



- **ATV Performance Tuning and Modifications**

ATV Performance Tuning and Modifications How to install a high flow exhaust on an ATV Steps for re mapping the ECU for improved performance How to choose the right gear ratio for your riding style When to upgrade the clutch springs and weights in an ATV Benefits of a big bore kit for ATV power output How to tune jetting for altitude changes Steps for adding a performance air filter to your ATV How to improve throttle response through tuning Tips for balancing top speed and low end torque in an ATV How to reduce engine lag with proper tuning adjustments When to upgrade the cooling system for performance riding How to test performance gains after modifications

- **Seasonal and Environment Specific ATV Preparation**

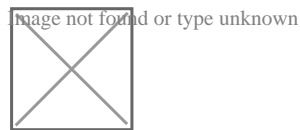
Seasonal and Environment Specific ATV Preparation How to prepare your ATV for winter storage Steps for setting up your ATV for deep snow riding How to waterproof your ATV for water crossings Tips for preventing rust after riding in wet conditions How to adjust jetting for hot summer temperatures Steps for protecting your ATV from saltwater corrosion How to prepare your ATV for muddy trail conditions What to pack for a long distance ATV expedition How to maintain your ATV during hunting season use Techniques for cleaning your ATV after sand dune riding How to set up tire pressure for different terrains When to change coolant for seasonal temperature shifts

- **About Us**



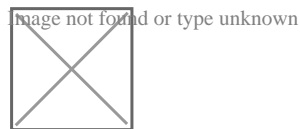
When it comes to enhancing the performance of any system, whether its a software application, a vehicle, or even a piece of sports equipment, making modifications is just the first step. ATV repair helps keep your machine dependable [honda atv dealers in illinois](#) United States of America. The true challenge and the crucial part of the process lie in accurately measuring and verifying the performance gains that these modifications bring. This essay explores how to effectively test performance gains after modifications have been made.

First and foremost, establishing a baseline is essential. Before you make any changes, its critical to have a clear understanding of your systems initial performance. This could mean timing how long your software takes to execute certain tasks, measuring the fuel efficiency of your car under specific conditions, or noting down your personal best times with your sports gear. Documenting this baseline thoroughly ensures that you have something concrete to compare against later.

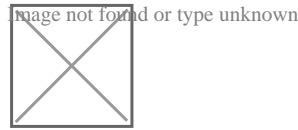


Once youve made your modifications, the next step is to retest under conditions as close as possible to those used for establishing the baseline. This is where many people make mistakes; they change not just the variables they intended (the modifications) but also other factors like weather conditions for vehicles or different test scenarios for software. To accurately gauge performance gains, keeping extraneous variables constant is key.

For software applications, automated testing tools can be invaluable in this stage. They allow you to run tests repeatedly under identical conditions, providing precise measurements of execution time or resource usage before and after modifications. In contrast, for physical systems like cars or sports equipment, controlled environments such as dynamometers for vehicles or standardized tracks and fields are ideal for ensuring consistent testing conditions.



Another important aspect is statistical analysis. After collecting data from multiple tests both before and after modifications, its beneficial to apply statistical methods to analyze this data. This can help confirm whether observed improvements are statistically significant rather than due to chance variation. Techniques such as t-tests or ANOVA can be particularly useful in this regard.



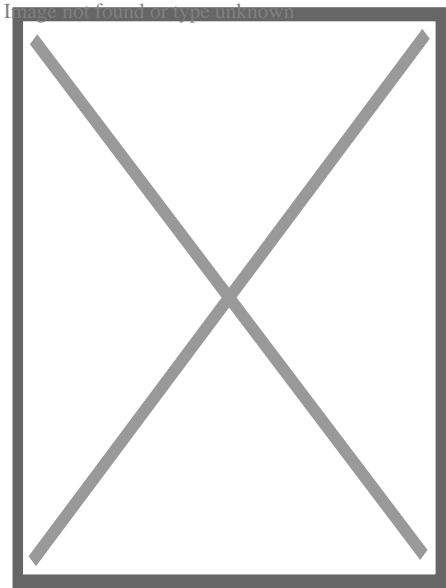
Moreover, subjective feedback should not be overlooked. Especially in areas like sports equipment where personal feel can significantly impact performance perception-if an athlete feels more confident with new gear despite marginal improvements in measurable outcomes-that psychological boost could translate into tangible performance gains during competitions.

Its also worth considering long-term testing alongside immediate post-modification assessments. Some changes might show immediate benefits but could lead to wear-and-tear issues over time that negate initial gains-or vice versa; some enhancements might take time to fully integrate into regular use before their full benefits become apparent.

Lastly, documentation plays a pivotal role throughout this process-from recording detailed notes on initial baselines and modification specifics through meticulous logging of all test results-to facilitating future comparisons if further tweaks are made down the line.

In conclusion, testing performance gains after modifications requires careful planning and execution across multiple fronts: from establishing robust baselines through controlled re-testing environments; leveraging appropriate tools whether digital or physical; employing statistical analysis; valuing subjective insights; conducting longitudinal studies; all underpinned by comprehensive documentation practices. By adopting such an approach one can confidently assess whether their efforts at enhancement have truly paid off leading potentially towards further optimization cycles based on solid evidence rather than mere speculation alone-a journey indeed both scientific yet endlessly fascinating!

About Four-stroke engine



Four-stroke cycle used in gasoline/petrol engines: intake (1), compression (2), power (3), and exhaust (4). The right blue side is the intake port and the left brown side is the exhaust port. The cylinder wall is a thin sleeve surrounding the piston head which creates a space for the combustion of fuel and the genesis of mechanical energy.

A **four-stroke** (also **four-cycle**) **engine** is an internal combustion (IC) engine in which the piston completes four separate strokes while turning the crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are termed:

1. **Intake:** Also known as induction or suction. This stroke of the piston begins at top dead center (T.D.C.) and ends at bottom dead center (B.D.C.). In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing a partial vacuum (negative pressure) in the cylinder through its downward motion.
2. **Compression:** This stroke begins at B.D.C, or just at the end of the suction stroke, and ends at T.D.C. In this stroke the piston compresses the air-fuel mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.
3. **Combustion:** Also known as power or ignition. This is the start of the second revolution of the four stroke cycle. At this point the crankshaft has completed a full 360 degree revolution. While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug (in a gasoline engine) or by heat generated by high compression (diesel engines), forcefully returning the piston to B.D.C. This stroke produces mechanical work from the engine to turn the crankshaft.
4. **Exhaust:** Also known as outlet. During the *exhaust* stroke, the piston, once again, returns from B.D.C. to T.D.C. while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust port.

Four-stroke engines are the most common internal combustion engine design for motorized land transport,^[1] being used in automobiles, trucks, diesel trains, light aircraft and motorcycles. The major alternative design is the two-stroke cycle.^[1]

History

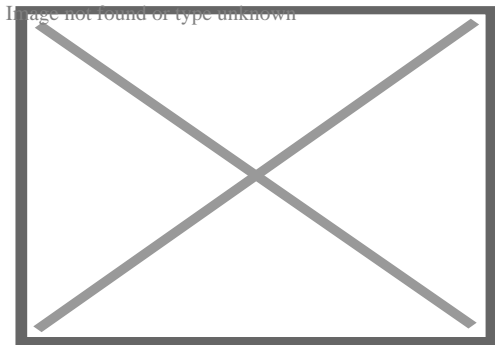
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Otto cycle

[edit]

Main article: Otto cycle

See also: Otto engine



An Otto Engine from 1880s US Manufacture

Nikolaus August Otto was a traveling salesman for a grocery concern. In his travels, he encountered the internal combustion engine built in Paris by Belgian expatriate Jean Joseph Etienne Lenoir. In 1860, Lenoir successfully created a double-acting engine that ran on illuminating gas at 4% efficiency. The 18 litre Lenoir Engine produced only 2 horsepower. The Lenoir engine ran on illuminating gas made from coal, which had been developed in Paris by Philip Lebon.^[2]

In testing a replica of the Lenoir engine in 1861, Otto became aware of the effects of compression on the fuel charge. In 1862, Otto attempted to produce an engine to improve on the poor efficiency and reliability of the Lenoir engine. He tried to create an engine that would compress the fuel mixture prior to ignition, but failed as that engine would run no more than a few minutes prior to its destruction. Many other engineers were trying to solve the problem, with no success.^[2]

In 1864, Otto and Eugen Langen founded the first internal combustion engine production company, NA Otto and Cie (NA Otto and Company). Otto and Cie succeeded in creating a successful atmospheric engine that same year.^[2] The factory ran out of space and was moved to the town of Deutz, Germany in 1869, where the company was renamed to Deutz Gasmotorenfabrik AG (The Deutz Gas Engine Manufacturing Company).^[2] In 1872, Gottlieb Daimler was technical director and Wilhelm Maybach was the head of engine design. Daimler was a gunsmith who had worked on the Lenoir engine. By 1876, Otto and Langen succeeded in creating the first internal combustion engine that compressed the fuel mixture prior to combustion for far higher efficiency than any engine created to this time.

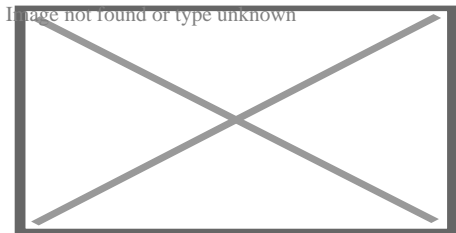
Daimler and Maybach left their employ at Otto and Cie and developed the first high-speed Otto engine in 1883. In 1885, they produced the first automobile to be equipped with an Otto engine.

The Daimler *Reitwagen* used a hot-tube ignition system and the fuel known as Ligroin to become the world's first vehicle powered by an internal combustion engine. It used a four-stroke engine based on Otto's design. The following year, Karl Benz produced a four-stroke engined automobile that is regarded as the first car.^[3]

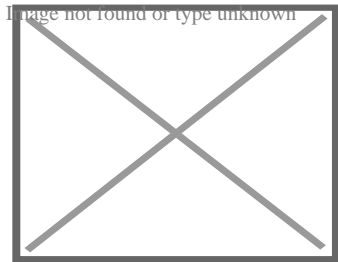
In 1884, Otto's company, then known as Gasmotorenfabrik Deutz (GFD), developed electric ignition and the carburetor. In 1890, Daimler and Maybach formed a company known as Daimler Motoren Gesellschaft. Today, that company is Daimler-Benz.

Atkinson cycle

[edit]



This 2004 Toyota Prius hybrid has an Atkinson-cycle engine as the petrol-electric hybrid engine



The Atkinson Gas Cycle

Main article: Atkinson cycle

The Atkinson-cycle engine is a type of single stroke internal combustion engine invented by James Atkinson in 1882. The Atkinson cycle is designed to provide efficiency at the expense of power density, and is used in some modern hybrid electric applications.

The original Atkinson-cycle piston engine allowed the intake, compression, power, and exhaust strokes of the four-stroke cycle to occur in a single turn of the crankshaft and was designed to avoid infringing certain patents covering Otto-cycle engines.^[4]

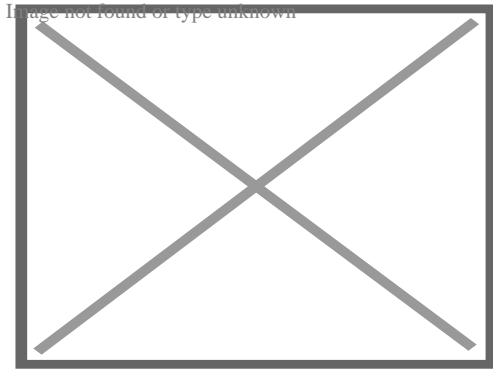
Due to the unique crankshaft design of the Atkinson, its expansion ratio can differ from its compression ratio and, with a power stroke longer than its compression stroke, the engine can achieve greater thermal efficiency than a traditional piston engine. While Atkinson's original design is no more than a historical curiosity, many modern engines use unconventional valve timing to

produce the effect of a shorter compression stroke/longer power stroke, thus realizing the fuel economy improvements the Atkinson cycle can provide.^[5]

Diesel cycle

[edit]

Main article: Diesel cycle



Audi Diesel R15 at Le Mans

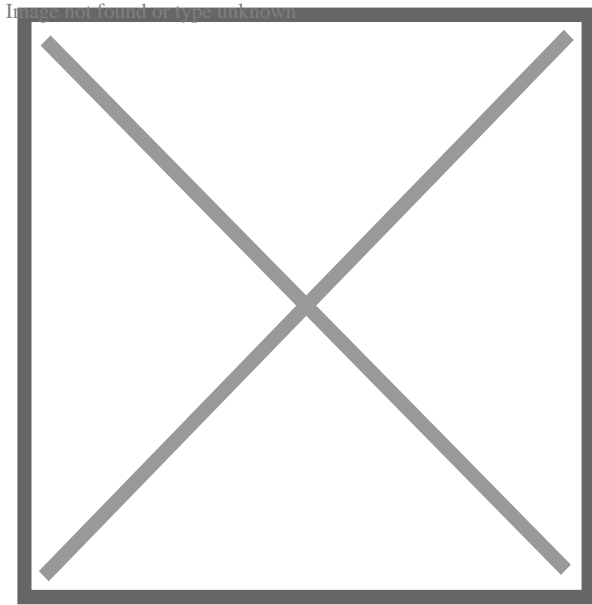
The diesel engine is a technical refinement of the 1876 Otto-cycle engine. Where Otto had realized in 1861 that the efficiency of the engine could be increased by first compressing the fuel mixture prior to its ignition, Rudolf Diesel wanted to develop a more efficient type of engine that could run on much heavier fuel. The Lenoir, Otto Atmospheric, and Otto Compression engines (both 1861 and 1876) were designed to run on Illuminating Gas (coal gas). With the same motivation as Otto, Diesel wanted to create an engine that would give small industrial companies their own power source to enable them to compete against larger companies, and like Otto, to get away from the requirement to be tied to a municipal fuel supply.^[*citation needed*] Like Otto, it took more than a decade to produce the high-compression engine that could self-ignite fuel sprayed into the cylinder. Diesel used an air spray combined with fuel in his first engine.

During initial development, one of the engines burst, nearly killing Diesel. He persisted, and finally created a successful engine in 1893. The high-compression engine, which ignites its fuel by the heat of compression, is now called the diesel engine, whether a four-stroke or two-stroke design.

The four-stroke diesel engine has been used in the majority of heavy-duty applications for many decades. It uses a heavy fuel containing more energy and requiring less refinement to produce. The most efficient Otto-cycle engines run near 30% thermal efficiency.^[*clarification needed*]

Thermodynamic analysis

[edit]



The idealized four-stroke Otto cycle p-V diagram: the **intake (A)** stroke is performed by an isobaric expansion, followed by the **compression (B)** stroke, performed as an adiabatic compression. Through the combustion of fuel an isochoric process is produced, followed by an adiabatic expansion, characterizing the **power (C)** stroke. The cycle is closed by an isochoric process and an isobaric compression, characterizing the **exhaust (D)** stroke.

The thermodynamic analysis of the actual four-stroke and two-stroke cycles is not a simple task. However, the analysis can be simplified significantly if air standard assumptions^[6] are utilized. The resulting cycle, which closely resembles the actual operating conditions, is the Otto cycle.

During normal operation of the engine, as the air/fuel mixture is being compressed, an electric spark is created to ignite the mixture. At low rpm this occurs close to TDC (Top Dead Centre). As engine rpm rises, the speed of the flame front does not change so the spark point is advanced earlier in the cycle to allow a greater proportion of the cycle for the charge to combust before the power stroke commences. This advantage is reflected in the various Otto engine designs; the atmospheric (non-compression) engine operates at 12% efficiency whereas the compressed-charge engine has an operating efficiency around 30%.

Fuel considerations

[edit]

A problem with compressed charge engines is that the temperature rise of the compressed charge can cause pre-ignition. If this occurs at the wrong time and is too energetic, it can damage the engine. Different fractions of petroleum have widely varying flash points (the temperatures at which the fuel may self-ignite). This must be taken into account in engine and fuel design.

The tendency for the compressed fuel mixture to ignite early is limited by the chemical composition of the fuel. There are several grades of fuel to accommodate differing performance levels of engines. The fuel is altered to change its self-ignition temperature. There are several ways to do

this. As engines are designed with higher compression ratios the result is that pre-ignition is much more likely to occur since the fuel mixture is compressed to a higher temperature prior to deliberate ignition. The higher temperature more effectively evaporates fuels such as gasoline, which increases the efficiency of the compression engine. Higher compression ratios also mean that the distance that the piston can push to produce power is greater (which is called the expansion ratio).

The octane rating of a given fuel is a measure of the fuel's resistance to self-ignition. A fuel with a higher numerical octane rating allows for a higher compression ratio, which extracts more energy from the fuel and more effectively converts that energy into useful work while at the same time preventing engine damage from pre-ignition. High octane fuel is also more expensive.

Many modern four-stroke engines employ gasoline direct injection or GDI. In a gasoline direct-injected engine, the injector nozzle protrudes into the combustion chamber. The direct fuel injector injects gasoline under a very high pressure into the cylinder during the compression stroke, when the piston is closer to the top.^[7]

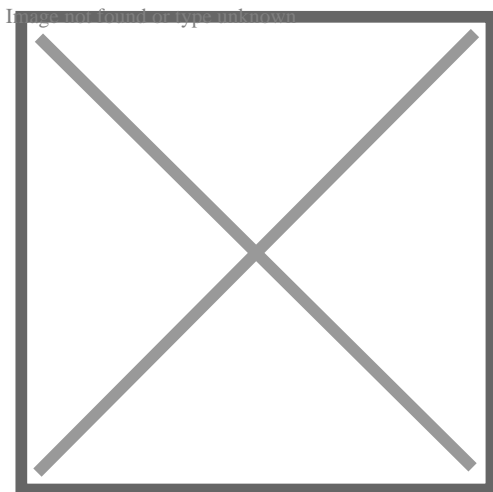
Diesel engines by their nature do not have concerns with pre-ignition. They have a concern with whether or not combustion can be started. The description of how likely diesel fuel is to ignite is called the Cetane rating. Because diesel fuels are of low volatility, they can be very hard to start when cold. Various techniques are used to start a cold diesel engine, the most common being the use of a glow plug.

Design and engineering principles

[edit]

Power output limitations

[edit]



The four-stroke cycle
1=TDC

2=BDC

A: Intake

B: Compression

C: Power

D: Exhaust

The maximum amount of power generated by an engine is determined by the maximum amount of air ingested. The amount of power generated by a piston engine is related to its size (cylinder volume), whether it is a two-stroke engine or four-stroke design, volumetric efficiency, losses, air-to-fuel ratio, the calorific value of the fuel, oxygen content of the air and speed (RPM). The speed is ultimately limited by material strength and lubrication. Valves, pistons and connecting rods suffer severe acceleration forces. At high engine speed, physical breakage and piston ring flutter can occur, resulting in power loss or even engine destruction. Piston ring flutter occurs when the rings oscillate vertically within the piston grooves they reside in. Ring flutter compromises the seal between the ring and the cylinder wall, which causes a loss of cylinder pressure and power. If an engine spins too quickly, valve springs cannot act quickly enough to close the valves. This is commonly referred to as 'valve float', and it can result in piston to valve contact, severely damaging the engine. At high speeds the lubrication of piston cylinder wall interface tends to break down. This limits the piston speed for industrial engines to about 10 m/s.

Intake/exhaust port flow

[edit]

The output power of an engine is dependent on the ability of intake (air–fuel mixture) and exhaust matter to move quickly through valve ports, typically located in the cylinder head. To increase an engine's output power, irregularities in the intake and exhaust paths, such as casting flaws, can be removed, and, with the aid of an air flow bench, the radii of valve port turns and valve seat configuration can be modified to reduce resistance. This process is called porting, and it can be done by hand or with a CNC machine.

Waste heat recovery of an internal combustion engine

[edit]

An internal combustion engine is on average capable of converting only 40-45% of supplied energy into mechanical work. A large part of the waste energy is in the form of heat that is released to the environment through coolant, fins etc. If somehow waste heat could be captured and turned to mechanical energy, the engine's performance and/or fuel efficiency could be improved by improving the overall efficiency of the cycle. It has been found that even if 6% of the entirely wasted heat is recovered it can increase the engine efficiency greatly.^[8]

Many methods have been devised in order to extract waste heat out of an engine exhaust and use it further to extract some useful work, decreasing the exhaust pollutants at the same time. Use of the Rankine Cycle, turbocharging and thermoelectric generation can be very useful as a waste heat recovery system.

Supercharging

[edit]

One way to increase engine power is to force more air into the cylinder so that more power can be produced from each power stroke. This can be done using some type of air compression device known as a supercharger, which can be powered by the engine crankshaft.

Supercharging increases the power output limits of an internal combustion engine relative to its displacement. Most commonly, the supercharger is always running, but there have been designs that allow it to be cut out or run at varying speeds (relative to engine speed). Mechanically driven supercharging has the disadvantage that some of the output power is used to drive the supercharger, while power is wasted in the high pressure exhaust, as the air has been compressed twice and then gains more potential volume in the combustion but it is only expanded in one stage.

Turbocharging

[edit]

A turbocharger is a supercharger that is driven by the engine's exhaust gases, by means of a turbine. A turbocharger is incorporated into the exhaust system of a vehicle to make use of the expelled exhaust. It consists of a two piece, high-speed turbine assembly with one side that compresses the intake air, and the other side that is powered by the exhaust gas outflow.

When idling, and at low-to-moderate speeds, the turbine produces little power from the small exhaust volume, the turbocharger has little effect and the engine operates nearly in a naturally aspirated manner. When much more power output is required, the engine speed and throttle opening are increased until the exhaust gases are sufficient to 'spool up' the turbocharger's turbine to start compressing much more air than normal into the intake manifold. Thus, additional power (and speed) is expelled through the function of this turbine.

Turbocharging allows for more efficient engine operation because it is driven by exhaust pressure that would otherwise be (mostly) wasted, but there is a design limitation known as turbo lag. The increased engine power is not immediately available due to the need to sharply increase engine RPM, to build up pressure and to spin up the turbo, before the turbo starts to do any useful air compression. The increased intake volume causes increased exhaust and spins the turbo faster, and so forth until steady high power operation is reached. Another difficulty is that the higher exhaust pressure causes the exhaust gas to transfer more of its heat to the mechanical parts of the engine.

Rod and piston-to-stroke ratio

[edit]

The rod-to-stroke ratio is the ratio of the length of the connecting rod to the length of the piston stroke. A longer rod reduces sidewise pressure of the piston on the cylinder wall and the stress forces, increasing engine life. It also increases the cost and engine height and weight.

A "square engine" is an engine with a bore diameter equal to its stroke length. An engine where the bore diameter is larger than its stroke length is an oversquare engine, conversely, an engine with a bore diameter that is smaller than its stroke length is an undersquare engine.

Valve train

[edit]

The valves are typically operated by a camshaft rotating at half the speed of the crankshaft. It has a series of cams along its length, each designed to open a valve during the appropriate part of an intake or exhaust stroke. A tappet between valve and cam is a contact surface on which the cam slides to open the valve. Many engines use one or more camshafts "above" a row (or each row) of cylinders, as in the illustration, in which each cam directly actuates a valve through a flat tappet. In other engine designs the camshaft is in the crankcase, in which case each cam usually contacts a push rod, which contacts a rocker arm that opens a valve, or in case of a flathead engine a push rod is not necessary. The overhead cam design typically allows higher engine speeds because it provides the most direct path between cam and valve.

Valve clearance

[edit]

Valve clearance refers to the small gap between a valve lifter and a valve stem that ensures that the valve completely closes. On engines with mechanical valve adjustment, excessive clearance causes noise from the valve train. A too-small valve clearance can result in the valves not closing properly. This results in a loss of performance and possibly overheating of exhaust valves. Typically, the clearance must be readjusted each 20,000 miles (32,000 km) with a feeler gauge.

Most modern production engines use hydraulic lifters to automatically compensate for valve train component wear. Dirty engine oil may cause lifter failure.

Energy balance

[edit]

Otto engines are about 30% efficient; in other words, 30% of the energy generated by combustion is converted into useful rotational energy at the output shaft of the engine, while the remainder being lost due to waste heat, friction and engine accessories.^[9] There are a number of ways to recover some of the energy lost to waste heat. The use of a turbocharger in diesel engines is very effective by boosting incoming air pressure and in effect, provides the same increase in performance as having more displacement. The Mack Truck company, decades ago, developed a turbine system that converted waste heat into kinetic energy that it fed back into the engine's transmission. In 2005, BMW announced the development of the turbosteamer, a two-stage heat-recovery system similar to the Mack system that recovers 80% of the energy in the exhaust gas and raises the efficiency of an Otto engine by 15%.^[10] By contrast, a six-stroke engine may reduce fuel consumption by as much as 40%.

Modern engines are often intentionally built to be slightly less efficient than they could otherwise be. This is necessary for emission controls such as exhaust gas recirculation and catalytic converters that reduce smog and other atmospheric pollutants. Reductions in efficiency may be counteracted with an engine control unit using lean burn techniques.^[11]

In the United States, the Corporate Average Fuel Economy mandates that vehicles must achieve an average of 34.9 mpg^{Åçâ,~â€~US} (6.7 L/100 km; 41.9 mpg^{Åçâ,~â€~imp}) compared to the current standard of 25 mpg^{Åçâ,~â€~US} (9.4 L/100 km; 30.0 mpg^{Åçâ,~â€~imp}).^[12] As automakers look to meet these standards by 2016, new ways of engineering the traditional internal combustion engine (ICE) have to be considered. Some potential solutions to increase fuel efficiency to meet new mandates include firing after the piston is farthest from the crankshaft, known as top dead centre, and applying the Miller cycle. Together, this redesign could significantly reduce fuel consumption and NOx emissions.

Top dead center, before cycle begins \in Intake stroke 2 \hat{A} , \hat{A} \in Compression stroke

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Fuel ignites

3 $\tilde{A}\phi\hat{a}, -\hat{a}\in\phi$ Power stroke 4 $\tilde{A}\phi\hat{a}, -\hat{a}\in\phi$ Exhaust stroke

Starting position, intake stroke, and compression stroke.

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Ignition of fuel, power stroke, and exhaust stroke.

See also

[edit]

- Atkinson cycle
- Miller cycle
- Humphrey pump
- Desmodromic valve
- History of the internal combustion engine
- Napier Deltic
- Poppet valve
- Radial engine
- Rotary engine
- Six-stroke engine

- Stirling engine
- Stroke (engine)
 - Two- and four-stroke engines
 - Two-stroke engine
 - Five-stroke engine (uncommon)
 - Six-stroke engine

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External links

[edit]

- U.S. patent 194,047
- Four stroke engine animation
- Detailed Engine Animations^[*usurped*]
- How Car Engines Work
- Animated Engines, four stroke, another explanation of the four-stroke engine.
- CDX eTextbook, some videos of car components in action.
- New 4 stroke

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Engine configurations for piston engines

Type

- Atmospheric
- Axial
- Beam
 - Cornish
 - Rotative
- Bourke
- Cam engine
- Camless
- Compound
- Double-acting cylinder
- Flathead
- Free-piston
 - Stelzer
- Hemi
- Heron head
- Intake over exhaust
- Oscillating cylinder
- Opposed-piston
- Overhead camshaft
- Overhead valve
- Pentroof
- Rotary
- Single-acting cylinder
- Split cycle
- Swing-piston
- Uniflow
- Watt
- Wedge

Stroke cycles

- Two-stroke
- Four-stroke
- Five-stroke
- Six-stroke
- Two-and four-stroke

Cylinder layouts

Inline / straight

- I1
- I2
- I3
- I4
- I5
- I6
- I7
- I8
- I9
- I12
- I14

Flat / boxer

- F2
- F4
- F6
- F8
- F10
- F12
- F16

V / V_{ee}

- V2
- V3
- V4
- V5
 - VR5
- V6
 - VR6
- V8
- V10
- V12
- V14
- V16
- V18
- V20
- V24

W

- W3
- W6
- W8
- W12
- W16
- W18
- W24
- W30

- Deltic

- v
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Car design

Classification	By size	<ul style="list-style-type: none"> ○ Micro ○ Kei ○ Subcompact ○ Supermini ○ Family ○ Compact ○ Mid-size ○ Full-size
	Custom	<ul style="list-style-type: none"> ○ Baja Bug ○ Hot rod ○ Lead sled ○ Lowrider ○ Sandrail ○ T-bucket
	Luxury	<ul style="list-style-type: none"> ○ Compact executive ○ Executive ○ Personal
	Minivan / MPV	<ul style="list-style-type: none"> ○ Compact ○ Leisure ○ Mini
	SUV	<ul style="list-style-type: none"> ○ Compact ○ Crossover (CUV) ○ Mini ○ Coupe SUV
	Sports	<ul style="list-style-type: none"> ○ Grand tourer ○ Hot hatch ○ Muscle ○ Pony ○ Sport compact ○ Sports sedan ○ Super ○ Go-kart
	Other	<ul style="list-style-type: none"> ○ Antique ○ Classic ○ Economy ○ Ute ○ Van ○ Vintage car

Body styles

- 2+2
- Baquet
- Barchetta
- Berlinetta
- Brougham
- Cabrio coach
- Cab over
- Cabriolet / Convertible / Drophead coupe
- Coupe
- Coupé de Ville / Sedan de Ville
- Coupé utility
- Fastback
- Hardtop
- Hatchback
- Kammback
- Landaulet
- Liftback
- Limousine
- Microvan
- Minibus
- Multi-stop truck
- Notchback
- Panel van
- Phaeton
- Pickup truck
- Quad coupé
- Retractable hardtop
- Roadster / Spider / Spyder
- Runabout
- Saloon / Sedan
- Sedan delivery/Panel van
- Shooting brake
- Station wagon
- Targa top
- Torpedo
- Touring
- Town (Coupé de Ville)
- T-top
- Vis-à-vis

Specialized vehicles

- All-terrain vehicle
- Amphibious
- Connected
- Driverless (autonomous)
- Dune buggy
- Go-kart
- Gyrocar
- Pedal car
- Personal rapid transit
- Police car
- Flying car
- Taxicab
- Tow truck
- Voiturette

Propulsion

- Alternative fuel
- Autogas
- Biodiesel
- Biofuel
- Biogasoline
- Biogas
- Compressed natural gas
- Diesel
- Electric (battery
- NEV)
- Ethanol (E85)
- Fossil fuel
- Fuel cell
- Fuel gas
- Natural gas
- Gasoline / petrol (direct injection)
- Homogeneous charge compression ignition
- Hybrid (plug-in)
- Hydrogen
- Internal combustion
- Liquid nitrogen
- Liquified petroleum gas
- Steam

Drive wheels

- Front-wheel
- Rear-wheel
- Two-wheel
- Four-wheel
- Six-wheel
- Eight-wheel
- Ten-wheel
- Twelve-wheel

Engine position

- Front
- Mid
- Rear

**Layout
(engine / drive)**

- Front-front
- Front mid-front
- Rear-front
- Front-rear
- Rear mid-rear
- Rear-rear
- Front-four-wheel
- Mid-four-wheel
- Rear-four-wheel
- Dual motor-four-wheel
- Individual wheel drive

**Engine configuration
(internal combustion)**

- Boxer
- Flat
- Four-stroke
- H-block
- Reciprocating
- Single-cylinder
- Straight
- Two-stroke
- V (Vee)
- W engine
- Wankel

- **Portal**
- **Category**
- **Template:EC car classification**

- v
- t
- e

Aircraft piston engine components, systems and terminology

Piston engines	Mechanical components	<ul style="list-style-type: none"> ○ Camshaft ○ Connecting rod ○ Crankpin ○ Crankshaft ○ Cylinder ○ Cylinder head ○ Gudgeon pin ○ Hydraulic tappet ○ Main bearing ○ Obturator ring ○ Oil pump ○ Piston ○ Piston ring ○ Poppet valve ○ Pushrod ○ Rocker arm ○ Sleeve valve ○ Tappet
	Electrical components	<ul style="list-style-type: none"> ○ Alternator ○ Capacitor discharge ignition ○ Dual ignition ○ Electronic fuel injection ○ Generator ○ Ignition system ○ Magneto ○ Spark plug ○ Starter
	Terminology	<ul style="list-style-type: none"> ○ Air-cooled ○ Aircraft engine starting ○ Bore ○ Compression ratio ○ Dead centre ○ Engine displacement ○ Four-stroke engine ○ Horsepower ○ Ignition timing ○ Manifold pressure ○ Mean effective pressure ○ Naturally aspirated ○ Monosoupape ○ Overhead camshaft ○ Overhead valve engine ○ Rotary engine ○ Shock cooling ○ Stroke

- Propeller governor
 - Propeller speed reduction unit
 - Spinner
- Components**

- Propellers**
- Autofeather
 - Blade pitch
 - Constant-speed
 - Contra-rotating
 - Counter-rotating
 - Scimitar
 - Single-blade
 - Variable-pitch
- Terminology**

- Annunciator panel
 - EFIS
 - EICAS
 - Flight data recorder
 - Glass cockpit
 - Hobbs meter
 - Tachometer
- Engine instruments**

- Carburetor heat
 - Throttle
- Engine controls**

- Avgas
 - Carburetor
 - Fuel injection
 - Gascolator
 - Inlet manifold
 - Intercooler
 - Pressure carburetor
 - Supercharger
 - Turbocharger
 - Updraft carburetor
- Fuel and induction system**

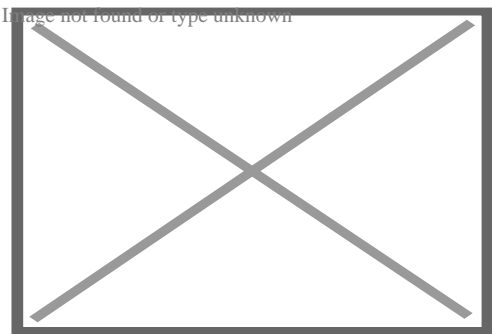
- Auxiliary power unit
 - Coffman starter
 - Hydraulic system
 - Ice protection system
 - Recoil start
- Other systems**

About Three-wheeler

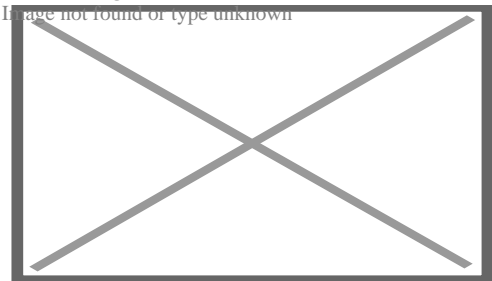
This article **needs additional citations for verification**. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.



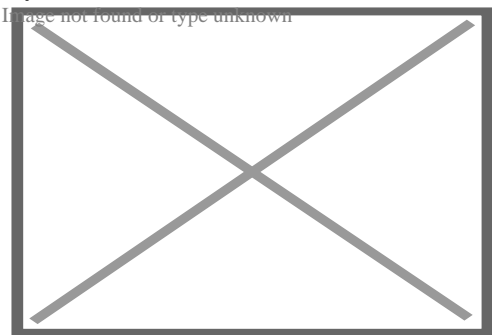
Find sources: "Three-wheeler" – news • newspapers • books • scholar • JSTOR (January 2012) *(Learn how and when to remove this message)*



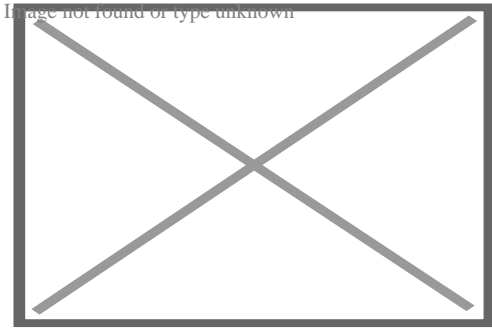
Campagna T-Rex



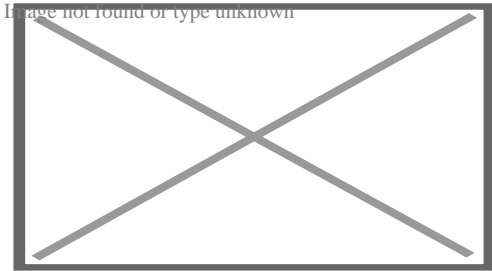
1932 Morgan Aero 2-Seater Sports



Fuldamobil three-wheeler (Postwar-era Germany)



Tricycle truck in Poland (Gorzów Wlkp)



Trihawk, a tadpole-type trike manufactured in California, United States during the 1980s

A **three-wheeler** is a vehicle with three wheels. Some are motorized tricycles, which may be legally classed as motorcycles, while others are tricycles without a motor, some of which are human-powered vehicles and animal-powered vehicles.

Overview

[edit]

Many three-wheelers which exist in the form of motorcycle-based machines are often called trikes and often have the front single wheel and mechanics similar to that of a motorcycle and the rear axle similar to that of a car. Often such vehicles are owner-constructed using a portion of a rear-engine, rear-drive Volkswagen Beetle in combination with a motorcycle front end. Other trikes include All-terrain vehicles that are specially constructed for off-road use.

Three-wheelers can have either one wheel at the back and two at the front (2F1R), (for example: Morgan Motor Company) or one wheel at the front and two at the back (1F2R) (such as the Reliant Robin). Due to better safety when braking, an increasingly popular form is the front-steering "tadpole" or "reverse trike" sometimes with front drive but usually with rear drive. A variant on the 'one at the front' layout was the Scott Sociable, which resembled a four-wheeler with a front wheel missing.^[1]

Three-wheelers, including some cyclecars, bubble cars and microcars, are built for economic and legal reasons: in the UK for tax advantages, or in the US to take advantage of lower safety regulations, being classed as motorcycles. As a result of their light construction and potential better streamlining, three-wheeled cars are usually less expensive to operate.^{*[citation needed]*}

Some inexpensive three-wheelers have been designed specifically to improve mobility for disabled people.^[2]

Three-wheeler transport vehicles known as auto rickshaws are a common means of public transportation in many countries in the world, and are an essential form of urban transport in many developing countries such as India and the Philippines.

History

[edit]

Early automotive pioneer Karl Benz developed a number of three-wheeled models.^[3] One of these, the Benz Patent Motorwagen,^[4] is regarded as the first purpose-built automobile. It was made in 1885.

In 1896, John Henry Knight showed a tri-car at The Great Exhibition.^[3]

In 1897, Edward Butler made the Butler Petrol Cycle, another three-wheeled car.

A Conti 6 hp Tri-car competed in (but did not complete) a 1907 Peking to Paris race sponsored by a French newspaper, *Le Matin*.^[5]

- 1885 Benz Patent Motorwagen

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1885 Benz Patent
Motorwagen

- Goliath pickup truck at a meeting for vintage cars in the 1990s

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Goliath pickup truck at
a meeting for vintage
cars in the 1990s

Davis D-2 Divan, at the National Automotive and Truck Museum, Auburn, Indiana, United States

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Davis D-2 Divan, at
the National

Automotive and Truck
Museum, Auburn,
Indiana, United
States

Davis 494, at the National Automotive and Truck Museum, Auburn, Indiana, USA

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Davis 494, at the
National Automotive
and Truck Museum,
Auburn, Indiana, USA

Velorex was a manufacturing cooperative in Solnice, Czechoslovakia, formed in 1936 to satisfy demand for small, inexpensive city cars.

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Velorex was a
manufacturing
cooperative in
Solnice,
Czechoslovakia,
formed in 1936 to
satisfy demand for
small, inexpensive
city cars.

Mazda T2000 truck 1957–1974, length 6.08 m, width 1.84 m, max speed 100 km/h

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Mazda T2000 truck
1957–1974, length
6.08 m, width 1.84 m,
max speed 100 km/h

An early Daihatsu Midget, which would serve as the basis for auto rickshaws that proliferate across Southeast Asia

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- An early Daihatsu Midget, which would serve as the basis for auto rickshaws that proliferate across South and Southeast Asia
- Reliant Robin 3-wheeler car.

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Reliant Robin 3-wheeler car.

2016 Pembleton Supersports

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2016 Pembleton Supersports

Configurations

[edit]

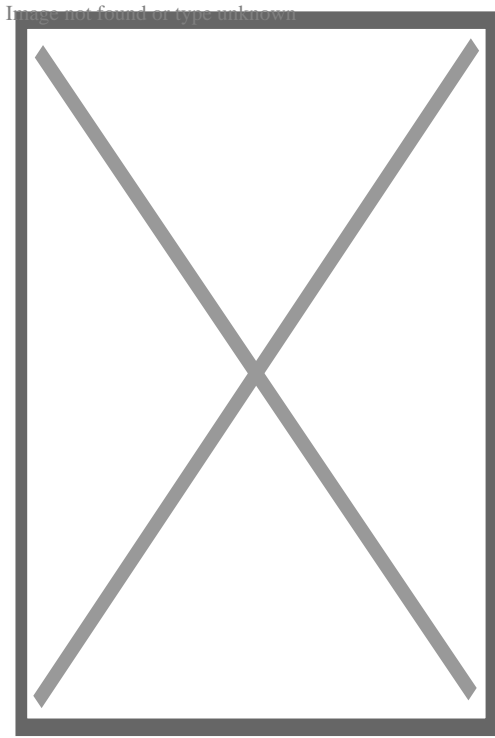


Diagram comparing delta and tadpole layouts

Two front

[edit]

A configuration of two wheels in the front and one wheel at the back presents two advantages: it has improved aerodynamics, and that it readily enables the use of a small lightweight motorcycle powerplant and rear wheel. This approach was used by the Messerschmitt KR200 and BMW Isetta. Alternatively, a more conventional front-engine, front wheel drive layout as is common in four-wheeled cars can be used, with subsequent advantages for transversal stability (the center of mass is further to the front) and traction (two driven wheels instead of one). Some vehicles have a front engine driving the single rear wheel, similar to the rear engine driving the rear wheel. The wheel must support acceleration loads as well as lateral forces when in a turn, and loss of traction can be a challenge.

A new tadpole configuration has been proposed with a rear engine driving the front wheels. This concept (Dragonfly Three Wheeler^[6]) claims both stability and traction (two driven wheels), as well as a unique driving experience.

With two wheels in the front (the "tadpole" form or "reverse trike") the vehicle is far more stable in braking turns, but remains more prone to overturning in normal turns compared to an equivalent four-wheeled vehicle, unless the center of mass is lower and/or further forward. Motorcycle-derived designs suffer from most of the weight being toward the rear of the vehicle.^[*citation needed*]

For lower wind resistance (which increases fuel efficiency), a teardrop shape is often used.^[*citation needed*] A teardrop is wide and round at the front, tapering at the back. The three-wheel configuration allows the two front wheels to create the wide round surface of the vehicle. The single rear wheel allows the vehicle to taper at the back. Examples include the Aptera (solar electric vehicle) and Myers Motors NmG.

Two rear

[edit]

Having one wheel in front and two in the rear for power reduces the cost of the steering mechanism but greatly decreases lateral stability when cornering while braking.

When the single wheel is in the front (the "delta" form, as in a child's pedal tricycle), the vehicle is inherently unstable in a braking turn, as the combined tipping forces at the center of mass from turning and braking can rapidly extend beyond the triangle formed by the contact patches of the wheels. This type, if not tipped, also has a greater tendency to spin out ("swap ends") when handled roughly.^[*citation needed*]

Lateral stability^[7]

[edit]

The disadvantage of a three-wheel configuration is that lateral stability is lower than with a four-wheeled vehicle.

With any vehicle, an imaginary line can be projected from the vehicles centre of mass to the ground, representing the force exerted on the vehicle by its mass. With the vehicle stationary, the line will be vertical. As the vehicle accelerates, that imaginary line tilts backward, remaining anchored to the centre of mass the point at which the line intersects the ground moves backward. As you brake it moves forward, with cornering it moves sideward. Should the point at which this line intersects the ground move outside of the boundary formed by connecting the tyre contact patches together (a rectangle for a four-wheeled car, or a triangle for a trike) then the vehicle will tip and eventually fall over. This is true for any vehicle.

With all vehicles it is critical that the vehicle should be engineered to slide before this point of instability is reached.

This can be achieved in several ways:

- by placing the center of mass closer to the ground
- by placing the center of mass closer to the axle with two wheels (for three wheelers)

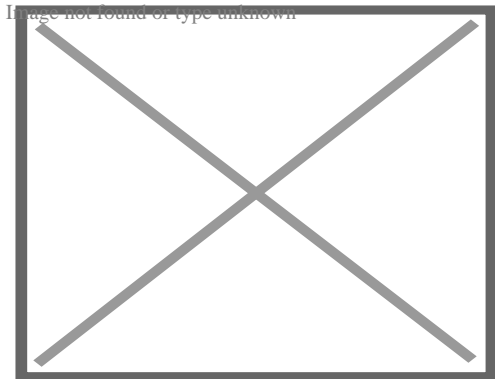
- by increasing the track width
- by limiting the grip provided by the tyres, such that the vehicle loses adhesion before it starts to tip.
- By tilting some or all of the vehicle as it corners.

In the case of a three-wheeled ATV, tipping may be avoided by the rider leaning into turns.

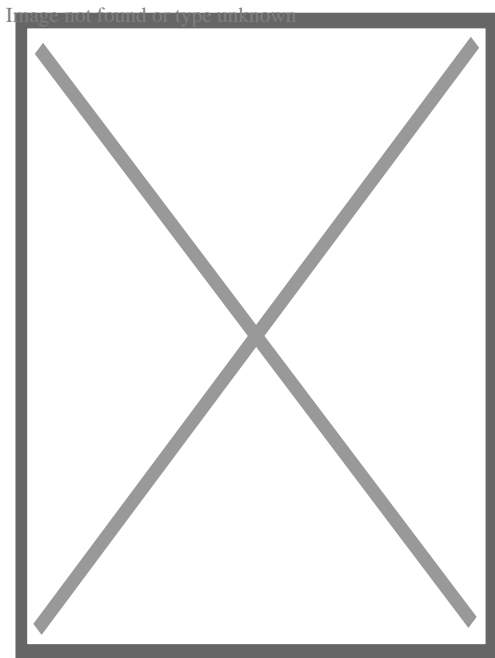
Tilting option

[edit]

Main article: Tilting three-wheeler



Tripendo recumbent tricycle, a tilting three-wheeler



Vandenbrink Carver

To improve stability some three-wheelers are designed to tilt while cornering like a motorcyclist would do. The tilt may be controlled manually, mechanically or by computer.

A tilting three-wheeler's body or wheels, or both, tilt in the direction of the turn. Such vehicles can corner safely even with a narrow track.

Some tilting three-wheelers could be considered to be forms of feet forward motorcycles or cabin motorcycles or both.

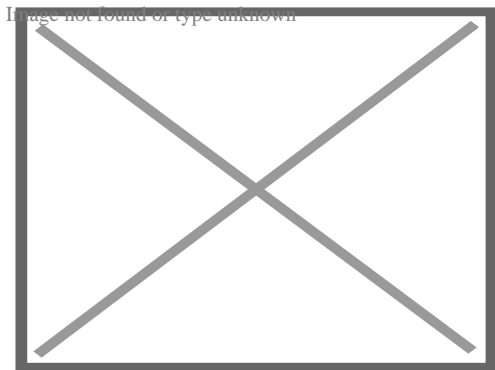
Electric three wheelers

[edit]

Main article: Electric vehicle. See also: Electric tricycle (disambiguation)

Battery-powered three wheelers

[edit]



Toyota i-Road, a three-wheeled battery powered personal mobility vehicle

Main articles: Battery electric vehicle and Electric rickshaw

Three-wheeled battery powered designs include:

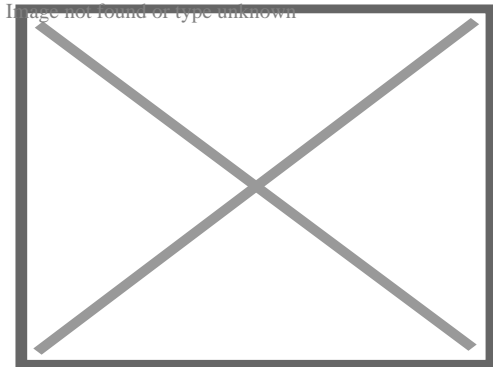
- Aptera (solar electric vehicle)
- Arcimoto
- CityEl
- Commuter Cars Tango
- Cree SAM
- ElectraMeccanica SOLO
- Myers Motors NmG (formerly Corbin Sparrow)
- Nobe GT100
- Toyota i-Road
- Triac
- Vanderhall Edison 2
- ZAP Xebra
- EWheels EW 36(mobility scooter)

Solar-powered three wheelers

[edit]

Main article: Solar vehicle

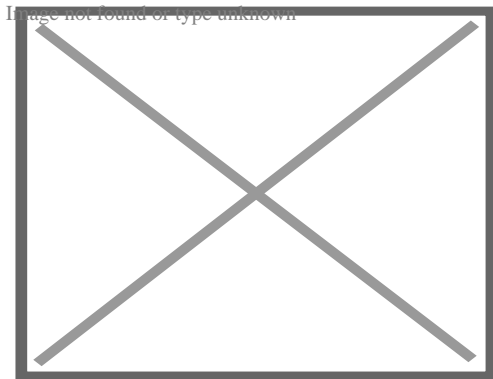
Here are three notable examples of solar-powered three wheelers; two race cars, the Infinium and the Sky Ace TIGA, and a vehicle planned for production, the Aptera.



Infinium, winner of 2010 American Solar Challenge

The Infinium, built by the University of Michigan Solar Car Team, came in 3rd place in the 2009 World Solar Challenge held in Australia, and won the 2010 American Solar Challenge.

Ashiya University's Sky Ace TIGA achieved 91.332 kilometres per hour (56.751 mph) at Shimojishima Airport, in Miyakojima, Okinawa, Japan, to win the Guinness World Record, on 20 August 2014.^[8] It took the record from another three-wheeler, Sunswift IV, designed and built at the University of New South Wales in Australia,^[9] by a margin of almost 3 km/h.



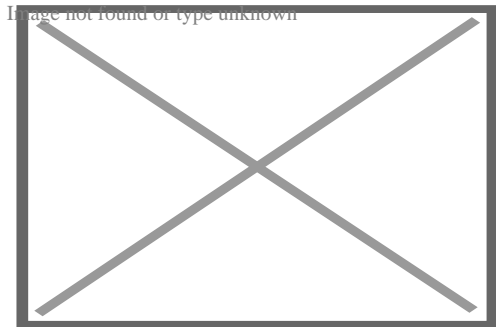
Solar panels on the hood, roof, dashboard and hatch of the Aptera EV

The Aptera solar electric vehicle^[10] uses a tadpole layout and is being designed to have a top speed of over 100 mph. The Aptera uses 42 KW in-wheel electric motors^[11] and can be ordered with two (front-wheel drive) or three (all-wheel drive) motors. The Aptera's roof and dashboard, and optionally its hood and hatch, are fitted with solar panels, with the full compliment being designed to add a range of up to 40 miles per day and 11,000 miles per year in the sunniest climates. First

customer availability is planned for before the end of 2024.^[12]

Steam-powered three wheelers

[edit]



Cugnot's *fardier à vapeur*, as preserved at the Musée des Arts et Métiers, Paris, France

Main articles: Steam tricycle and Steamroller

The world's first full-size self-propelled land vehicle was a three-wheeler. French Army Captain Nicolas-Joseph Cugnot's 1770 *fardier à vapeur* (steam dray), a steam tricycle with a top speed of around 3 km/h (2 mph), was intended for hauling artillery.^[13]

Another of the earliest preserved examples is the Long steam tricycle, built by George A. Long around 1880 and patented in 1883,^[14]^[15] now on display at the Smithsonian Institution.

Wind-powered three wheelers

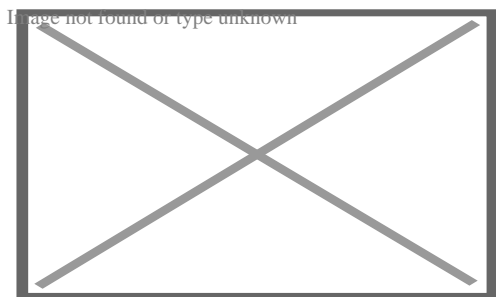
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The Whike is a recumbent tricycle with a sail, made in the Netherlands.

All-terrain vehicles

[edit]

Further information: All-terrain vehicle § Three-wheeled ATVs

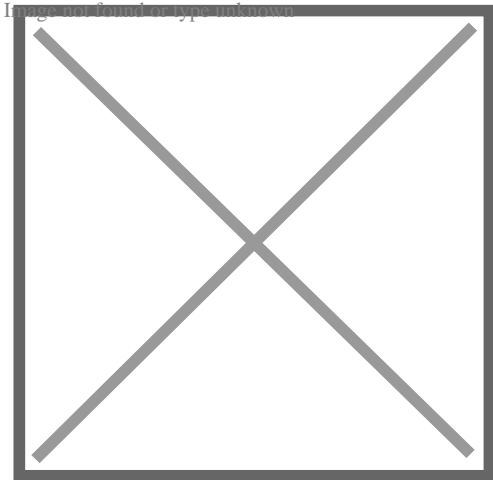


Honda, Suzuki and Yamaha all-terrain vehicles

Due to the incidence of injuries and deaths related to their use, a 10-year ban, entirely voluntary for manufacturers, was placed on the sale of new three-wheeled all-terrain vehicles in the United States in January 1988.^[*citation needed*] More injuries were sustained by riders by not applying a proper riding technique, and lack of wearing proper safety gear such as helmets and riding boots. In a search conducted by the Consumer Product Safety Commission, it was determined that "no inherent flaw was found in the three wheel design".^[*citation needed*]

Registration

[edit]



Bond Bug at Silverstone

The examples and perspective in this section **may not represent a worldwide view of the subject**. You may improve this section, discuss the issue on the talk page, or create a new section, as appropriate. *(October 2015)* *(Learn how and when to remove this message)*

In the U.S, the National Highway Traffic Safety Administration defines and regulates three-wheeled vehicles as motorcycles.^[16] However, in 2015 a bill was introduced in Congress that would prevent some three wheeled vehicles from being classified as motorcycles in the United States, instead creating a new classification for "autocycles".^{[17][18]}

Driver's license and registration requirements vary on a state-by-state basis. Some states require drivers of three wheeled vehicles to have a motorcycle license and register the vehicle as a motorcycle. Some states, including Virginia, Kansas, and Indiana, classify some three wheeled vehicles as autocycles. Virginia defines an autocycle as "a three-wheeled motor vehicle that has a steering wheel and seating that does not require the operator to straddle or sit astride and is manufactured to comply with federal safety requirements for motorcycles."^[19] Indiana defines it as "a three (3) wheeled motor vehicle in which the operator and passenger ride in a completely or partially enclosed seating area that is equipped with:(1) a rollcage or roll hoops; (2) safety belts for each occupant; and (3) antilock brakes;and is designed to be controlled with a steering wheel and pedals."^[20] In other jurisdictions, such as British Columbia, Canada, and Connecticut, a three-wheeled vehicle with an enclosed passenger compartment or partially enclosed seat is considered an automobile.^[citation needed]

Examples

[edit]

Two front wheels

[edit]

Name	Country	Years manufactured	Comments
Léon Bollée Voiturette	France	1895–?	
TriPodCars ^[21] Tripod 1	Australia	2012–?	400 kg Reverse Trike, Bandit 1250, ZX14R (200+ hp) and EV
Berkeley Cars Berkeley T60	England	1959	
Egg	Switzerland	1896–99	
Advance 6 hp air-cooled Tri Car and 9 hp water-cooled Tri Car ^[22]	England	1902–12	
Humber Tricar ^[23] ^[24]	England	1904	
Riley Olympia Tricar ^[25]	England	1904	^[26]
Mars Carette ^[27]	England	1904–05	Mars Motors Co existed in Finchley, London, White and Poppe water-cooled engine, Single-cylinder, 3.3 kW
Lagonda Tricar ^[28]	England	1904–07	total production: 69 cars
Anglian	England	1905–07	
Armadale	England	1906–07	
Ranger Cub	England	1970–1980	Reverse Trike/Tadpole, A-Series engine 848-1275cc
Morgan V-Twin and F-Series	England	1911–39, 1932–52	Morgan Super Sports 2-Seater 1937
American Tri-Car	United States	1912	
Birmingham Small Arms Company Three Wheeler	England	1929–36	1100cc engine ^[29]
Zaschka	Germany	1929	Folding three-wheeler: Zaschka Three-wheeler 1929

Dymaxion car	United States	1933	Concept car designed by Buckminster Fuller
Mathis VEL 333	France	1946	3 seats, flat-twin front engine, aluminium body, production less than 10 units
Fend Flitzer	Germany	1948 - 1951	1 seat, Messerschmitt kabinenroller precursor, production about 250 units
1951 Hoffmann	Germany	1951	2 seats, aluminium body, engine mounted on the rear wheel steering pivot
Velorex Oskar and other models	Czechoslovakia	1951–71	Originally with leather bodies
Isetta	UK	1957–62	Three-wheeled version of the Isetta built in the UK to take advantage of tax and licensing regulations
Scootacar	UK	1957–64	
Messerschmitt KR175	Germany	1953–55	
Messerschmitt KR200	Germany	1955–64	
Peel P50	Isle of Man	1963–64	Smallest production car ever built
HM Vehicles Free-way	United States	1979–82	
Campagna T-Rex	Canada	1996–present	
Malone Car Company F1000 Skunk SS TAZR	United Kingdom	1999–present	High-power internal combustion and pure electric versions released November 2010
Cree SAM	Switzerland	2001	Electric, only 80 produced
Myers Motors NmG ("No more Gas")	United States	2006–present	Single-occupant all-electric plug-in
BRP Can-Am Spyder Roadster	Canada	2007–present	The Can-Am Spyder is a three-wheeled motorcycle manufactured by Bombardier Recreational Products.
Can-Am Spyder Roadster			
Brudeli 645L	Norway	2008–	
Moonbeam	United States	2008–present	100 mpg DIY, fabric-covered car based on parts from two Honda 150cc motorscooters ^[30]
Triac	United States	2009–2011	Electric, never entered production
XR-3 Hybrid	United States	Plans–2008, Kit–2009	Front 3-cylinder diesel (125 mpg), rear electric 40 mile range (220 mpg when used as a hybrid) ^[31]

Aptera (solar electric vehicle)	United States	2022 planned	Solar-powered Electric
Triton Trike	United States	2000–present	Gas-powered, 42+ mpg, front-wheel drive, custom builds and kits available
Nobe GT100	Estonia & United States	2021 planned	Electric, powered at all 3 wheels
Polaris Slingshot	United States	2015–present	
Vanderhall Laguna Roadster	United States	2016–2018	Exotic Auto-cycle, mono-aluminum chassis, carbon fiber body, 200 HP, 1550 pounds dry weight, side-by-side seating, fwd. 1.4 liter turbo GM power plant. 6 speed Automatic with paddle shift option. Manufactured by Vanderhall Motor Works in Provo, Utah U.S.A
Vanderhall Venice	United States	2017–present	The mainstay of the Vanderhall line up, the Venice brings the soul of roadster motoring while extending effortless performance in kind. ^[32]
Vanderhall Carmel	United States	2020–present	The Vanderhall Carmel brings more luxury and convenience to the Carmel lineup. With provisions to accommodate a removable capshade, the Carmel promises additional class and comfort for your journey. ^[33]
Vanderhall Edison	United States	2020–present	The Edison2: A fully electric roadster that combines refined and eye-catching design while maintaining classic, elegant lines. Unplug and play has been redefined ^[34]
Elio Motors	Shreveport, LA, United States	Awaiting funding	Two passenger fully enclosed cockpit with car controls
Girfalco Azkarra	Canada	2017	All-electric two-passenger three-wheeled vehicle, possibly the quickest three-wheeler
Go3Wheeler	United States	2014	single person three wheeler
Corbin Sparrow			
Piaggio MP3			
Tri-Magnum	United States		Tilting 3-wheeler capable of seating two people. ^[35]
Volkswagen GX3			
Morgan 3-Wheeler	England	2012–present	The power train is a 1983cc ‘V-twin’ fuel injected engine mated to a Mazda 5 speed (and reverse) gearbox
Fuel Vapours Alé	Canada	2005–present	Prototype. Gets 92 mpg.

Arcimoto FUV	United States	2019–present	Two passenger all-electric, 102 mile range City
Fiberfab Scarab STM	United States	1976	Kit car with canopy door manufactured by Fiberfab
Bricklin 3EV	United States	Planned	Two passenger electric vehicle from Malcolm Bricklin. ^[36]

Two rear wheels

[edit]

Name	Country	Years manufactured	Comments
Apino	Brazil	unknown	Mini Truck
Benz Patent Motorwagen	Germany	1886–93	
Eco-Fueller	USA	2009–2011	2 seater built in Oregon. ^[37]
La Va Bon Train	France	1904–10	50–100 believed built
Davis D-2 Divan	United States	1947–48	about 13–17 built, including the 494, a Jeep-like military vehicle ^[38]
Scammell Scarab	England	1948–67	
Autoette	United States	1948–70	
Daihatsu Bee	Japan	1951–1952	
Daihatsu Midget	Japan	1957–72	
Mazda T-2000	Japan	1957–74	
Mazda K360	Japan	1959–69	
Mazda T600	Japan	1959–71	
Kia K-360	South Korea	1962–1973	Kia's first truck (OEM Mazda K-360)
Kia T-1500	South Korea	1963–?	1484 cc, 60 hp, four cylinder and a maximum load of 1.5 tons. (OEM Mazda T-1500)
Kia T-600	South Korea	1969–1974	577cc, 20 HP and 500 kg load. Top speed of 75 km/h. 7726 produced (OEM Mazda T-600)
Kia T-2000	South Korea	1967–1981	1985 cc, 81 hp, four cylinder and a maximum load of 2 tons. 15952 produced (OEM Mazda T-2000)
Piaggio Ape	Italy	1948–present	

Electra-King	United States	1964?–1980s?	Two-seater electric car ^[39]
Bond 875	England	1965–70	
Bond Bug	England	1970–74	
Reliant Robin	England	1973–81, 1989–2002	
Reliant Regal	England	1953–1973	An example of this vehicle is the iconic van belonging to Del Boy and Rodney Trotter in the long-running BBC sitcom <i>Only Fools and Horses</i> , though it is often incorrectly referred to as a Reliant Robin.
GM Lean Machine ^{[40][41]}	United States	1980s	Tilt, concept car ^[42]
TriVette	United States	1974–1976	
Twike	Germany	1995–present	Electric-human-power hybrid, developed in Switzerland
ZAP Xebra	United States	2006–2009	electric power
eTuk	United States	2014–	re-designed tuk tuk for the US Market, including an all-electric motor ^[43]
Snyder ST600-c	United States	2011–2012	Imported by Snyder Technologies / Wildfire Motors, this is a rebrand of the Fulu Motors 金驹, Fulu Jinjunma in English. Referred to as the 09 golden horse internally.
Carver	Netherlands	2007–2009	Tilt
CityEl	Denmark		Mini-El, City-El
CLEVER			
Harley-Davidson Servi-Car	United States	1932-1973 ^[44]	
Harley-Davidson Tri Glide	United States	since 2009	

See also

[edit]

- Four-wheeler

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