The team
The team began activities in August of 2010 and it is made up by 19 students from of Manuela Toro Morice and Jose Collazos high schools (HS) located in Caguas Juncos respectively (See picture 1). The mentor teacher Jose Serrano is related to the Jose Collazos school and decided to involve 4 students in order to give an opportunity to these students and expand the program in the future. The schools are at 16 minutes by car one from other so the students can attend to all the enterprise activities without problem. (See picture 2).

Picture 1. Members of Robotic Club Alliance team.

Picture 2. Location of Manuela Toro Morice and Jose Collazos Schools.

The name chosen by the enterprise was Robotic Club Alliance (RCA); it has a CEO, a Finance Director and an Activity Coordinator (students). Also a parent’s committee was created in order to organize the fundraising activities. In addition, the enterprise has gotten the support of Caguas municipality with money and adapting the Manuela Toro’s facilities for the smooth running of the program (i.e. Internet network).

Currently 50% of the team are female, the ages range between 16 and 17 years old and 53% are in 11th grade (See picture 3). The students live in the central eastern region of Puerto Rico that it is considered an economically disadvantage area (facing economic constraints) due to the closing of manufacturing and technological plants within the last
decade, but at the same time with great opportunities to develop a science and technology-based economic development program for the region. The group uses the MTU High school Enterprise logo with a slight modification: they added the name of the school and the Universidad del Turabo (UT) (see picture 4).

![Pie Chart](image)

**Picture 3.** Students Distribution in high schools levels.

**Picture 4.** Robotic Club Alliance’s logo.

**Robotic Club Alliance Mission**
Design and build technological solutions to make easier scientific research reducing possible risks in humans.

**Robotic Alliance Vision**
Be the most efficient group in the creation and promotion of technological solutions for marine research.

**Operations**
The enterprise meets once or twice on a week (4 hours) at Manuela Toro Morice’ facilities depending on the requirements of the project. The mentoring to the enterprise is given by an advisory board formed by the UT student enterprise “Innovatronics”, the teacher and the UT advisor (See picture 6). They plan the activities that the students should follow along semester (See the appendix 1). In addition to the project activities, the HSE members participate in field trips planned by the advisory board. The last year
the students visited the Business Incubator of Caguas Municipality where they had the opportunity to meet with entrepreneurs in technological areas.

**Picture 6.** Advisory board: Sandra R Pedraza (UT advisor), Juan Serrano (Teacher) and Raymond Borges (Innovatronics member-UT enterprise) with two of the RCA members.

**The Project**
The enterprise focused on the construction of two Remotely Operated Vehicles (ROVs). A ROV is essentially an underwater robot to be used for example in marine inspections. The robot has basically a mechanical device adapted with motors and an images system to inspect underwater environments. The priority in this first stage was the robots worked in underwater environments. In later stages the ROVs will be optimized and adapted to run more functions (i.e. pick objects up).

The concepts creation, designs (esthetic and mechanical), prototypes construction and the final robots were developed by the team. It (the team) decided the materials the shapes, sizes, materials and technical requirements. At the end, two robots made of PVC tubes were constructed: the THROV- (Trash Hunter ROV) and the EVO (Evolution) (Pictures 7 and 8); they are in an optimization stage in order to improve the functions and to be presented y MTU Expo Enterprise 2010. The figure 1 shows the methodology implemented in the project.

**Picture 7.** THROV (Trash hunter ROV)  
**Picture 8.** EVO (Evolution) ROV
ROV’s Construction

Need Identification: use, why, how

Brainstorming
How could it be? (drawings)

Is it Feasible?

No

Prototypes construction at scale

Yes

Design optimization

Materials and size decision

Construction and Testing

Final Products

Figure 1. Methodology Flow Chart.
The group received training in design methodology and in basic electronic and physics (See picture 9). They conduct several experiments to learn the principles to assemble a circuit and to alter the flotation of an object. This semester the Manuela Toro Morice’s advisory board plans to implement classes of modeling software and programming.

Picture 9. Raymond Borges (Innovatronics Member) teaching an electronic class.

Plans
This semester the group will focus on optimizing the robots to participate in the MTU expo. The parents’ committee arose funding to pay the expenses of several members of the team and the group will travel to Houghton on April 12th. Additionally RCA members will receive training in modeling software and programming therefore, several classes will be scheduled. Currently the teacher mentor is contacting several communication media to disseminate the program and getting funding for the projects. The UT will continue supporting administratively and technically the team.
APPENDIX 1

Manuela Toro Morice RCA activities Aug-Dec 2009

Itinerary

1. **Saturday August 15, 2009**
   - High School Enterprise Program formal explanation

Who’s involved? How will the projects develop? Who will decide what will be the projects? And what activities will we be taking part of during the semester?
   - HSE Goals
     
     (As a STEM fields project and at the same as a Business project)
     - HSE project development structure
     - HSE Workshops

Science Wiz laboratory kits and Lego Mindstorms
   - HSE Road trips (Arecibo Observatory, etc)

Generating funds for sustainable profitability and HSE students use, such as for food, for more road trips, for entrance quota to parks.
   - PR supporting organizations for businesses such as SBDTC and www.Enterprise.com
   - Enterprise competition
   - Have students bring to their next class some basic materials to make initial small scale designs of the projects

2. **Saturday August 22, 2009**
   - Innovation
   - Brainstorming
   - Analytical Problem Solving
   - Creative Problem Solving
   - Creative Thinking
   - Innovative Design
   - Relaxed Awareness
   - Ideo
   - Possible project ideas suggestions motivation

After break
Repeat all the concepts for the initial design of the projects
Assemble initial design with materials that we will have the students bring from their houses. Such as sticks, glue and paper.
3. **Saturday August 29, 2009**
   - Brainstorming possible cash generating activities for HSE use
   - Introduction to electricity theoretical concepts
   - Introduction to electricity labs 1 from Science Wiz Inventions and Electric lab kits
   - Making basic circuits and applying different loads
   - Page 1 to 21 of electricity lab kit

   After break we will construct 1:4 scale models of projects using pvc pipes, glue and other basic materials.

4. **Saturday September 5, 2009**
   - Introduction to electricity theoretical concepts
   - Introduction to electricity labs 2 from Science Wiz Inventions and Electric lab kits
   - Making a simple electric Motor
   - Making a simple electric generator
   - Page 1 to 15 of inventions kit

   After break we will formally name the 2 projects and establish the individual goals. We will also establish objectives and sketch initial design with specifications

5. **Saturday September 19, 2009**
   - Business Aspects of HSE
   - Developing a business plan

   After break continue work on main projects

6. **Saturday September 26, 2009**
   - Introduction to electricity theoretical concepts
   - Introduction to electricity labs 3 from Science Wiz Inventions and Electric lab kits
   - Page 24 to end of electricity lab kit (parallel and circuits in series) and pages 16 to 18 from inventions lab kit (to build a electromagnet)

   After break we will have the students start designing individual mechanisms. For the projects and further establish small goals and milestones

7. **Saturday October 3, 2009**
   - Developing a marketing plan
   - Possible money generating activities
   - Design, group ideas for generating sustainability
• Arrange activities for fund raising
• Develop Logos, posters, and brochures

8. **Saturday October 17, 2009**

• Introduction to electricity theoretical concepts
• Introduction to electricity labs 4 from Science Wiz Inventions and Electric lab kits
• Making a telegraph and a relay
• Pages 18 to 24 of inventions kit

After break continue work on main projects

9. **Saturday October 24, 2009**

• Initial testing on main projects outside in the University pool

10. **Saturday October 31, 2009**

• Introduction to electricity theoretical concepts
• Introduction to electricity labs 5 from Science Wiz Inventions and Electric lab kits
• Pages 25 to end of inventions lab kit
• Making a basic radio

After break continue work on main projects
Revise current goals and timelines and update with new information

11. **Saturday November 7, 2009**

• Second Road trip

12. **Saturday November 14, 2009**

Continue work on main projects
Arrange documentation and plans, sketches for both designs.

13. **Saturday November 21, 2009**

• Introduction to Basic Algorithms

14. **Saturday November 28, 2009**

• Introduction to Basic Programming C++

15. **Saturday November 3, 2009**

• Begin Theoretical Integration of autonomous systems into projects
• Theoretical applications

16. **Saturday December 5, 2009**
   • Introduction to programming part 2

17. **Saturday December 12, 2009**
   • Begin research on Integrating embedded systems to autonomously control robot projects

18. **Saturday December 19, 2009**
   • Begin Integrating systems to autonomously control projects