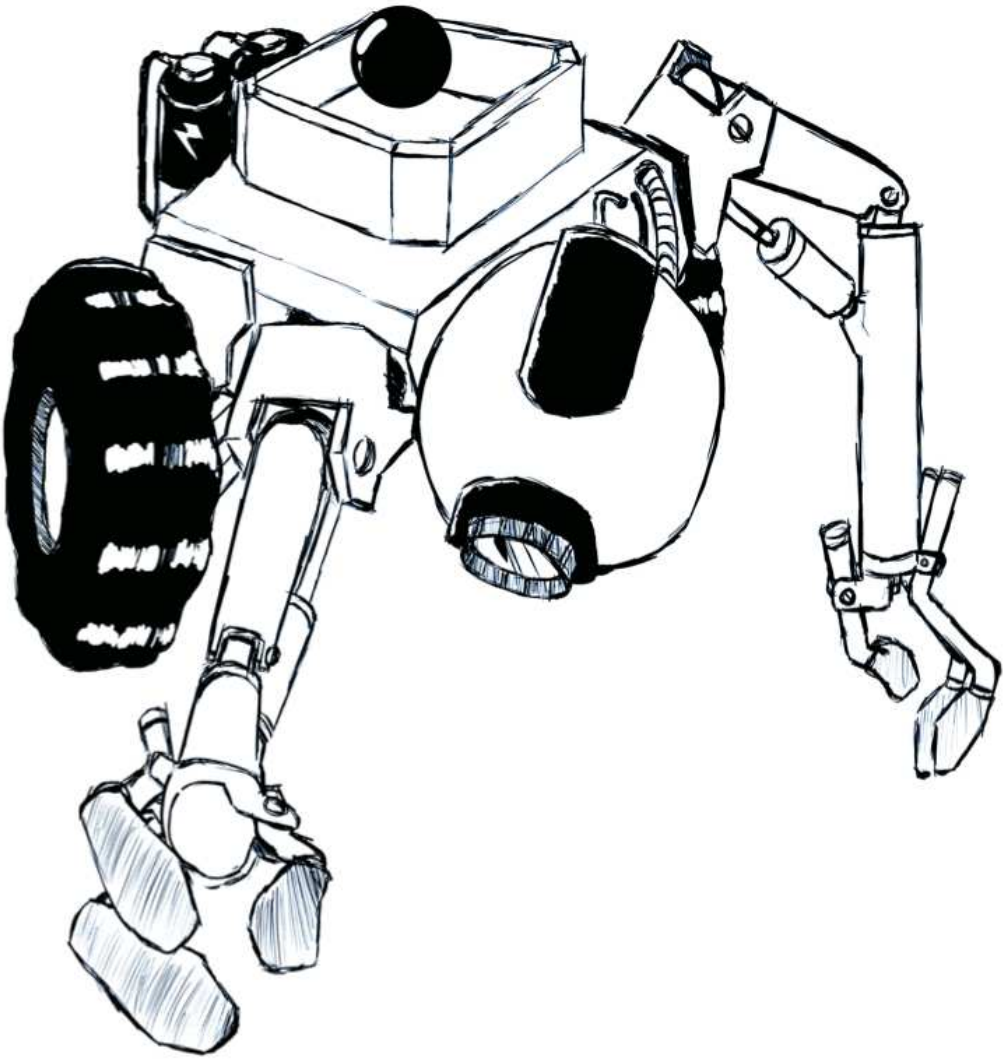
MASLAB 2011



Mobile Autonomous Systems Laboratory
Friday, January 28, 2011
5:00 pm in 26-100
Proudly Sponsored by Boeing

Introduction

Welcome to Maslab (6.186/2.972) autonomous robotics competition! This is our tenth anniversary. Teams of MIT students have had less than a month to build and program robots that explore an unknown playing field without human intervention. Today, as the robots race to collect red or green balls and launch them over yellow walls, you will see what each team has accomplished.

Significantly more difficult than most other robotics contests, Maslab encourages teams to work together and to share ideas. Furthermore, each Maslab team begins with a kit of high quality components, which are made possible by Maslab's gold sponsor, Boeing, as well as other sponsors including Two-Sigma, Oracle, and the EECS department. While there will be a team that scores the most points, Maslab's emphasis is on creative robots, clever ideas, and solid engineering.

Maslab staff members strive to ensure that teams have the knowledge and equipment to tackle this challenge. We present lectures on relevant topics such as mechanical design, sensors, computer vision, control theory, and mapping. We also stock our lab with a variety of building materials, sensors, and tools. After a month of hard work, each team has built an exciting and innovative robot capable of attacking a research-quality robotics problem.

Maslab has almost no pre-requisites and aims to be accessible to all MIT students regardless of experience. This year's teams include students at all stages in their MIT careers and from several different departments (including Mechanical Engineering, Electrical Engineering and Computer Science, Aeronautics and Astronautics, Management, and Math). Participants earn 6 units of general elective credit and 6 engineering design points (EDPs).

Contest Rules

Each robot has three minutes to score as many points as possible. There are two sides to the field. One side with red balls and the other with green balls. Two robots will play at the same time and will score by placing balls of their designated color through the yellow-lined "mouseholes" in the wall or over yellow walls. The scoring is as follows:

- **Possession** = 1 point for a ball of their color in "possession" which is determined by whether or not the ball is located within the infrastructure of the robot.
- **Porch** = 2 points are awarded for a ball of their color that is within a 12 inch radius of the mousehole at the end of the run.
- **In Yellow Goals** = 4 points for each ball of their color that is placed inside a yellow mousehole at the end of the run.
- **Over Yellow Wall** = 6 points for each ball of their color scored over the yellow wall.
- **Scoring of Other Colored Ball** = 0 points will be given for possession, porching, or scoring of a ball of the other team's color.
- **Out of Bounds** = -1 point for every ball put out of bounds by a robot.
- **Over Time Penalty** = -3 points if the robot runs over the time limit by more than 10 seconds.

In each round, each robot runs against another robot and will play on both sides of the field. Scores are counted as the SUM of these two runs. The points in the game cannot be negative. Also note that the above scores do not stack (i.e. a robot cannot get possession points and porch points for possessing balls on the porch at the end of the competition). Ties are broken based on number of balls displaced, then by seating rank and finally by lowest robot weight.

The game is double elimination where the team with the largest number of points advances to play teams in the next round. A team that loses the first time will go into the losers' bracket. If they lose a second time, they are eliminated from the game. The victor of the winners' bracket will play the victor of the losers' bracket in the final round. Before the start of the competition, several rounds were already run to determine placement in the brackets.

Maslab Kit

Each team received an identical kit of parts at the beginning of January. This kit served as a starting point for their robot; however, teams were not limited to their kits' contents and could purchase items on their own to pursue creative strategies.

Mechanical The basic kit included enough parts to build a simple robot: a computer, a robotics controller, a digital camera, motors with integrated gearheads, wheels, and basic hardware to attach everything together. While students are encouraged to use wood and metal shops around campus, the Maslab shop provided basic building tools such as a scroll saw, drill press, sheet metal brake and shear, as well as many useful hand tools and a large selection of building material. Thanks to Mark Belanger and Stephen Banzaert, students this year also have access to the Edgerton machine shop and the Edgerton lasercutter.

Electrical The electrical components used in Maslab are quite different from other contests. At the heart of each team's robot is the is a small-form EEEPC netbook computer with a 1.6GHz Intel Atom processor,

1GB memory, a 150GB hard disk, wireless networking, and a full complement of standard PC ports. This PC runs Ubuntu Linux 10.10.

The computer itself cannot control motors nor interface with sensors, so the Maslab staff designed and manufactured a custom robotics controller board. We call the controller the "uOrc", for "Micro-Our Robotics Controller." This board serves as a slave to the computer, executing simple commands under the direction of a program running on the computer. The computer and uOrc communicate over a USB link. The Orc has support for three bi-directional 12V motors, servos, analog and digital sensor inputs, optical encoders, and infrared range finders.

While the usual assortment of robotics sensors is available (ultrasound range finders, infrared range finders, momentary buttons), a digital camera is the heart of the Maslab experience. The color camera has a resolution of 320x240 and serves as the robots' primary sensor, scanning the playing field looking for targets and scoring areas. Image processing is a computationally intensive task, which is why an Intel processor is part of the basic Maslab kit. A fast PC with plenty of memory also allows students to use more complex algorithms, such as optimal path finding algorithms and fine-grained occupancy grids. Maslab robots draw a significant amount of power. The kit includes a 12 volt, 5 amp-hour lead-acid battery which provides a runtime of a couple hours.

Software Students have written complex Java programs to control their robots using several low-level libraries provided by the staff. The uOrc firmware and application programming interface (API) hides hardware details from users so they can execute simple commands such as setMotor() rather than manually produce pulse-width-modulated control signals. Maslab staff members provided several functions to ease the task of image processing, but every team developed its own image processing algorithms and strategies from scratch.

To help in the debugging process, the Maslab staff developed the "BotClient." This graphical application allows teams to easily visualize the data collected by their robot. For example, the BotClient could display raw and processed images from the camera or plot sensor values as a function of time. A team's robot transmits this data using wireless networking to another PC where it is displayed. Another debugging tool was "OrcSpy," which allows teams to monitor inputs and outputs from their uOrc boards.

Strategy

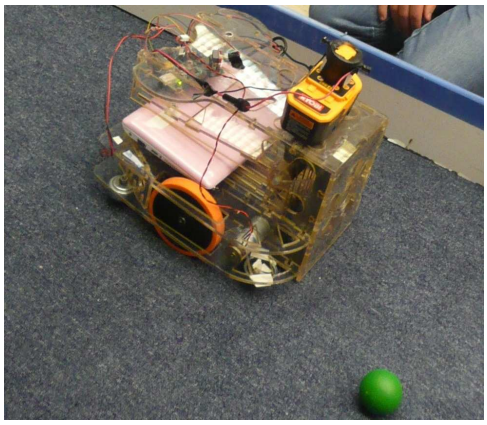
Each team's robot is a unique creation with its own mix of creative mechanical, electrical, and high-level strategies. Maslab robots involve considerable mechanical design: teams must build from scratch mechanisms to capture, transport, and score targets. Some teams decided to build circular robots that can spin in place without getting stuck; others chose to maximize the size of their robots to carry the most balls.

Each team had to make various design tradeoffs when working on the electrical aspects of their robot. For example, if a team wanted to use a fancy ultrasound sensor or extra drive motor, they had to sacrifice a certain number of simpler sensors. Some teams used infrared range finders to precisely determine the target position, while other teams relied solely on their robot's digital camera. Many teams used contact switches to detect a ball in their bin, or to detect a collision with a wall.

Finally, each team developed their own high-level strategy. Some teams use a simple, stateless strategy to repeatedly search for and grab a red or green target, then find a scoring area and drop it off. Others waited to capture a certain number of balls before trying to find a new goal in which to score. More advanced teams created an internal map of the playing field to find unexplored regions or to remember where the yellow wall was in order to get back to it quickly. Acquiring more data enables the robot to choose more efficient routes but uses more CPU time, so the time limit imposes a fundamental design tradeoff.

Team 1: Magnetometer? But I hardly...

Robot Name: Unlimited Gigaspace Gatling Gun Cyclotronic Flux Converter with Lemony Freshness, and Fifty Percent More Electrolytes.



Team Members:

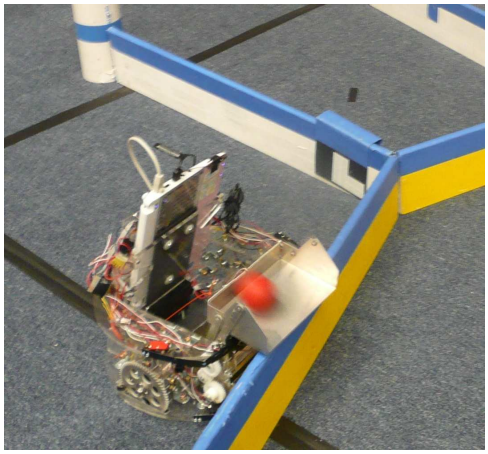
- Erons (Snake Eyes) Ohienmhen
- Cory (Olis Force) Robinson
- Andrea (Iron Maiden) Lincoln
- Allan (Iron Man) Miramonti
- Matthew (Mr. Diamonds) Redmond

"So much depends upon a small camera
Glistening with sweat and tears beside the laser cut acrylic."
-William Carlos Williams?

There once was a robot from Random
With a quasi-non-existent fandom
Did not attempt SLAM,
or a Kalman Filtered cam
It had ugly wheels of orange.

Team 2: Pi Tau Zeta Electronics Research Society (PTZERS)

Robot Name: putzputz

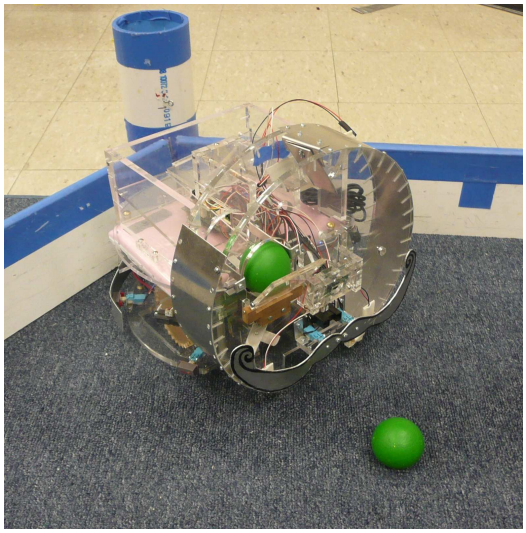


Team Members:

- Leighton Barnes
- Stanislav Nikolov
- Cathy Wu
- Dan Fourie

Putzputz is the result of 3 weeks of Asian parenting. We pushed hard for her to learn to explore her world and redesign it as she sees fit. Early on, she showed a clear aptitude for fetching balls, and we worked hard to teach her to face all her challenges head on. Aside from her occasional temper tantrums, little Putzputz has grown up so quickly and has made us very proud.

Team 3: We-Ski!
Robot Name: Monsieur Robot

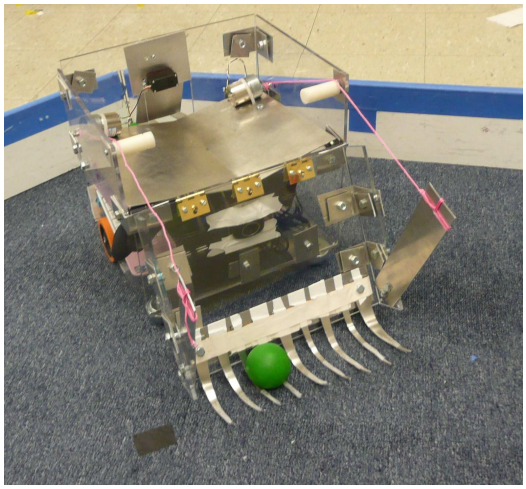


Monsieur Robot is a cheerful robot sporting a stylish moustache and monocle. This gentleman knight collects all the cannon balls he can on the battle field. Show him yellow walls and he will charge to the enemy's fortress, kindly delivering ammunition with his drawbridge. Come snow or sleet, Monsieur is always ready to challenge the labyrinth. Que la partie commence.

Team Members:

- Faye Wu
- James White
- Audren Cloitre
- Stephanie Lin

Team 6: Slamba
Robot Name: Mrs. Steampunk Cthulhu

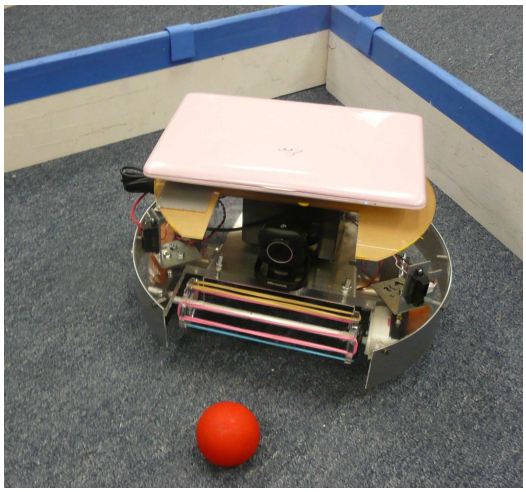


Our robot is the fearsome wife of the great and powerful Cthulhu. It will not only devour balls, but also the souls of our opponents. Using its mighty teeth and treacherous scoop, it will converge on balls, entrap them in its clutches, raising the scoop and depositing them inside herself. Then she will find the walls and rain her captured prey upon our trembling enemies. Beware, opponents, for you face Mrs. Cthulhu.

Team Members:

- Melissa (Piper) Hunt
- Xavier Jackson
- Shawn Westerdale
- Michael Olague

Team 7: Los Mighty Patos
Robot Name: Patito Feo

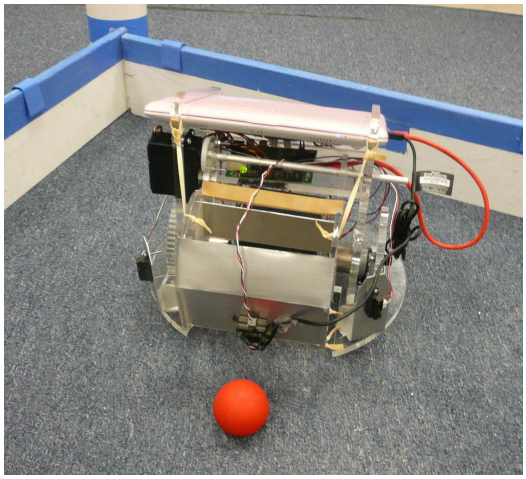


Team Members:

- Christian Segura
- Javier Ramos
- Rafael Crespo
- Roberto Melendez

This robot is a very simple design that moves around and collects balls under the robot. It has two IR sensors in the front which tell the robot when its about to crash into a wall. The body of the robot is circular and the wheels are placed in such a way that the robot can rotate about its own center without displacing any objects. The robot collects the balls by using a dribbler made of rubber bands that push balls into the robot. When the robot sees a goal it goes to the goal counter-rotates the dribbler which makes the balls go out then backs up and goes forward to push the balls into the goal.

Team 7: Los Mighty Patos
Robot Name: Duck Taped



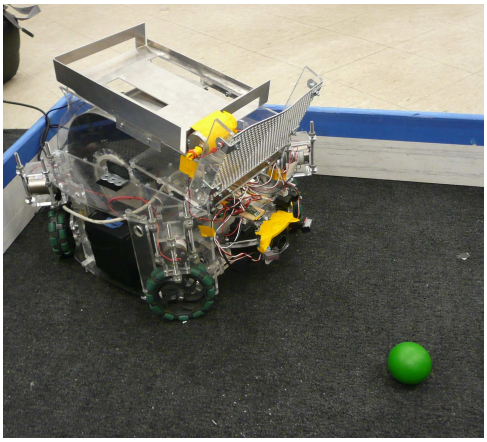
Team Members:

- Christian Segura
- Javier Ramos
- Rafael Crespo
- Roberto Melendez

This is Team 7's second robot. This attempts to score by collecting the balls using a rotating arm. Then it approaches a wall, takes a 180 degree turn and swings its arm up and the balls roll off the laptop to the other side of the field. The robot maintains the same size and shape of the previous robot. The robot is decorated with our team emblem (the duck). The robot has 3 IR sensors and a gyro that it uses to avoid walls and turn precisely.

Team 9: Vega and the Voltrons

Robot Name: Voltron



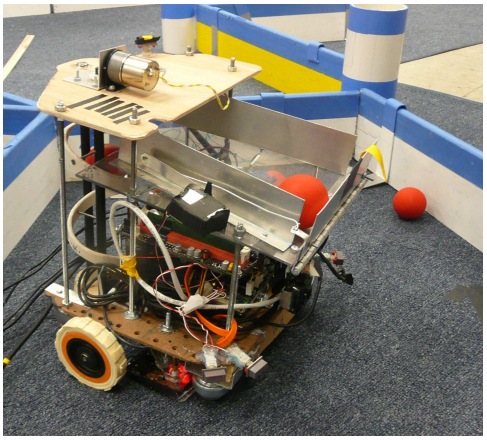
Team Members:

- William Thalheimer
- Joel Santisteban
- Aaron "Swag master flex" Prindle
- Christopher Dessonville
- Will Vega-Brown

From days of long ago, from uncharted regions of the universe, comes a legend, the legend of Voltron: Defender of the Universe; a mighty robot, loved by good, feared by evil. With a razor sharp rubber band roller in the front and a planet sized roller in the back, Voltron can gather and elevate the horrifying wooden balls as fast as the evil King Zarkon can throw them. When Voltrons innards are done processing its foes, it dumps their remains over the yellow-brick wall of the mythical Castle of Voltrons. As Planet Arus often features treacherous and winding terrain to navigate, Voltron features tetra-omni drive, allowing it to move and rotate in any direction at blinding speeds. But Voltron has more than incredible agility, it also possesses extraordinary strength. With a body composed entirely of acrylic and sheetmetal, and reinforced steel supports and axles, Voltron dwarfs the competition with both the largest footprint and weight. But Voltron's true strength relies in its intelligence. Sporting a LIDAR system to map its surroundings in stunning 2D, and a separate processer to handle four of Voltron's unbelievable six motors, Voltron's awareness can match its stunning physique. With a new struggle in MASLAB 2011, it is once again time to call on this invincible robot. The Alliance can rest easy knowing that Voltron is back to restore peace to the galaxy.

Team 10: WIRELESS

Robot Name: ALL YOUR BALL ARE BELONG TO US

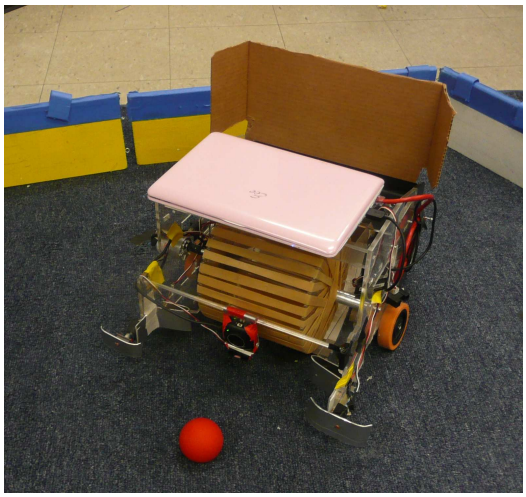


Team Members:

- Arvin Shahbazi Moghaddam
- Wojciech Musial
- Tongji Li
- Alex Teuffer

IN A. D. 2011
WAR WAS BEGINNING
CAPTAIN: WHAT HAPPEN ?
MECHANIC: SOMEBODY SET US UP THE BOMB.
OPERATOR: WE GET SIGNAL.
CAPTAIN: WHAT!
OPERATOR: MAIN SCREEN TURN ON.
CAPTAIN: IT'S YOU!
CATS: HOW ARE YOU GENTLEMEN ! !
CATS: ALL YOUR BALL ARE BELONG TO US.
CATS: YOU ARE ON THE WAY TO DESTRUCTION.
CAPTAIN: WHAT YOU SAY ! !
CATS: YOU HAVE NO CHANCE TO SURVIVE MAKE YOUR TIME.
CATS: HA HA HA HA ....
OPERATOR: CAPTAIN ! !
CAPTAIN: TAKE OFF EVERY 'ZIG' ! !
CAPTAIN: YOU KNOW WHAT YOU DOING.
CAPTAIN: MOVE 'ZIG'.
CAPTAIN: FOR GREAT JUSTICE.

Team 11
Robot Name: reFUSES



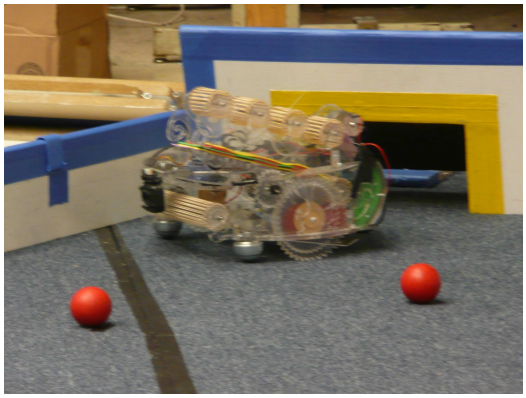
Team Members:

- Kiarash Adl
- William Souillard-Mandar
- Tim Robertson
- Kristen Anderson

reFUSES likes to do everything its own way. It collects balls with a large rubber band roller but instead of having balls fly forward with the roller, the balls jump backwards into a bin. Instead of depositing balls at the front of the robot, it deposits balls by turning 180 degrees and opening a servo gate in the back.

Team 11's robot is named reFUSES.
Instead of turning on, it blows fuses.
If asked to fail, our robot confuses.
Against another robot that loses,
our robot wins without bruises.
This robot, in Maslab, cruises.

Team 13: 41w
Robot Name: A.W.E.S.O.M.-O



Team Members:

- Dmitri Megretski
- Rebecca Han
- Kevin Ellis
- Bayley Wang

A.W.E.S.O.M.-O takes in balls through its front-mounted ball intake. The balls are stored in a hopper near the base of the robot. Gears drive other rollers both within and on top of the robot to raise balls up and over the yellow walls. A front-mounted camera tracks balls, walls, and goals. IR sensors are used for navigation.

Staff

Maslab is an entirely student-run contest staffed by volunteer students who have devoted a significant part of their fall term and IAP to creating the Maslab experience.

Core Team	
Program Director	Ellen Yi Chen
Operations Director	Eric Timmons
Technical Director	Bhaskar Mookerji
Software Director	Geza Knovacs
Mechanical Director	Sam Powers
Fundraising Director	Jessica Ruprecht
Lab Staffers	Arthur Petron
	David Benhaim
	Kimberlee Collins
	Chris Celio
Maslab Founder	Edwin Olson

Acknowledgements The staff would like to thank our family, friends, and research advisors for their patience as we worked on Maslab! We also thank the students: their enthusiasm, patience, and advice help Maslab grow and improve, and we take pride in their accomplishments. The following people also deserve special gratitude for their support:

Professor Leslie Kaelbling	Professor Russ Tedrake	Professor Seth Teller	Mina Hsiang
Chris Terman	Anne Hunter	Maria Nargi	Patricia Sampson
John Sweeney	Ron Roscoe	Mark Belanger	Stephen Banzaert
The Edgerton Center			

Maslab is made possible by through generous donations from:

Dr. John A. Wilkens
Dr. Lucile S. Wilkens
Dr. Howard Schneider
Mr. Jesse N. Pavel

Maslab could not exist without the generous contributions of our sponsors.

Gold Sponsor:

Silver Sponsors:

Bronze Sponsors: