. We needed that extra energy against the increasingly well armored bots. The width of the S7 drum teeth was increased from 3/4" to 1" to take all the impact energy. All hex screws were changed to flat or round head, so they wouldn't be torn off. We also built our first lightweight — Touro Light (**Figure 5**) — using the same idea as Touro. **Figure 6** shows one of our most exciting matches — Touro against Sub Zero. In only our second year at RoboGames, we went undefeated in both middle and light classes to win two gold medals. It was a wonderful experience!

Even though our robots didn't break, we've learned a lot from the fights. We had to change Touro Light's drive motors after every match — using only two 775 motors was not enough for a lightweight. After facing Pipe Wench, we realized that it would be good for Touro if its drum was reversible, to effectively work even when flipped over.

We also realized that our robot's ground clearance was too low, since it got stuck quite often. In Brazil, our arena does not have to take the punishment of heavy or super-heavy bots, so its floor is very smooth (with seams no greater than 1 mm). If you have a match right after The Judge or Megabyte, several seams may have opened up. We've realized that the bot has to adapt to the arena, and not the other way around.

For RoboGames 2008, we decreased the thickness of Touro's top and bottom plates to gain a little ground clearance. This didn't solve the problem, but it did help a little bit. Touro's drum became reversible after changing the weapon solenoid to a pair of Victor speed controllers. Touro Light's drive motor was changed to an 18V DeWalt. This led to the birth of our first featherweight: Touro Feather.

Touro was doing well until it got defeated twice by the vertical spinner Professor Chaos. One of our main problems was our 1" wide tooth which did not withstand a weapon-to-weapon hit while Touro was flipped over. Touro Light didn't do well either – its planetary gearboxes didn't take the higher power from the 18V DeWalt, shearing the pins from the last stage in two different matches. Touro Feather had a very powerful brushless motor spinning the drum, however, the drum's v-belts were too rigid which prevented the brushless motors from spinning up sometimes. The low starting torque of brushless motors can be a problem if the BESC (brushless electronic speed controller) is not well programmed.

In 2009, I released the English version of the RioBotz Tutorial. I had learned so much at the RoboGames 2007 and 2008 events – both from other builders and from broken parts – that the tutorial doubled in size, reaching 380 pages. You learn a lot from these types of events. It's like drinking water from a fire hose sometimes, so be ready to take several pictures and notes.

For RoboGames 2009, we increased Touro's S7 drum tooth width to 1.5", using a new drum with a higher moment of inertia. Both Touro and Touro Light's drums featured a single S7 tooth, balanced by a tungsten counterweight flush with the drum. Touro Light's drivetrain was upgraded to a pair of DeWalt power drives. Touro

FIGURE 8. Touro Light vs. Come to Mamma.
(Photo by Brian Benson)

Figure 10. Touro Maximus vs. Sewer Snake.
(Photo by Brian Benson)

Feather had its weapon motor switched to a brushless with a lower speed constant to increase its starting torque. Touro's higher energy drum and single tooth did quite a bit of damage on its opponents. However, Touro was sent to the loser's bracket by Mortician (**Figure 7**), and in another fight got stuck in the arena due to its low clearance.

Touro Light delivered some nice hits with its single toothed drum (**Figure 8**), but its drive motors overheated so much they caught fire. We talked later with the guys from Texas Heat and found that we should have used a current limiter between the Victors and the DeWalts since we were over-volting them quite a bit.

Touro Feather was doing okay until the double KO against Death by Translation (**Figure 9**) ripped all the drive motors from their gearboxes and made the weapon's brushless motor pop open. The robot was entirely rebuilt that night for the following day's match, but it was still crippled and did not do well.

Touro Maximus — our first heavyweight robot — was built specifically to compete at RoboGames 2009. It is a wider version of Touro, with almost the same length and height. Unfortunately, it didn't do well against Original Sin and Sewer Snake (**Figure 10**) and their skillful drivers.

We also debuted our 3 kg Sumo bots which won two gold and two silver medals! Their development was an excellent lesson in fuzzy logic for the team. We competed in fairy, ant, beetle, and auto-beetle categories.

For the upcoming RoboGames 2010, we've decided to entirely redesign the Touro family — from middle to hobbyweights. The main issue with the previous versions was their very low clearance. They also used too many screws which was a pit repair nightmare.

We're currently experimenting with a new design. Touro and Touro Light's entire chassis has just been waterjet cut from a 3" thick aluminum plate. In this way, each bot's chassis only consists of two parts, making it a "bi-body" (a two-part unibody). This decreases the number of screws, while making the robot stronger. Both top and bottom plates are still separate parts. We've increased the size of all the screws, in order to use fewer of them and make the pit stops faster. The new chassis will leave a higher ground clearance to avoid getting stuck in the arena. The waterjet design allowed us to make the bots with a curved shape, eliminating several stress raisers. The same idea is applied to Touro Feather and to our hobby Touro Jr.

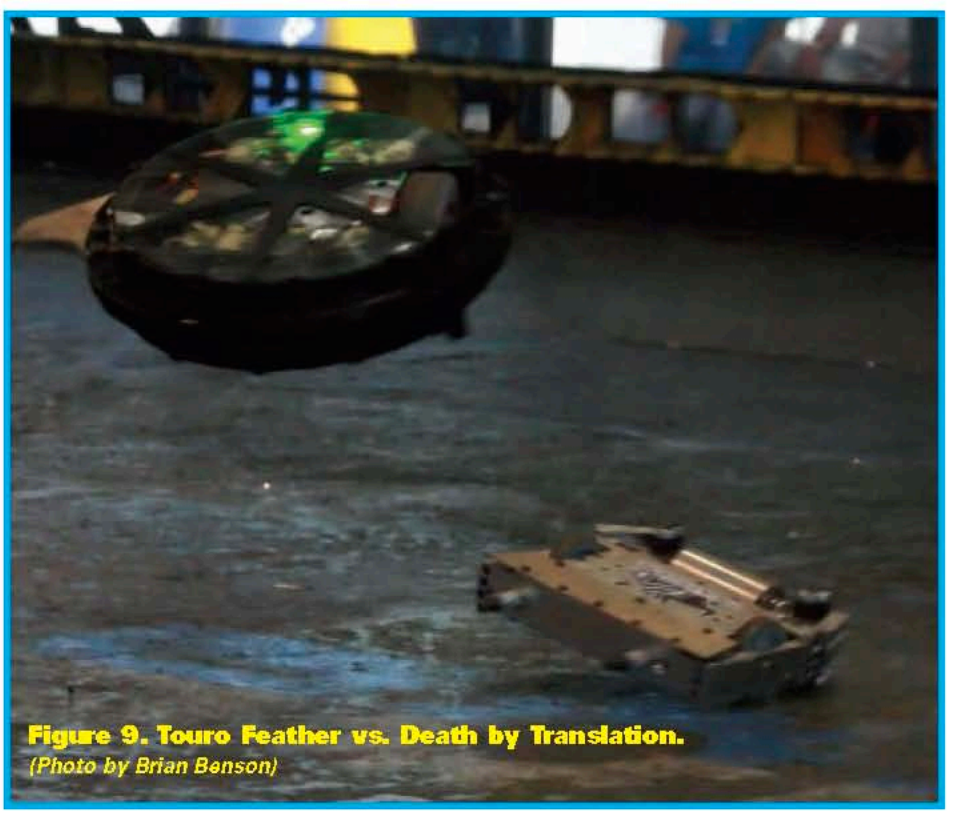

Figure 9. Touro Feather vs. Death by Translation.
(Photo by Brian Benson)

The new profile should make it possible — depending on the drum energy — to self-right the bot by just using the gyro effects. It's already working with Touro Feather. I'm not sure how effective they will be, but at least they'll look cool!

This April will mark our fifth year at RoboGames. We'll be competing in all combat classes except super-heavy, entering both autonomous and remote controlled 3 kg Sumo. We'll also have the international debut of our Hockey Pro Team. We've come a long way in four short years, and it's been a tremendous growth experience — not to mention all the friends we've made.

We hope to see you *all* at RoboGames 2010! **SV**