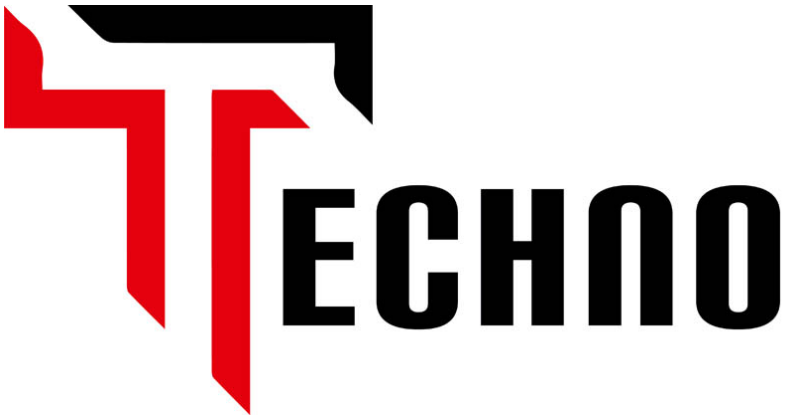

Legendary BattleBots Research Document

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Most Successful Championship winning BattleBots:

The following are some of the top innovative and innovative BattleBots that I have seen so far :

1) Bite Force(by Paul Ventimiglia):

Widely considered the GOAT. Won 3 championships (Season 1 reboot 2015, 2018, 2019). Its simple but brutally effective vertical spinner and tank-like durability made it almost unbeatable.

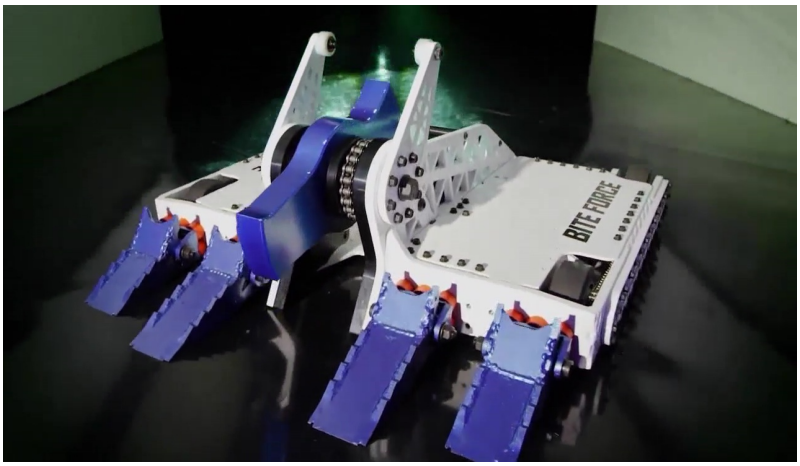
2) Tombstone (by Ray Billings):

Iconic for its terrifying horizontal spinner. Won Season 2 (2016) and has countless knockouts. It's famous for destroying opponents and itself in the process.

3) End Game (by Jack Barker & Nick):

Won Season 5 (2020). Compact, super powerful vertical spinner, excellent driving.

Bite Force BattleBot Composition:



Basic Type:

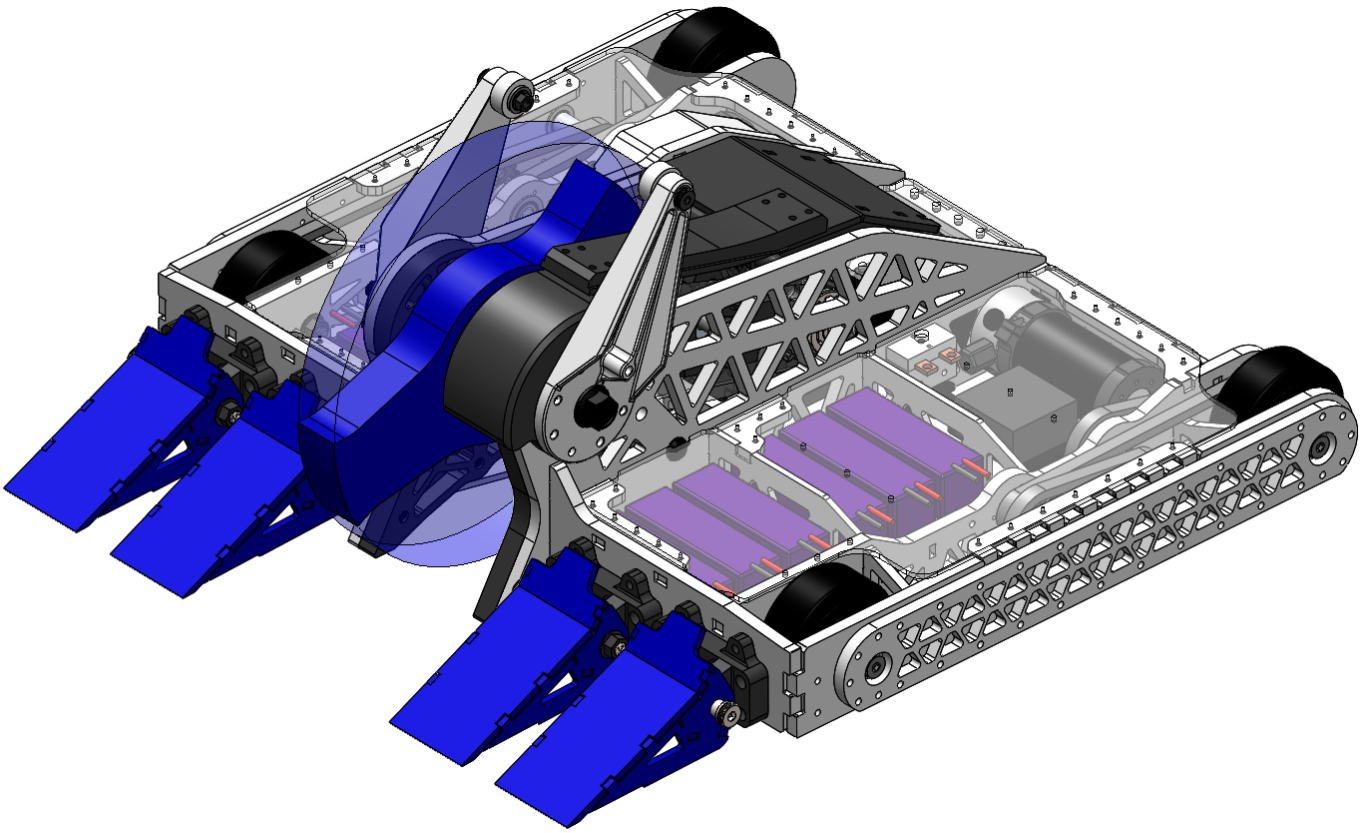
Bot class: Vertical spinner
Builder: Paul Ventimiglia (Team Aptyx Design)
Weight class: Heavyweight

Weapon:

Primary weapon: Single vertical spinning bar or disc.

Material: Typically hardened tool steel for maximum durability and cutting power.

Speed: Spins at extremely high RPM (~2500–3000+),



Armor:

Main Chassis: Robust welded steel or titanium, extremely rigid.

Front Wedge/Plow: Hardened steel wedge to deflect hits and feed opponents into the spinner.

Side/Top Armor: Modular panels, easily replaced between fights.

Drive system:

Type: 4-wheel drive
Motors: High-torque brushed or brushless DC motors (AmpFlow or custom)
Drive Wheels: Four custom wheels with high-grip rubber or polyurethane treads for traction
Transmission: Direct chain or belt drive to each wheel
Control: Differential steering (tank steering) with precise speed controllers (ESCs)

Other Notables:

Batteries: High-capacity LiPo battery packs.
Electronics: Bulletproof custom ESCs (electronic speed controllers) and redundant receivers.
Self-Righting: The shape of Bite Force helps it flip back over using its spinner momentum and wedge.

Tombstone Battlebot Composition:

Tombstone BattleBot - 2021

Basic Type:

Bot class: Horizontal bar spinner
Weight: Heavyweight
Builder: Ray Billings (Hardcore robotics)

Weapon:

Type: Horizontal spinning bar
Material: S7 hardened tool steel – extremely tough , good impact resistance.
Length: ~36–42 inches (varies by version).
Weight: The weapon alone can weigh ~65–80 lbs – up to a third of the total robot weight.
Speed: Spins up to ~2500–3000 RPM.
Energy: Delivers ~60–80 kJ of kinetic energy.

Drive system:

Drivetrain: Two-wheel drive.

Motors: High-torque brushed DC motors (like AmpFlows).

Top Speed: Around 6–8 mph (not built for speed – just control and weapon delivery).

Chassis & Armor:

Frame: Boxy aluminum frame with hardened steel armor panels.

Armor Style: Tough but not overly thick – Tombstone relies more on offense than absorbing hits.

Design Philosophy: "Best defense is a ridiculous offense" – if you hit hard enough, you don't need fancy wedges or lifting arms.

Battery and Electric Components:

Weapon Motor: Huge brushed DC motor or E-Tech brushed motor (lots of torque).

Batteries: High-discharge LiPo packs for quick bursts of energy.

ESCs: Custom or heavy-duty controllers to handle massive weapon motor currents.

Lithium Polymer Battery pack

End Game BattleBot:

Basic Type:

Team: OYES Robotics (New Zealand) – Jack Barker & Nick Mabey

Bot Class: Vertical spinner

Weight: ~250 lbs (BattleBots heavyweight limit)

Championship: Won BattleBots Season 5 (2020), also a top contender in later seasons.

Weapon:

Type: Vertical spinning bar or disc

Material: S7 tool steel – same as Tombstone's bar, super tough for impacts

Weight: ~50–60 lbs (significant portion of total weight)

Design: Short, thick, direct-drive bar or asymmetric disk (depending on fight)

RPM: ~2500–3500 RPM – very high for a vertical spinner

Energy: Delivers ~50–70 kJ of kinetic energy per hit

Mounting: Direct-driven with a powerful brushless motor + belt or gear reduction for torque

End game 2018

End game 2020

Drivetrain :

Drive Motors: 4-wheel drive – brushless motors, high torque

Traction: Large, wide custom wheels with excellent grip for pushing and precise driving

Top Speed: Around 8–10 mph – quick and agile for positioning.

Chassis & Armor :

Frame: Sturdy welded aluminum or titanium main chassis with thick side armor

Front Plow: Hardened steel wedgelets or forks – key for getting under opponents and feeding them into the spinner

Modular: End Game uses interchangeable front armor – forks for low bots, wedge for heavy spinners.

Electronics & Power:

Weapon Motor: Huge brushless outrunner motor (like Motenergy ME0708 or similar)

Battery: High-discharge LiPo packs

ESC: Heavy-duty brushless controllers for both drive and weapon

BattleBot Weapons:

BattleBots use a wide variety of creative and destructive weapons. These weapons are designed to damage, disable , or outmaneuver opponents. Here's a breakdown of the main categories of BattleBots weapons.

1. Spinners:

A. Vertical Spinners:

Mechanism: Spinning disc or drum mounted vertically . Hits opponents upward to flip or damage.

Drive: Belt and pulley (common), sometimes direct motor drive.

Examples: Tombstone (horizontal), Bite Force, Witch Doctor

Components: Brushless motor, pulley/belt, weapon shaft, hardened steel teeth.

B. Horizontal Spinners:

Mechanism: Horizontal bar or disc that hits opponents sideways.

Drive: Chain or belt drive.

Pros/Cons: Huge impact force, but can self-damage due to gyroscopic forces

C. Full-Body Spinners:

Mechanism: Entire bot spins, sometimes with exposed cutting surfaces.

Drive: Direct or belt drive, needs strong bearing systems.

2. Drums & Eggbeaters:

Mechanism: High-speed rotating drum with teeth or impactors; smaller than full discs.

Drive: Belt drive usually.

Good Against: Wedges and exposed parts.

Examples: Minotaur, Yeti.

3. Flippers:

Mechanism: Uses compressed gas (CO_2 or pneumatics) to launch bots into the air.

Drive: Pneumatic cylinder + valve system.

Examples: Bronco, Hydra

Pros: Can throw bots out of the arena (OOTA).

Weakness: Limited number of shots per match.

4. Hammers / Axes:

Mechanism: Arm swings down with a heavy hammer or axe to strike top of opponents.

Drive: Pneumatic or electric actuator.

Examples: Beta, Shatter!

Pros: Good vs. poorly armored tops.

5. Clamps / Crushers:

Mechanism: Grabs opponent and crushes or holds them.

Drive: Hydraulic ram or strong servo motors.

Examples: Quantum, Petunia

Pros: Control-based, slow but effective.

Cons: Usually less destructive.

6. Lifters:

Mechanism: Forks or arms lift opponents to tip or control them.

Drive: Electric motors with gearboxes or linear actuators.

Examples: Forklift-style bots like Duck! or Lifters like Lock-Jaw

Control-Based Strategy: Not necessarily destructive but dominant in pushing matches.

7. Wedges / Rammers:

Mechanism: Passive weapon – designed to get under opponents and push them.

Drive: High-torque drive motors for pushing.

Examples: Duck!, Blacksmith (combined with hammer)

Defensive Weapon: Focuses on armor and control rather than attacks.

Drive system for BattleBots :

The drive system of a BattleBot is what allows it to move, turn, and push opponents – it's just as important as the weapon. In fact, even the strongest weapon is useless if your bot can't drive reliably or quickly. Let’s break down the BattleBots drive system in depth, including all major components, types, and how they're integrated.

1. Basic Function of a Drive System:

At its core, a BattleBot drive system converts electrical energy from batteries into rotational motion of wheels or tracks.

2. Main Components of a Drive System:

A. Motors:

Brushed DC Motors (common):

Easy to control with ESCs (electronic speed controllers).

Reliable and simpler wiring.

Examples: Banebots, CIM motors.

Brushless DC Motors:

More efficient, lighter, higher RPM

Require special brushless ESCs (more expensive).

Increasingly popular in high-tier bots.

Key Specs:

Torque (Nm): For pushing power.

RPM: Speed of wheel rotation.

KV rating (brushless only): RPM per volt.

Stall Current: Important for selecting ESCs and batteries.

B. Speed Controllers (ESCs):

An ESC (Electronic Speed Controller) takes power from the battery and uses PWM signals from your radio receiver to regulate how fast and in which direction a motor spins.

a. Types of ESCs (BattleBot-Specific):

Brushed ESC:

Simpler, controls 2-wire brushed motors Drive motors in 2WD/4WD.

Brushless ESC:

More advanced, needed for 3-phase brushless motors Spinners, some high-end drives.

. Reversible ESC:

Allows full forward and backward control BattleBots always need this.

Dual ESC:

Controls 2 motors independently from one board Compact drive bots.

VESC (Open Source):

Highly programmable, supports sensors, telemetry, current limits Top-tier bots, both drive & weapon.

b.ESCs Used in Real BattleBots:

Witch Doctor VESC for spinner, dual brushed for drive Brushless + Brushed

Shatter! VESC-based for both drive and weapon All Brushless

Tombstone Custom ESCs to handle massive current draw Brushed weapon + drive.

c. ESC Protection Features:

Overheat shutdown

Low voltage cutoff (LVC) to protect LiPo batteries

Overcurrent cutoff

Signal loss failsafe

These protections help prevent fires, explosions, or bot failures during combat.

Power system components for BattleBots:

The power system components of a BattleBot are responsible for safely and efficiently delivering electrical energy to every major system – drive, weapon, electronics, actuators, and sensors. Below is a breakdown of all essential components in a BattleBot power system, organized by function and importance.

1. Battery (Primary Power Source):

. **Type**: Typically LiPo (Lithium Polymer), or sometimes $LiFePO_4$ or NiMH (rarely).

Voltage (V): Depends on the number of cells (S). Each LiPo cell = 3.7V. Common configs: 4S (14.8V), 6S (22.2V), 8S (29.6V).

Capacity (mAh): Affects runtime. Typical: 3000–10000mAh.

C Rating(Discharge rate): Determines how fast current can be delivered.
Example: 5000mAh delivers 200A as output.

Mounting: Must be shock-protected and securely strapped in fireproof housing.

2. Power Connectors:

Used to connect the battery to the rest of the system.

Common Types:

XT60 / XT90: Mid to high power.
EC5 / EC8: High current.
AS150 Anti-spark: Prevents voltage arc when plugging in.
Deans (T-Plug): Older, still used in lighter bots.

Note: Anti-spark plugs are critical for preventing damage to ESCs when plugging in high-voltage batteries.

3. Power Distribution Board (PDB) / Bus:

Central board or terminal setup that distributes power to all major components.

Functions:

Connects main battery output to:

Drive ESCs.

Weapon ESCs.

Voltage regulators.

LEDs, cooling fans, microcontrollers.

4. Electronic Speed Controllers (ESCs):

Receives power from battery and throttle signal from receiver, and regulates power to motors.

Types:

Brushed ESC: For brushed motors (2 wires)

Brushless ESC: For 3-phase brushless motors (3 wires)

VESC: Smart, programmable ESCs (for advanced bots)

5. BEC (Battery Eliminator Circuit) / Voltage Regulators:

Convert high voltage (14.8V–29.6V) to safe voltages (5V/6V) for electronics.

Integrated BECs: Many ESCs include a BEC to power the radio receiver.

Standalone BECs / Step-down converters: Used when. ESCs don't have one or when isolation is needed for sensitive electronics.

6. Main Power Switch / Kill Switch:

Mandatory in competitions.

Cuts all power from the battery instantly for safety.

Types:

Physical key or loop pull (used by referees before/after matches).

Heavy-duty switches rated for 100–300A.

Often placed on the top or rear for access.

7. Fuses / Circuit Breakers :

Protect your wiring, ESCs, and batteries from short circuits or overloads.

Types:

Automotive blade fuses (common for subsystems)

ANL/Mega fuses for heavy weapon systems

Polyfuses (self-resetting) for logic electronics