

AUTOMATION
THE CAR COMPANY TYCOON GAME

Engine Designer



A Beginner's Guide
to Solid Engine Design

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1 Introduction

As there are many new people coming to Automation with little or no technical background, a tutorial on how to design proper engines in the game can help getting started. This document is meant to be a **Manual** as well as a **Learning-by-Doing Tutorial**. So always have the game open while reading the texts and follow the rough guidance given by the hints and tutorials to learn effectively. Use the **provided pre-built engines** ([download here](#)) to practise what you read in the respective chapters.

If you want to be good at the game, you have know how to focus on various specifications. Therefore, you have to **familiarize yourself with the game mechanics**, you have to try stuff out, learn the dependencies and, of course, make mistakes to find out where the limits are. There are some good in-game **tutorial videos** which explain the basic functionalities of the engine parts. In addition to that, this tutorial is focussing on showing interconnections between these parts. In order to understand and ingrain these dependencies into your brain, **practise is unavoidable**. This will allow you to make solid decisions quickly, for instance in Multiplayer and real- time Grand Campaign gameplay. It's not as tedious as it sounds and will reward you greatly in the long run.



If no mistake you have made, yet losing you are,
a different game you should play.

- Yoda -

The most important **hints** will look like the one shown above, so that you can quickly browse through the pages and read deeper into stuff you think you did not know so far. For the technical topics there are good **in-game explanations** which will not be repeated here.

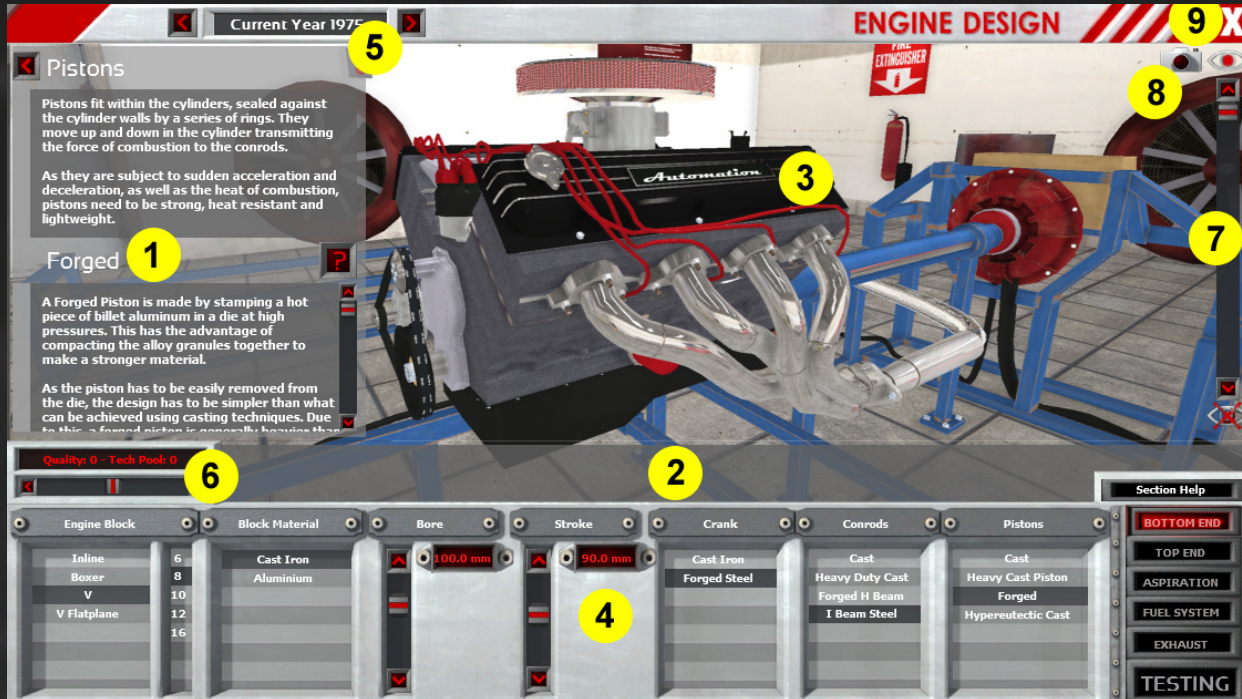
The basic structure of this Engine Design Guide looks like this: First there is a **brief overview of the Engine Designer features**. Just in case you missed something more or less important. After that, you can learn how to make a **properly running engine** in Sandbox Mode. No focus on power, economy, reliability, cost or whatsoever, just pointing out the **biggest difficulties** you can get yourself into, the way you can recognize them and possibilities to fix them. After finishing this part, you are ready for some **basic strategies for engine development** which might help you a lot if you have problems in the full game. This should give you the knowledge required to be successful in both the Grand Campaign and in Multiplayer. There is another big part of the game, especially in these early days of development of the game: **Scenarios!** These require a different approach, as some of the engine's stats are left out of the scoring. Thus you have to build very specialized, maybe weird engines which probably would not be sensible during campaign gameplay at all. How to be successful in scenarios and how the underlying mechanics work will be shown, too.

Any **feedback** on this tutorial/manual is very much appreciated! Have fun!

Der Bayer (Martin)

2 The Engine Designer

2.1 Basic Overview



1: Help Area

Here you find information about how stuff works. On the **top** there is the purpose and basic functionality, on the **bottom** the information for the specific part you have selected. The **button with the arrow to the left** lets you hide the help text to get a clearer view of the engine. You can display the help text again by clicking the button again (now it shows an arrow to the right). The **question mark** button directs you to the help video for the specific part the displayed help belongs to. By clicking the button **Section Help** in the lower right, you can access all of the videos for the specific Engine Designer Tab.

2: Hint & Stat Bar

On this bar, you get **viable information** about what the properties of the selected part (price, weight, man hours, general performance) are when you are designing an engine. This helps to estimate which part best suits your goals without having to test the whole engine for each different part. Compare the Pros and Cons and make your decision.

When you are in **Testing** mode, you get information about your engine's problems, and the two most critical problems are displayed. Your goal is to make it empty! In the Engine Designer **Scenarios**, your score is displayed here, too.

3: Engine view

4: Parts and Settings Tab

Here you can **choose parts and set sliders** to make an awesome engine. You can switch between different tabs by clicking the big buttons on the right. You have to select parts in the Bottom End Tab **from left to right** first and then **switch to the next tab below** where you again choose parts from left to right. You can always come back and change parts afterwards.

In the Testing Tab, your engine's **stats or animated gauges** will be displayed here.

5: Current Year

Here you can **set the year** your engine is built in. This will determine the available engine parts in the different tabs. In Scenarios, the manufacture year cannot be changed.

6: Quality & Tech Pool

This lets you **adjust the quality** of the **respective tab** it is displayed in. A click towards the right side means better quality, a click towards the left side makes it worse. In Scenarios, there might be Tech Pool Points available, which for example allow for cheap quality increases (see Chapter 2.7).

7: Visibility Slider

This lets you **strip down the engine** to its bones and take a closer look at all the parts of the engine. In Test mode, you can **watch them moving**.

8: Screenshot

This button takes a **screenshot of the current view** of the engine without all the menus and help texts. The screenshots are saved at the following location:

C:\Users\USERNAME\Documents\Automation\Photos

9: Exit

This button lets you **exit the Engine Designer** and takes you back to the Engine Manager.

2.2 Bottom End



1: Engine Block

The Engine Block determines the **general layout** of the engine. There are three major options with different numbers of cylinders: Inline, V and Boxer.

Engine Block	Inline	V	Boxer
Material Cost	low	average	high
Man Hours	low	high	high
Service Cost	low	average	high
Smoothness	low (3 and 4 cyl.)	rough (6 cyl.)	high
Weight	average	light	heavy
Size	long, narrow	compact	flat

Note: V and Boxer engines are only available in the pre-order/full version, not in the Demo. The Demo is limited to naturally aspirated Inline 4 engines.

The choice of the layout depends on your philosophy and the application of the engine. The **number of cylinders** scales on how much capacity your engine has. You set the capacity per cylinder with the Bore and Stroke sliders. Modern production engines mostly have **between 0.3 and 0.7 liters of capacity per cylinder**. If you stay in that area, you are probably fine. For special applications and in Scenarios, you will probably need to build extraordinary engines.

2: Block Material

The Block Material has the biggest influence on the final **weight of your engine**. There are four materials available from different years on. Your choice should depend on budget and on the car type the engine will be placed in. For economical cars and sportscars you will probably choose lighter materials.

Block Material	Cast Iron	Aluminium	AlSi	Magnesium
Tech Year		1970	1995	2012
Material Cost	low	average	high	very high
Man Hours	very low	average	low	very high
Weight	high	average	light	very light
Emissions	high	low	low	low



Try to avoid using different materials for the engine block and the head. Else you will get a MTBF penalty, especially in early game years.

Note: After the year 2020, there is no more MTBF penalty for mismatched parts. You can choose a Magnesium block without a penalty then.

3: Bore & Stroke

Bore and Stroke determine the capacity per cylinder.

- more Bore:**
 - Pros:** more power/torque, better economy
 - Cons:** expensive, bigger engine size, higher octane rating, lower smoothness, more prone to valve float, large weight increase
- more Stroke:**
 - Pros:** more power/torque
 - Cons:** more cost, lower smoothness, less MTBF if overdone, medium weight increase



In the game the engine size scales with bore only. Keep that in mind when designing engines for small engine bays.

4: Crank

The Crank is a shaft with crankpins onto which the conrods are fit. It is driven by the pistons via the conrods and translates the linear movement of the pistons into a rotational movement. At one end, it transfers the engine's power to the clutch and the gearbox. Depending on the engine size and purpose, it has to withstand a certain amount of **torque**. In the game, there are three different kinds of crankshafts which can endure different amounts of torque.

Crank	Cast Iron	Forged Steel	Billet Steel
Tech Year		1955	1985
Requirements	none	Forge Works	CNC Shop
Torque	low	average	high
Material Cost	high	average	low
Man Hours	low	average	high
Smoothness	low	average	high
Weight	high	average	low

5: Conrods

The Conrods connect the pistons with the crank. They have to withstand both **RPM** and **torque** strain. You can choose between 5 different kinds of conrods.

Conrods	Cast	Heavy Duty Cast	Forged H Beam	I Beam Steel	I Beam Titanium
Tech Year			1955	1965	1995
Requirements	none	none	Forge Works	Forge Works	CNC Shop
Torque	very low	high	high	average	very high
RPM	average	very low	average	high	very high
Material Cost	low	high	low	very low	extremely high
Man Hours	low	average	low	low	high
Weight	average	very high	low	low	very low

6: Pistons

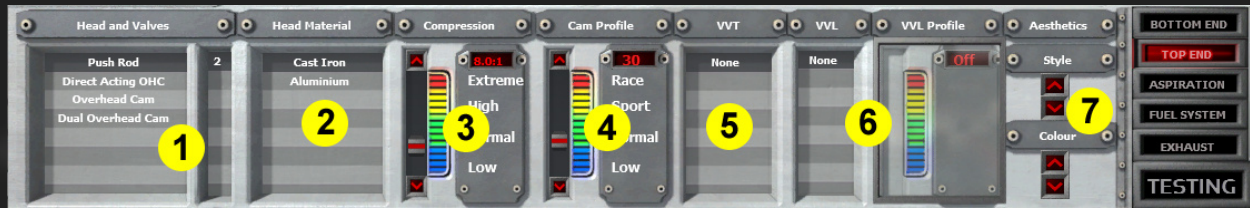
The Pistons are moving up and down in the cylinder and are one border of the combustion chamber. They must be able to withstand the pressure of the explosion shock waves (the force is proportional to the engine's **torque**) and the **friction** between the cylinder and the piston rings. The maximum speed a piston is running at is defined by the **RPM limit** and the **stroke**. As pistons have direct contact with the combustion chamber, they also **influence an engine's emissions**. You can select one out of six different piston types.

Pistons	Cast	Heavy Duty Cast	Forged	Hyper-eutectic Cast	Low Friction Cast	Lightweight Forged
Tech Year			1955	1970	1990	1990
Requirements	none	none	Forge Works	none	none	Forge Works
Torque	very low	high	very high	average	low	average
RPM	average	very low	high	average	low	very high
Material Cost	low	low	low	average	high	average
Man Hours	very low	low	average	average	high	very high
Economy	average	average	average	average	high	average
Emissions	average	average	high	very low	low	very high
Weight	average	very high	average	average	low	very low



Choose a sensible combination of crank, conrods and pistons. Take parts with similar Pros and Cons. The weakest part will fail first.

2.3 Top End



1: Head and Valves

The engine's Head Type determines, how efficient an engine can **breathe**. The more valves you choose, the more efficient the engine will be, that means more power and better economy. The **friction** of the valve train is another important factor for economy.

The **maximum RPM** of a head type shows, how prone to **valve float** it is. When valve float is occurring, the valves don't close when they should anymore. This introduces power losses and eventually lower MTBF (valves can even hit the piston for high compression engines). Few, heavy valves, a low cam profile and high RPM are the main causes for valve float.

The head type also is a major factor in the engine's total weight, cost and service cost.

Head Type	Push Rod	Direct Acting OHC	Overhead Cam	Dual Overhead Cam
Valve Count	2	2	2, 3, 4	2, 4, 5
Max. RPM	low	average	average	high
Friction	very high	low	average	very low
Material Cost	average	very low	low	high
Man Hours	very low	low	average	high
Weight	very low	low	average	high
Size	small	average	average	big
Service Cost	very low	low	high	average

Note: The head types Push Rod and DOHC 5 Valves can't be chosen in combination with VVL.

2: Head Material

The head material choice is similar to that of the **engine block**. There are only 3 different materials available though. Match the head material with the block material to avoid the resulting MTBF penalty.

Head Material	Cast Iron	Aluminium	AISi
Tech Year		1970	1995
Material Cost	low	average	high
Man Hours	very low	average	low
Weight	high	average	light
Emissions	high	low	low

Note: After the year 2020, there is no more MTBF penalty for mismatched parts. For example, you can choose a Magnesium block without a penalty then.

3: Compression Ratio

The compression ratio is the measure for how much the air in a cylinder is compressed when the piston moves from the bottom dead centre to the top dead centre. If the volume is only a tenth of what it was before, the compression ratio is 10.0:1.

A higher compression ratio results in **more power, better economy and better responsiveness**, but it will **raise emissions** and the **RON/AKI rating**. Balance the setting of this slider together with the sliders for Ignition Timing and Fuel Mixture to make the most of power and economy at a given fuel quality.

4: Cam Profile

The cam profile describes, how long, how wide and when the intake and outlet valves are opened. In the game, these three things are all combined and optimized in one single slider. The chosen cam profile sets the point in the rev range where the engine is the most efficient. That means when peak torque and best brake specific fuel consumption is reached. This slider allows you to **set the basic shape of the torque and - thus - power curve** with this slider.

The cam profile probably is **the most important choice** you make when designing an engine. It defines the characteristics of your engine. Low settings result in good efficiency at low (cruising) revs, but low top-end power. Higher settings result in worse efficiency at low RPM but high top-end power, so go for this when you want to design a performance engine.

- **Low Settings:** good economy, high low-end torque
- **High Settings:** more power (at higher RPM), lower RON/AKI rating

Your task usually is to set the slider such that the **peak power** is reached **a few hundred revs before the RPM limit**. In Engine Designer **Scenarios** this is different, because the engine MTBF gets worse at higher RPM. In this case, you set the RPM limit right at peak power (or sometimes even lower).

5: VVT (Variable Valve Timing)

VVT can alter the “when the intake and outlet valves are opened” part of the cam profile by turning the camshaft by a specific angle according to the current RPM the engine is running at. This means that VVT to some degree (pun intended) can **optimise the cam profile** over the whole RPM range, which results in slightly better economy and slightly higher power and torque especially at low RPM (for which the basic cam profile is not optimised). The more aggressive the cam profile is, the more the effects can be seen at low RPM. While this system is relatively simple, it comes at a cost and adds weight. The timing optimisation over the rev range also results in **lower emissions**.

If you are using DOHC (two camshafts), you can choose if you want to install the system on the intake side, the exhaust side, or on both camshafts. The introduction year of VVT in the game is 1992.

6: VVL (Variable Valve Lift)

VVL basically **adds a second cam profile** to the camshaft which is optimised for a different RPM range than the first one. This lets you design an engine which is both efficient at low RPM and can make much power at high RPM. The game **automatically switches** to the cam profile which allows for more power at current RPM. The system weighs a lot and is expensive, but potentially very powerful.

VVL cannot be chosen for the head types Push Rod and DOHC 5 valves. The introduction year of VVL in the game is 1992.

7: Aesthetics

You can choose different rocker covers for your engines. These are just **eye candy**, they have **no effect** on weight, size, cost or any other of the stats. Choose whatever you like. Maybe you can try to match the looks with the era the engine is built in or colour you eco-boxes in green etc.

2.4 Aspiration

Note: Forced Induction is only available in the pre-order/full version, not in the Demo.

This chapter is not 100% complete because at the moment only natural aspiration and turbochargers can be chosen. Special techniques are required to set up a turbo properly, but a detailed explanation on that will be added as soon as more aspiration options (superchargers) are available, so that the differences can be worked out properly.

Naturally Aspirated:

A naturally aspirated engine sucks in air through the opened intake valves by the vacuum which builds up when the piston is moving down. There are no further options to optimise this process.

Turbocharger:



1: Type

The aspiration type defines how air from outside the engine is brought into it. This can happen **naturally** or **enforced** by a special device. Forced induction pushes **more air** into the cylinder which then can be mixed with **more fuel**, thus making **more power**. Turbochargers unlock in 1975.

2: Setup

The Setup lets you choose the **number of turbochargers**. You can go for one big turbo or more, smaller ones (depending on the engine configuration).

3: Options

Choose between ball bearings and journal bearings. Ball bearings have **less friction** and allow for better efficiency and power, but are more expensive. They unlock in 1980.

4: Intercooler

When air is compressed, it becomes hot. When you cool it down, you can feed **more air** into the cylinder and make more power. The size of the intercooler determines how much air can be cooled down efficiently. So if you want to run **high boost pressure**, or need to feed a **big engine**, you should choose a big intercooler. Big intercoolers are heavy and expensive. Water-air intercoolers are more efficient than air-air intercoolers, but more expensive and heavier.

5: Presets

Presets let you choose pre-built turbos for three **different applications**. For those they are running reasonably well and are a good choice if you either don't want to fiddle around with four additional sliders or want a **good starting point** for a custom turbo. With the economy preset you can choose a quite small intercooler. Performance and race turbos need bigger intercoolers. Keep an eye on the boost preview graph and the advanced test mode to judge if you have chosen the right settings.

6: Compressor

The compressor is driven by the turbo's shaft and compresses intake air. Choosing a bigger compressor is better when you want to run on **high boost**. The turbo will **spool later** the bigger the compressor is.

7: Turbine

The turbine is driven by the exhaust gases and drives the turbo's shaft, providing the compressor with the needed power. The bigger the turbine is, the **more boost** can be built up. The turbo will **spool later** the bigger the turbine is.

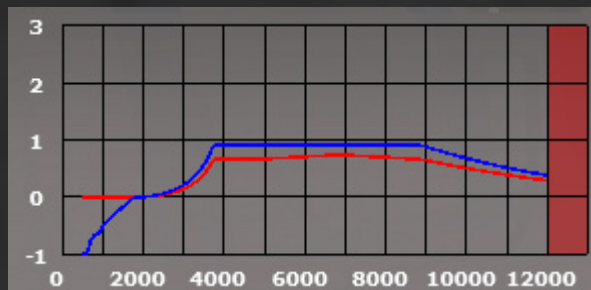
8: AR Ratio

The AR ratio is a measure for the turbo's profile through which the exhaust gases are running. If it is too small, **backpressure builds up** and the efficiency gets worse. If it is too big, the turbo **spools too late** or not at all.

9: Max Boost

The maximum boost sets the boost level at which the wastegate opens. Boost **cannot get higher** than this value. The higher the maximum boost built up by the turbo, the **more power** you make and the higher the **effective compression** and therefore the RON/AKI rating will be.

Boost Preview Graph



The Boost Preview Graph shows the **performance** of your current setup **over the whole RPM range**. The blue line indicates how much pressure the setup **theoretically** can make under full throttle. The red line shows how much boost the engine **actually** receives. If the two lines are very far apart, your setup is not efficient. The best solution to this is to use a bigger and/or different type of **intercooler**.

2.5 Fuel System



1&2: Fuel System & Config

Here the Fuel System of the engine is chosen. There are two major groups, carburettors and injection systems. The latter perform better in general but are more expensive and heavier.

- Carburettors

Carburettor	Single Barrel	2 Barrel	4 Barrel	DCOE
Tech Year		1948	1955	1965
Max. Power	very low	low	average	high
Fuel Efficiency	very low	low	average	low
Responsiven.	very low	very low	very low	low
Emissions	very high	very high	high	high
RON/AKI	very high	high	average	high
Material Cost	very low	very low	low	average
Man Hours	very low	very low	very low	very low
Service Cost	low	low	low	low
Weight	very low	low	average	very low

An increased number of carburettors will allow for more power, a lower RON rating and better economy and responsiveness. The drawbacks are more weight, man hours, material cost and service cost and lower MTBF. An increased number of barrels per carburettor has similar effects except for higher MTBF because they are a more advanced technology.

- Injection

Injection	Mech. Injection	Single Point EFI	Multi Point EFI	Direct Injection
Tech Year	1968	1988	1992	2003
Max. Power	very high	very high	very high	extremely high
Fuel Efficiency	average	high	very high	extremely high
Responsiven.	high	average	very high	extremely high
Emissions	average	high	very high	extremely high
RON/AKI	very high	high	average	extremely low
Material Cost	extremely high	low	high	very high
Man Hours	high	low	average	very high
Service Cost	high	low	average	very high
Weight	very high	average	high	very high

An increased number of throttle bodies will allow for more power (at high RPM), better responsiveness and a lower RON rating at a higher material cost, more man hours and more weight (except throttle per cylinder configurations, which are lighter).

3: Intake

The intake is another factor on how well an engine will **breathe**. Ideally you would want a very short intake without an air filter, but this would significantly increase the **intake noise**, raise the **service costs** and **reduce MTBF**.

Intake	Standard	Performance	Race
Air Flow	low	high	extremely high
Loudness	low	average	high
MTBF	no effect	no effect	reduced
Material Cost	low	low	high
Man Hours	high	high	low
Service Cost	low	average	extremely high
Weight	high	average	low

4: Fuel Type

The fuel type defines **fuel quality**, which determines at which RON/AKI rating your engine will begin to **knock**. Basically, you select on which lowest fuel quality the engine will run. You can sell cars with your engine on all markets which provide at least the fuel quality you designed the engine for.

Fuel Type	Regular Leaded	Super Leaded	Low Quality Unleaded	Regular Unleaded	Premium Unleaded	Super Unleaded	Ultimate Unleaded
Year of Introduction			1960	1970	1985	1990	1995
RON (AKI)	92 (87.4)	98 (93.1)	80 (76.0)	91 (86.4)	95 (90.3)	98 (93.1)	100 (95.0)
Catalytic Converter	no	no	yes	yes	yes	yes	yes

Note: Leaded fuel cannot be chosen in combination with Catalytic Converters because it would damage them.

5: Fuel Mixture

Fuel mixture is the ratio between how much more air is fed into the engine for a given amount of fuel. The stoichiometric mixture of air to fuel is 14.7:1. With the slider you set the richest mixture the engine runs. A **richer fuel mixture** allows for **more power, better responsiveness** and a **lower RON/AKI rating**. **Economy and Emissions** will **get worse**. If you run an engine **too rich**, you will **lose power**. The maximum fuel mixture (without sacrificing power) for each fuel system in a naturally aspirated engine is shown in the table below. With forced induction, you can run richer fuel mixtures (around limit for naturally aspirated engine minus maximum boost in bar).

Fuel Mixture	Single Barrel	2 Barrel	4 Barrel	DCOE
Max. Mixture	13.6:1	13.4:1	13.1:1	13.4:1
	Mech. Injection	Single Point EFI	Multi Point EFI	Direct Injection
Max. Mixture	12.6:1	12.9:1	12.4:1	11.9:1

6: Ignition Timing

Ignition Timing describes the time at which the air-fuel mixture is ignited relative to the piston being at its upper dead-center position. Early times are called advanced, while later timings are called retarded. **Advanced timing is good for power output, responsiveness and economy**, but it will **raise the RON/AKI** rating. Balance the setting of this slider with the sliders for compression ratio and fuel mixture to make the most of power and economy at a given fuel quality.

7: RPM limit

The RPM limit defines how high the engine can rev. Basically, an engine makes **more power at higher RPM** (up to a point defined by the cam profile). **MTBF will be reduced** the higher the engine can rev though. The bottom end parts and the valves must be able to cope with the RPM, else MTBF will be reduced very much or the engine will even break down.

2.6 Exhaust



1: Headers

The exhaust headers are a main factor when it comes to designing powerful engines, but they are important for basic engines as well. Every exhaust manifold type has its own **resonance curve at different RPM** depending on engine configuration, which gives a small **boost on efficiency** in that area. Basically, the more expensive manifolds have their resonances at higher RPM. There are huge differences in **maximum power output** (air flow), material cost, man hours, weight and loudness. You can choose between five different types.

Headers	Cast Log	Short Cast	Tubular	Long Tubular	Race Tubular
Manufacturing Restrictions	none	none	none	none	No Mass Production
Air Flow	very low	average	high	very high	extremely high
Weight	high	very high	low	very low	average
Material Cost	high	very high	low	very low	average
Man Hours	very low	low	average	high	extremely high
Loudness	low	low	average	high	high

2: Exhausters

The number of exhausters can be increased for some engine types, if you want to make a **quiet engine**. Two small pipes are not as loud as one big pipe. You must invest some money and will increase the weight of the engine though.

3: Muffler Bypass

This is a gimmick which lets the exhaust gasses **pass the muffler(s)** while at full throttle. The engine will be louder then but still quiet when cruising.

4: Exhaust Diameter

The Exhaust Diameter defines the **exhaust air flow**. Larger diameters allow the gasses to flow more freely, but too big diameters will cost some power because the resonance effect is lost. This effect makes the exhaust gasses move out of the cylinder more easily, reducing how much the piston has to “push” the exhaust gases. The diameter for **optimum power output** must have the best **resonance effect at the peak power RPM**. This usually happens at a diameter for which a slightly higher maximum power output than the engine’s power output is predicted in the hint area. If you optimise the exhaust for high RPM, **economy at low RPM will drop** a bit because the piston has to “push” more in that RPM range. Make sure not to use a much **too small diameter**, as you will **lose lots of power**.



Match the exhaust diameter with the engine's peak power and then enlarge it by 1-2 clicks for maximum power output.

5: Catalytic Converter

A catalytic converter is the most important to **reduce emissions**. It will reduce air flow a bit and raise material cost, man hours and weight. The engine becomes more quiet, too.

Catalytic Converter	None	Two-Way	Three-Way	High-Flow Three-Way
Emissions	extremely high	average	very low	very low
Air Flow	extremely high	average	high	very high
Weight	very low	average	high	average
Material Cost	extremely low	average	high	very high
Man Hours	very low	low	low	very high
Loudness	high	low	low	low

Note: Catalytic converters can only be chosen if the engine is running on unleaded fuel.

6: Mufflers

The purpose of Mufflers is to **reduce** the engine's **loudness**. This comes with the drawbacks of more weight, material cost and reduced air flow. You can add up to two mufflers per exhaust pipe and can choose between 3 types.

Muffler	None	Baffled	Reverse Flow	Straight Through
Air Flow	extremely high	low	average	high
Weight	extremely low	low	very high	high
Material Cost	extremely low	low	very high	average
Loudness	extremely high	average	very low	high

2.7 Quality and Tech Pool

By setting the quality slider to positive values, you get **better quality parts** in the specific tab in the Engine Designer **for increased cost**. Setting it to negative values changes things the other way around. Internally, raising quality by 1 means raising technology year by 2. So the quality slider basically allows for choosing if you want to build premium or cheap products.

In the full game you will be doing **research** towards the different tabs in the engine designer, like Top End or Fuel System. This research works on a relative basis to the current year and states how far you are ahead of what is considered common knowledge. How far advanced you are is measured by your **Tech Pool**. If it is the year 2000 and your tech allows unlocking parts that will be common knowledge in 2010, then your "Pool" for that tab is 10 points. You will get a penalty (for example on MTBF) for that part by unlocking it early.

What you do with these points is up to you:

- Build future tech
- Build higher grade items at no big price increase
- Build normal grade items cheaper

Using "future parts" is not as easy though: While the technology probably will give you a **performance edge** over your competition, **reliability (MTBF) will suffer** if the tech is new to everyone including you. If you want to build tech from 5 years in the future with the reliability it has got in 5 years, you have to spend 5 points on unlocking the tech and 10 points on quality to make it as reliable as it would be in 5 years time.

In Single Player Engine Scenarios, the Tech Pool feature is already implemented. There are some scenarios, where you can make excellent use of "future" tech.

Quality Slider effects

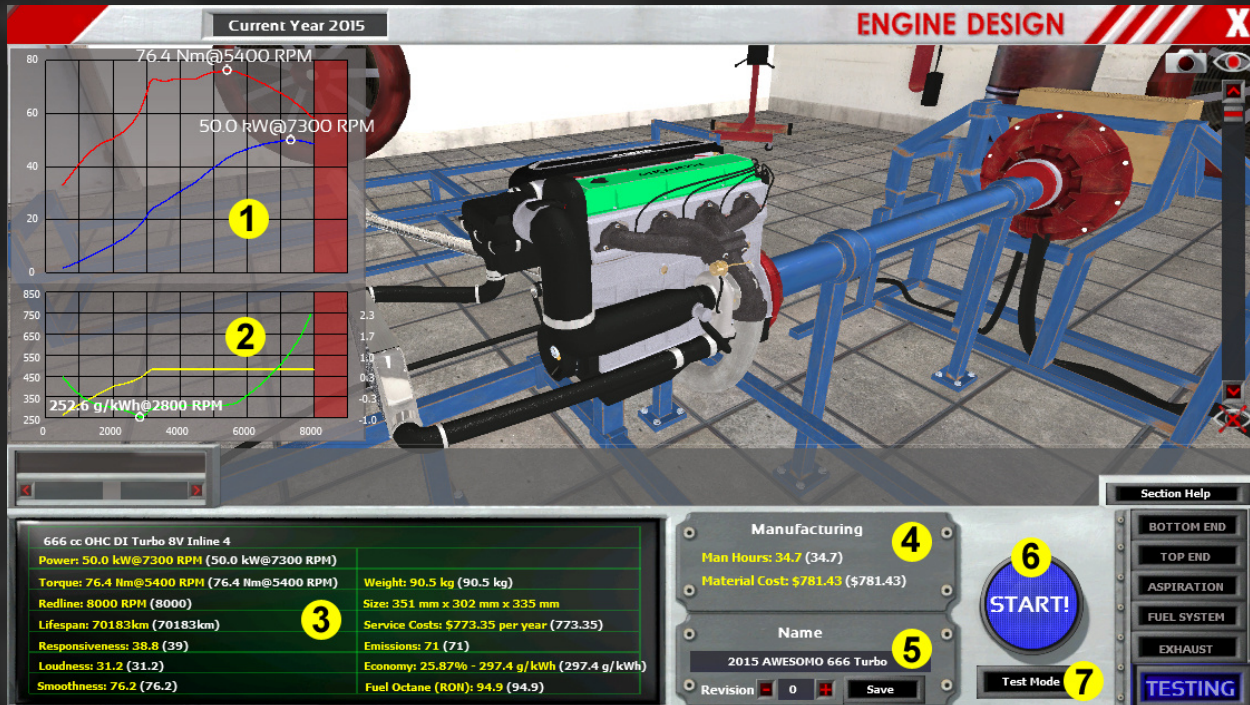
In the following, the various effects for quality on different Engine Designer tabs are shown. Negative quality has the respective opposite effects. Probably most important is Fuel System quality.

- **Bottom End Tab:** higher Bottom End rev-ability, higher MTBF, higher Smoothness, less Weight (thus less Material Cost), less Emissions (depending on chosen parts), more Man Hours (thus higher Total Cost)
- **Top End Tab:** higher Top End rev-ability (prone to Valve Float, thus possibly more power at high RPM), higher air flow (thus more Power and Torque), higher MTBF, less Weight (thus less Material cost), less Emissions (depending on chosen parts), better Economy, lower RON rating, more Man Hours (thus higher Total Cost)
- **Aspiration Tab (affects only Forced Induction):** more Power and Torque, higher MTBF, less Weight, better Economy, lower RON-rating, higher Material Cost, more Man Hours
- **Fuel System Tab:** higher MTBF (huge effect especially for carburettors), less Weight, less Service Costs, less Emissions, better Economy, lower RON rating, higher Material Cost, more Man Hours
- **Exhaust Tab:** better air flow (more Power and Torque at smaller diameters possible, thus slightly worse Economy possible if power does not match air flow anymore), higher MTBF, lower Loudness, less Weight, less Material cost, more Man Hours (thus higher Total Cost)

2.8 Testing

2.8.1 Basic Test Mode

The Basic Test Mode gives you all **engine stats**. You have to perform a test run first to be able to see the data. When you change something, you have to do another test to get the updated results.



1: Power and Torque Graph

Power (blue graph) and torque (red graph) are displayed for the whole rev range. The respective highest values are marked with a small white circle and the power and torque values are displayed next to it.

2: Economy and Boost graph

The green line represents the engine's economy/BSFC (brake specific fuel consumption, inverse efficiency) at full throttle (y-axis is on the left). This helps you to decide **cruising RPMs** for the gearbox once you put it into a car in the Car Designer. The economy stat is calculated from the data in this graph: It's the **average value** between 1500 and 2500 RPM, because that is probably the range where cruising RPMs will be chosen. The yellow line is the boost (forced induction only, y-axis is on the right).

3: Engine Stats

This is what you need to know about your engine to judge how it performs. These values will have an effect on the stats of the car the engine is placed in.

4: Manufacturing Info

Here you can see how much the engine will cost both in money for the material and in workforce/manufacturing capacity of your factory.

5: Save Engine

Here you can alter the auto-generated name of the engine. Click into the box and type in another name (**there is no flashing cursor yet**). You can assign a revision number to your engine if you want to design different versions of one base engine and still save it with the same name.

A click on save will save the engine with the set name at this location:

C:\Users\USERNAME\Documents\Automation\Engines

You can share engine files (.lua-files) with your friends easily, just move the engine files into this folder.

6: Start/Skip Automatic Test Run

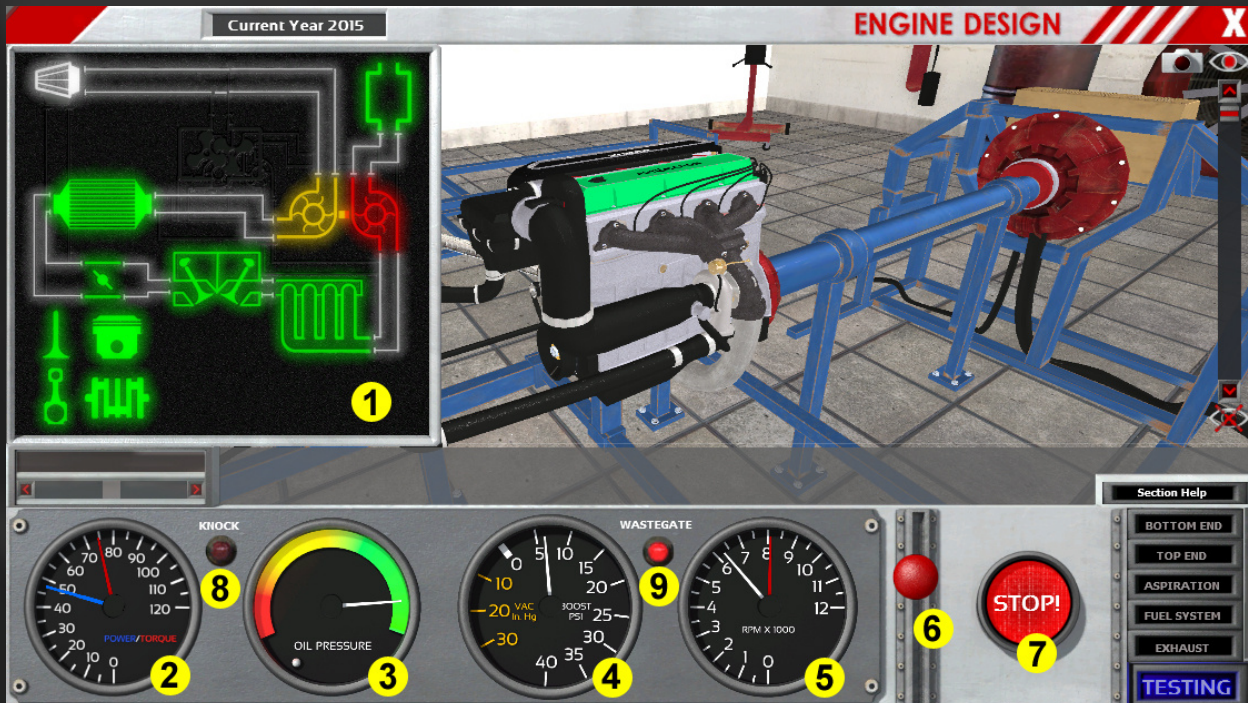
Here you can start the automatic test run which will test the engine up to the set RPM limit and give you the engine stats. You can **skip the test** by clicking the button again if you don't want to wait.

7: Test Mode Button

This lets you switch between Basic and Advanced Test Mode.

2.8.2 Advanced Test Mode

The advanced test mode lets you control the engine manually. You can check if the engine is having any issues and **identify which part causes problems**. In the flow chart, the respective part will change its colour from green to yellow or red, depending on how big is the problem. If the colour gets consistently worse the higher the RPM go, you are facing a RPM (or boost, forced induction only) problem, if it does not, it is probably a problem caused by too much torque (if happening near peak torque) or too low air flow (if happening near peak power). The gauges at the bottom of the screen show some important stats of the engine.



1: Flow Chart

This shows, how well the air flows through the engine. It can help to diagnose problems with the engine. On the bottom left, you can also see if parts are struggling with torque or RPM.

2: Power & Torque Gauge

Power (blue needle) and torque (red needle) are displayed.

3: Oil Pressure Gauge

Here you can see the oil pressure. If the engine is near to exploding, the needle will start to shake.

4: Boost Pressure Gauge

Boost pressure is displayed here. For naturally aspirated engines (or if boost has not yet been built up), the needle will be in the yellow area. When there is boost, the needle will be in the white area.

5: RPM Gauge

Here you can see the current RPM (white needle) and the engine's redline (stationary red needle).

6: Throttle/RPM Lever

Control the engine with clicking and dragging this lever.

7: Start/Stop Button

Start and stop the engine here.

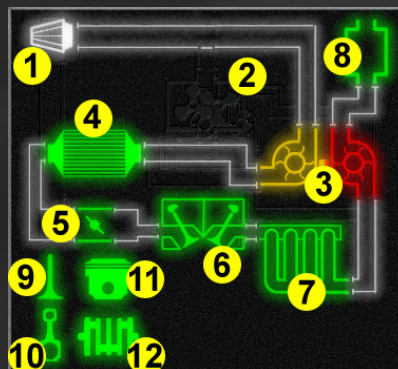
8: Knock Light

This lights up when the engine is knocking

9: Wastegate Light

This lights up when maximum boost pressure is reached and the wastegate opens. So this is not an indicator for something being wrong with the engine!

Flow Chart



Air Flow:

(1) Air intake, (2) Supercharger (greyed out here, not used on this engine), (3) Turbocharger (left: compressor, right: turbine), (4) Intercooler (forced induction only), (5) Throttle, (6) Head and Valves, (7) Exhaust Headers, (8) Exhaust Diameter & Mufflers

RPM and Torque:

(9) Valves (shows valve float), (10) Conrods, (11) Pistons, (12) Crank

2.8.3 Engine Stats

In the stats area there are 15 stats displayed which have an influence on the performance of the car the engine is placed in. However, not only the numeric values are important. The trend of Power/Torque and Economy for instance are important for the calculation of how easy the car is to drive, how fast it accelerates and what the actual mileage of the car is. This also depends on choices you make in the Car Designer.

- **Power:** maximum power of the engine (at RPM)
- **Torque:** maximum torque of the engine (at RPM)
- **Redline:** maximum RPM of the engine (this might drop if the engine fails)
- **MTBF:** mean time between failures (a measure of reliability)
- **Responsiveness:** engine response when throttle is hit (generic value)
- **Loudness:** how loud the engine is (generic value)
- **Smoothness:** how smooth the engine runs (vibrations, generic value)
- **Weight:** total weight of the engine
- **Size:** size of the engine without intake and exhaust piping (must fit in engine bay)
- **Service Cost:** annual maintenance cost of the engine
- **Emissions:** emission rating (generic value)
- **Economy:** efficiency (in percent), average brake specific fuel consumption between 1500 and 2500 RPM (in g/kWh, lbs/hph or similar)
- **Fuel Octane:** octane rating (this must be lower than the octane rating for the fuel type to prevent the engine from knocking)
- **Man Hours:** needed manufacturing capacity/workforce (cost per hour depends on the factory)
- **Material Cost:** cost of raw materials

Note: In scenarios, there will be no material cost shown, only the total cost of the engine. In these cases there is a set cost per man hour, which is summed up and automatically is added to the material costs.

3 Building Engines in Sandbox Mode

Constantly failing at building solid engines is the worst thing that can happen if you want to learn the mechanics of the Engine Designer. So this chapter will start with how you can diagnose what is wrong with your engine and how you can “cure” the problems. After you have a running engine, you will be able to see the small, but significant differences of the changes you make to the engine in a much clearer way. Also, you will notice instantaneously when new problems start to build up.



Always build an engine without any failures first before finetuning it for a specific application.

In order to show you the different problems you can have with engines, I prepared a pack of Inline 4 engines (.lua files) which show different problems ([download here](#)). Extract them to your Engine folder (C:\Users\USERNAME\Documents\Automation\Engines) and open them when you read through the respective text in Chapter 3.2. If you do this, you can learn how to diagnose the failure and how to fix it. Try combinations of the different suggested methods for fixing the problem.

3.1 Engine Diagnostics

There are two features in the game that will help you to diagnose problems of your engine.

The first one is in **Basic Test Mode** and shown in text form in the hint bar. After a test run, various messages can be displayed if there is something wrong with the engine. If there is a major problem, the engine will not start at all or you will be able to hear knocking or disintegration of the engine.

In **Advanced Test Mode**, you will get more precise feedback: Which part is the one which causes problems? What is limiting air flow? Use that information to track down errors.

3.2 Common Difficulties

In this Chapter, all of the possible major engine problems are covered. You can learn how to cure them by using the provided engine files. Consider the whole chapter 3.2 as important hints because you will need that very often until you develop a sense for what a combination of engine parts can do and you are able to build working engines in one try.

3.2.1 Knocking

Tutorial engine: Knock Knock
Targets: Power higher than 70 kW
MTBF higher than 60000 km
only use stated methods below

Knocking occurs when unburned air-fuel-mixture in the cylinder explodes prematurely because of exposure to too high pressure and too high temperature. This means that the air-fuel mixture is not burned at the optimum moment anymore. The explosion and the resulting shockwave cause a metallic pinging sound.

Diagnosis in Hint Area: *The engine is knocking and reducing its MTBF, try lowering the compression*

The engine failed due to knock, try lowering the compression.

Diagnosis in Advanced Test Mode: *The Knock-Lamp lights up.*

Symptoms:

- reduced or zero MTBF
- reduced or zero power/torque
- very bad economy

Quick Cure:

- reduced compression ratio
- more retarded/less advanced Ignition Timing
- more aggressive cam profile
- richer fuel fixture
- less boost (Forced Induction only)
- more advanced fuel systems
- better fuel system quality
- more carburettors (if using carburettors)

3.2.2 RPM

Tutorial engine: Rev to Death
Targets: Rev limit higher than 8500
MTBF higher than 50000 km
only use stated methods below

The bottom end parts can only withstand a certain maximum rotational/translational speed before they disintegrate. You have to make sure to use the parts in the non-critical RPM/relative speed range.

Diagnosis in Hint Area: *A bottom end part is reducing its MTBF, due to starting to reach its RPM limit.*

A bottom end part has failed due to the max RPM being too high.

Diagnosis in Advanced Test Mode: *Crank, Conrod or Piston changes colour from green to yellow/red.*

Symptoms: - reduced or zero MTBF

Quick Cure:

- reduce RPM limit
- less stroke
- more rev-resistant conrods/pistons (whatever fails)
- higher bottom end quality

3.2.3 Torque

Tutorial engine: Torque Trauma
Targets: MTBF higher than 40000 km
Torque higher than 220 Nm
only use stated methods below

Bottom end parts can only withstand a certain maximum torque before they disintegrate. The engine's torque is proportional to the force on the bottom end parts. You have to make sure to use the parts below critical torque/force numbers.

Diagnosis in Hint Area: *A bottom end part is reducing the MTBF, as it is starting to reach its torque limit.*

A bottom end part has failed due to too much torque.

Diagnosis in Advanced Test Mode: *Crank, conrod or piston changes colour from green to yellow/red.*

Symptoms: - reduced or zero MTBF

Quick Cure:

- less stroke/capacity
- more torque-resistant crank/conrods/pistons
- higher bottom end quality
- leaner fuel mixture, lower compression ratio and ignition timing

3.2.4 Valve Float

Tutorial engine: Floating Failure
Targets: Power higher than 85 kW
MTBF higher than 43000 km
only use stated methods below

Valve Float is an effect that occurs when the valves don't remain in contact with the camshaft and thus are not closing or opening the intake or exhaust ports of the cylinders as they are supposed to. This happens at high RPM, when the valve springs cannot cope with the then high kinetic energy of the (for the given RPM too heavy) valves. In extreme cases, valves remain open so long, that the piston can touch the valves when it is moving upwards, resulting in catastrophic damage. Stiffer springs can help to press the valves against the camshaft, but this results in higher friction, more workload for the engine to open the valves and thus lower efficiency. In Automation, the spring stiffness is bound to the cam profile setting.

Diagnosis in Hint Area: *Valve Float is occurring and reducing the engine's MTBF.*
The engine has failed due to valve float. Reduce the maximum RPM.

Diagnosis in Advanced Test Mode: *Valve changes colour from green to yellow/red.*

Symptoms:

- reduced or zero MTBF
- reduced power/torque at high RPM

Quick Cure:

- more valves per cylinder
- more rev-durable head type
- smaller bore/stroke-ratio
- lower RPM limit
- more aggressive cam profile
- more Top End Quality

3.2.5 Running too rich

Tutorial engine: Rich Racer
Targets: Power higher than 150 kW
only use stated methods below

If the fuel mixture is too rich (too much fuel and not enough air), the combustion process will not run as intended, or not at all because the mixture can hardly be burned. This results in less power or no power at all when the engine is unable to start. The highest possible fuel mixture varies from fuel system to fuel system. More modern fuel systems can handle more fuel because they can better mix fuel and air.

Diagnosis in Hint Area: *The engine is running rich and reducing the power output.*
The engine is running too rich and is unable to run.

Diagnosis in Advanced Test Mode: *Not possible.*

Symptoms:

- reduced power/torque
- zero MTBF if way too rich

Quick Cure:

- leaner fuel mixture (reduce compression ratio and ignition timing if needed)
- fuel system with higher possible maximum fuel mixture
- more boost (Forced Induction only)

3.2.6 Exhaust restrictions

*Tutorial engine: Exhaust Error
Targets: Power higher than 170 kW
Man Hours lower than 33.0
only use stated methods below*

If the exhaust diameter is too small or the exhaust manifold doesn't allow for enough air flow, power output can be limited because the exhaust gas cannot be extracted out of the engine properly.

Diagnosis in Hint Area: *Not possible.*

Diagnosis in Advanced Test Mode: *Exhaust manifold changes colour from green to yellow/red.
Muffler changes colour from green to yellow/red.*

Symptoms:

- reduced power/torque
- higher RON requirements/Knocking

Quick Cure:

- more expensive exhaust manifold
- bigger exhaust diameter

3.3 Strategies for Engine Development

3.3.1 Influencing Engine Stats

The following table gives a quick overview, which sliders and selections affect every engine stat. For further information check out the descriptions in chapter 2.

Power/Torque	Sliders	Selections	Weight	Sliders	Selections
	Bore & Stroke	Aspiration		Bore & Stroke	Materials
	Cam Profile	Head Type		Exhaust Diameter	Aspiration Options
	Fuel Mixture	Fuel System		Aspiration Sliders	Fuel System
	Compression Ratio	Intake		Quality	Intake
	Ignition Timing	Headers			Headers
	Exhaust Diameter	VVT			Catalytic Converter
	Quality				Mufflers
				Bottom End Parts	
Lifespan	Sliders	Selections	Size	Sliders	Selections
	Bore & Stroke	Bottom End Parts		Bore & Stroke	Head Type
	RPM Limit	Fuel System & Configuration		Aspiration Sliders	Fuel System & Configuration
	Quality	Materials			Intake
		Head Type			Headers
Responsiveness	Sliders	Selections			Aspiration Options
	Fuel Mixture	Aspiration Options	Service Costs	Sliders	Selections
	Ignition Timing	Fuel System & Configuration		Bore & Stroke	Intake
	Compression Ratio				Fuel System & Configuration
	Cam Profile				Aspiration
	Aspiration Sliders				Head Type
					Engine Configuration
Loudness	Sliders	Selections	Emissions	Sliders	Selections
	Exhaust Diameter	Mufflers		Fuel Mixture	Catalytic Converter
	Aspiration Sliders	Catalytic Converter		Compression Ratio	Fuel System & Configuration
	Quality	Intake		Cam Profile	Fuel System & Configuration
				Quality	Pistons
					Materials
Smoothness	Sliders	Selections	Economy	Sliders	Selections
	Bore & Stroke	Engine Configuration		Fuel Mixture	Fuel System & Configuration
	Quality	Bottom End Parts		Cam Profile	Fuel System & Configuration
				Compression Ratio	Aspiration Options
		Ignition Timing		Head Type	
		Bore & Stroke		Pistons	
		Aspiration Sliders			
		Quality			
				Exhaust Diameter	Pistons
			Bore & Stroke	VVT/VVL	
			Aspiration Sliders		
			Quality		
Material Cost	Sliders	Selections	Man Hours	Sliders	Selections
	Bore & Stroke	All Selections		Quality	All Selections
	Exhaust Diameter	Engine Configuration			Engine Configuration
	Aspiration Sliders				
	Quality				

3.3.2 Connections between Engine and Car Stats

This chapter will be added when the Car Designer is finished.

3.3.3 Performance Engines

General Hints

- Big capacity is always good for power. Don't make the engine too heavy, the car still has to handle well.
- Go for a high-revving engine to make use of more aggressive cam profiles. Decrease stroke and choose better bottom end parts if necessary.
- Use more fuel, a better fuel type and fully use the octane rating (ignition timing and compression ratio).
- More throttle bodies or carburetors will help to increase responsiveness.
- Keep an eye on the engine's air flow (intake, throttle, valves, exhaust manifold and diameter). To be sure all is going as it should, check the advanced test mode flow chart.
- Forced induction will boost power a lot, but totally changes the engine characteristics.

Tutorial engine:

Targets:

Power Pack

Power more than 250 kW

MTBF more than 70000 km

Material Cost less than \$1500

Man Hours less than 40

Responsiveness more than 50

Weight less than 180.0 kg

stick with Inline 4 and Current Year

3.3.4 Economy Engines

General Hints

- The most important choices for low fuel consumption are the fuel system (the more modern, the better), the cam profile (keep it in the area 20-40) and the fuel mixture (the lower, the better).
- The air flow is important here, too: Use many valves and quite big bore.
- Use low friction parts: Pistons and Head Type.
- Use more fuel, a better fuel type and fully use the octane rating (ignition timing and compression ratio).
- VVL helps a lot to keep economy at low revs and still make lots of top end power.
- Adjust the exhaust diameter to use exhaust resonances. Maybe even cut off some top end power for a little economy boost at low revs.
- Don't make the engine too big: As soon as you place the engine into a car, you will notice the bad effects of high weight and a too powerful engine at low revs, which has to suck against a pretty much closed throttle when cruising.

Tutorial engine: *Treehugger*
Targets: *Power more than 125 kW*
MTBF more than 80000 km
Material Cost less than \$1100
Man Hours less than 40
Economy less than 280 g/kWh
Weight less than 150 kg
stick with Inline 4 and Current Year

3.3.5 Low Cost Engines

General Hints

- To cut cost (sum of manufacturing cost and material cost), choose reasonably good and cheap parts and a small engine. The engine configuration is a huge factor, too. The lower the number of cylinders, the lower the total cost.
- Cut Quality where you can. Do this in those tabs in the Engine Designer, where you spend lots of money. Usually this is the case in the Bottom End and Fuel System tab.
- Use standard air intakes, low capacity and simple fuel systems and head types to cut service costs.
- Don't use too low quality parts if you want to compete with premium competitors. The engine still has to be good.

Tutorial engine: *Money Maker*
Targets: *Material Cost less than \$500*
Power more than 75 kW
MTBF more than 50000 km
Man Hours less than 18.0
Service Costs less than \$600
stick with Inline 4, Cam Profile 40 and Current Year

3.3.6 Miscellaneous

Lightweight

- Use light materials and small engines.
- A relatively long stroke compared to bore (“undersquare engine”) will make the engine lighter at a given capacity.
- Use light head types, exhaust headers, mufflers, and bottom end parts.
- Use a low number of carburetors or multi throttle bodies. Performance intakes are lighter than standard ones.
- Better quality reduces weight.

MTBF

- Make sure the engine is not facing any problems (especially torque, RPM and valve float)! They kill MTBF.
- Low quality is also bad.
- Use a low RPM limit.
- More modern fuel systems are more reliable.
- More carburetors = more parts that can fail.
- Don’t use different materials for engine block and head.
- The head type push rods is very reliable.
- Don’t use race intakes, they contain no filter and suck in dust.
- Forced induction: Too much boost might cause heat problems and reduce MTBF.

Compact Engines

- V engines are more cube-ish, Boxer engines are flat. Inline engines are long but narrow.
- Less bore equals smaller engine. In the game, the engines don’t scale with stroke!
- The choice of exhaust headers and head type can make a difference (bad: race headers, good: push rods).
- The fuel system, its configuration and the air intake are also an important factor. Here you have to try out, there is no solution that always works.
- Forced induction will need more space. But the intercooler and piping are not counted towards the engine size because that depends on the placement in the car.

4 Engine Designer Scenarios

4.1 How Scenarios Work

In Scenarios you are confronted with a story, where you have to meet certain criteria and get a score on your engine. The more you exceed the specifications, the more points you get. Every specification has a weight factor assigned to it, which determines the amount of score this stat can give you in comparison to the other specifications. As soon as you successfully completed a scenario (achieved at least bronze rank), your progress and the engine will be saved, so that you can optimise the engine and try to achieve a higher rank some other time.

There are several groups of scenarios which focus on different engine types and have been released along the way of development of the game. Check out the tutorials, these are similar to the tutorials in chapter 3 of this guide, but a bit more complex and rewarding (because of the score).

Scenario Groups

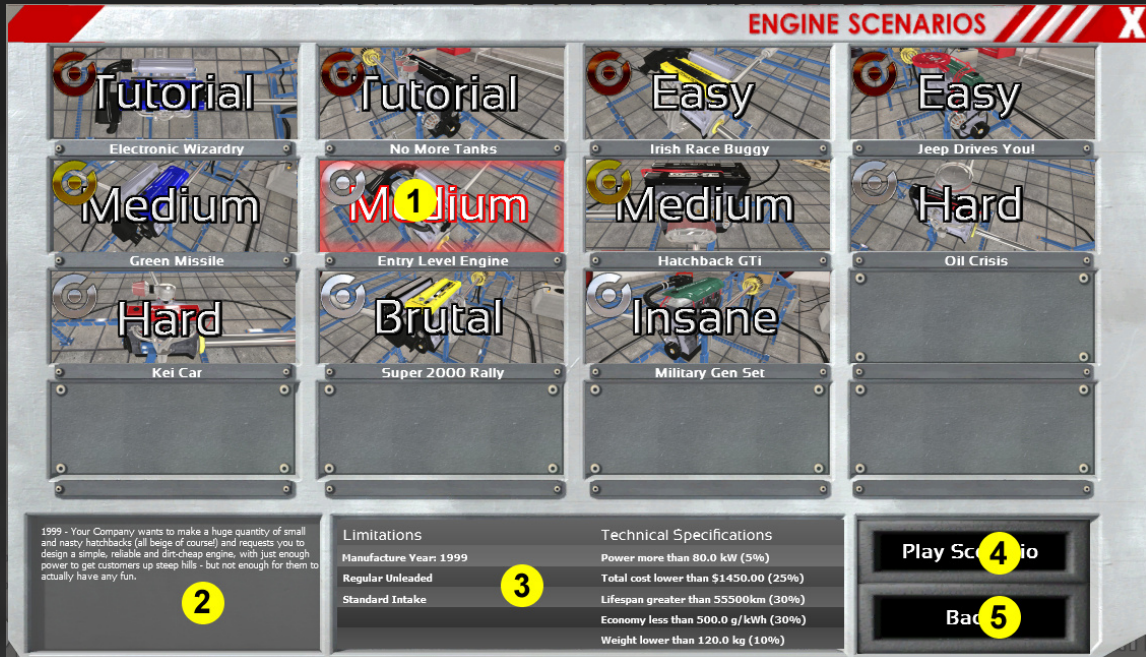


1: Here you can select a group of scenarios

- Tutorials
- Inline 4 Engines (naturally aspirated only)
- V8 Engines (flatplane and crossplane, naturally aspirated only)
- General (Inline 4, Inline 6, V8 and turbochargers)

2: Back to the Main Menu

Scenario Selection



1: Scenario Selection with Difficulty Rating (currently active is marked red)

2: Scenario Description for active Scenario

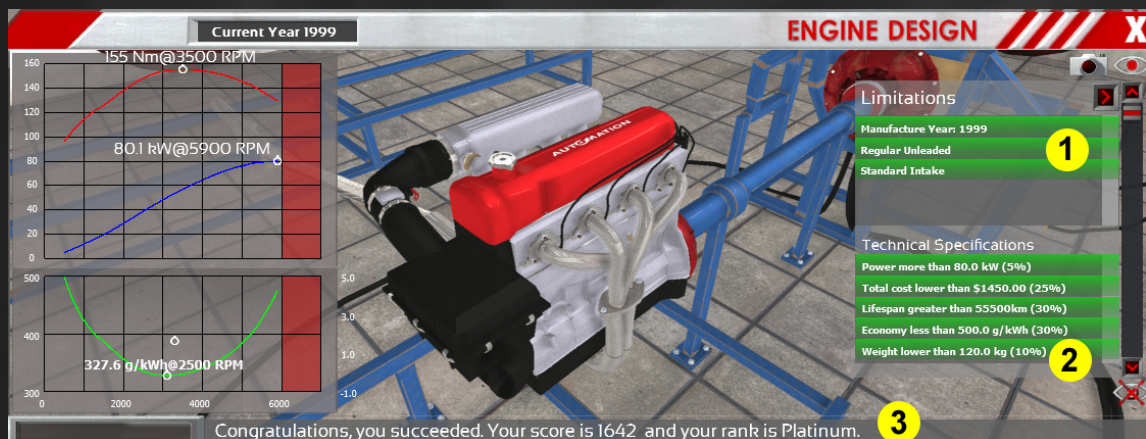
3: Limitations and Specifications for active Scenario

4: Play active Scenario

5: Back to Scenario Group Selection

Playing Scenarios

In the Engine Designer you have the limitations and specifications of the scenario displayed at the right. If you do not meet the limitations or the specifications, they will be marked red. If everything is okay and you succeed in the scenario, everything is green.



1: Scenario Limitations (just meet these)

2: Scenario Specifications (exceed these as far as possible for more points)

3: Your current score and rank (it's only there when you pass the scenario)

4.2 Scoring

Score Calculation

$$\text{Score} = 1000 + \sum \left[\left(\frac{|\text{stat}-\text{target}|}{\text{target}} + 1 \right)^2 \cdot \text{weight} \right]$$

As you can see, the important engine stats count quadratic towards the score: The more you exceed the target value of the specification, the more points you get (in a quadratic progression).

Difficulty & Ranks

Scenario Scores	Bronze	Silver	Gold	Platinum
Tutorial	1000	1500	1875	2125
Easy	1000	1384	1672	1864
Medium	1000	1276	1483	1621
Hard	1000	1176	1308	1396
Brutal	1000	1084	1147	1189
Insane	1000	1041	1072	1092

4.3 Strategies

Focusing on one or two stats

Due to the maths of the scoring system, focusing on one or two stats, probably those with the **highest weight**, is a good choice to make more points. As an example, let's look at the case of the **opposed targets** power (30%) and economy (10%). Here it could be a good choice to go for maximum power and to neglect economy (just meet the minimum requirement there). To identify opposed stats, take a look at the hints for the sliders and parts.

There are also stats which **go hand in hand** which one another, for example power and responsiveness when you run the engine on a richer fuel mixture. If you can make score with power, responsiveness and economy, give the engine as much fuel as it can take (still fulfilling economy requirement). So you **improve two stats and worsen only one**.

Small steps

Always make only small changes to your engine to see if you get closer to the targets. Don't change too many parts or manipulate too many sliders before testing the engine again. Especially when you have reached bronze already, you can improve the score **step by step** pretty easily with this strategy.

Spend the money

As long as you don't get too many points on total cost (around 20% or lower), it is a good idea to spend the budget on **good parts**. This usually will **improve most of the target stats**. So you get less points on one single stat (money) and more points on most of the other stats.

Quality & Tech Pool

Don't improve quality too much, as this is very **expensive**. Better go for reduced quality to save money. This is best done in the bottom end tab, the aspiration tab (when using forced induction) and for expensive fuel systems like direct injection or mechanical injection. It will cost some MTBF though, so don't do this when you get lots of points for that.

When you have **Tech Pool Points**, you most probably ought to use them, this does not cost a lot.

Capacity is all that matters (sometimes)

Especially when there is **no weight target**, an easy way to get more score with power is bigger capacity. This does not cost very much and is quite effective.

Engine configuration

When you take a look at the cost limit in most scenarios, you can **guess which engine type should fit** well to that scenario. Don't go for many cylinders when you only can make an engine with small capacity. Switch to a bigger engine type when you can't make enough capacity with the small ones or are facing unfixable torque, RPM and valve float problems. Other important stats are **smoothness and weight** when it comes to choosing an engine type.

Proper Use of VVL

You want to make score with power and economy at the same time and still can spend some money? Go for VVL and optimise the lower cam profile for economy and the higher cam profile for power.

The right RPM limit

In scenarios, the right RPM limit is not few hundreds of RPM higher than the RPM for maximum power. Better **set it a bit lower** to get more points on MTBF. Power curves are quite flat near the top so you don't lose a lot of power.

When you have no economy target or are using VVL, **move the maximum torque RPM close to the rev limiter RPM**. This will give you the highest power at a fixed RPM limit.

Aspiration

If you want to go the easy way on most of the scenarios, **leave forced induction out**. You then have far less sliders to optimise and lower total costs. As a consequence, you can spend the money on bigger capacity or better parts. For scenarios with high weight on power, forced induction might be the better choice if you want to reach platinum rank.

Stuck? Try something completely different!

If you find yourself totally stuck, think over your engine configuration: Do all the parts make sense? Are you focusing on the right stats? Even if you think you are right, try out something totally different. Not always the obvious choices are the best.

4.4 Scenario Walkthroughs

On the Automation wiki page there are [walkthroughs](#) which will guide you to bronze in every single scenario and give hints for further optimization for the engine. Note that these engines don't have to be the best and only solutions. Also, the tutorials might not always be up to date and done with the most recent game build, so minor deviations can be possible. Nevertheless, they should give you a clue on how to approach a scenario.

5 Multiplayer

5.1 Introduction to Quick-Fire Multiplayer

Engine Quick-Fire Multiplayer basically works like Singleplayer Engine Designer scenarios, just the limits and specifications you have to meet are **randomly generated**. Based on the specifications and the generated weights the built engines get a score and the player with the highest score wins. Players are ranked on a global leaderboard which makes it easy to judge your engine designing skills.

Game Lobby



1: Games Tab

See a list of all running games, create and join games.

2: Players Tab

See a list of all players waiting in the lobby and chat with them. You can also check out their stats there.

3: Rankings Tab

Here you can look at the top players and your rank in the global ladder.

4: Running Games List

Check out all of the currently running games and their settings. Note that you can only join, if the remaining time is 0. Refresh the page to update the list.

5: Refresh

Refresh the game list.

6: Create Game

Create a new game with your preferred settings.

7: Join Game

Join the selected game from the list.

8: Player Stats

Some interesting stats about your Multiplayer performance.

9: Global stats

Some interesting stats about running and past games.

Game Room



1: Player List

A list of all the players in your game with rank and power level. The colour indicates the players' rank and if they are ready for the game (green).

2: Game Settings

3: Generated Limitations and Specifications

These appear as soon as all players are ready and the countdown has started.

4: Chat window

5: Textbox for Chatting

6: Send Chat Message

7: Leave Game and go back to the Game Lobby

8: Ready for the game

5.2 Game Settings

There are several game settings which set the general difficulty of the random scenario and allow for quite different gameplay experiences:

Number of Stats & Limits

The number of Stats and Limits can be chosen independently. In general, the more limits and stats you choose the harder the game becomes. Having more hard limits is easier than having more scored stats because you just have to fulfill the limits and don't have to develop an engine which is really good in multiple aspects.

Game Time

This setting limits the time (in seconds) you have to build the engine and is the most important factor for difficulty. Long game times allow for many tries and much optimization, favoring players which are good at fine-tuning engines. For succeeding in short game times being good at judging how your engine will perform while designing it is very important, because it is basically impossible to try completely different approaches when the first one fails. In this case, players which are good at quickly building rather average but working solutions can have an advantage.

Countdown Time

Preparation time for the actual game is a minor factor for difficulty, but should not be underestimated for very short game times. Try to already have a plan in mind when the countdown ends.

Hardcore Modes

You like the challenge of being on the edge between success and total failure? Then these settings are made for you. There are two types of hardcore modes which can be combined: Limiting the number of test runs you are allowed to make, and blocking the Start button after destroying the engine. Note that with manual test mode you can stop an engine before breaking. You won't get the engines stats though, so don't use it when you are allowed to only have one try.

5.3 Power Level

Each player has a Power Level (PL), which represents his/her rank on the global leaderboard. Depending on how well you do in Multiplayer, you get points added and probably climb up the ladder. But not only winning games will give you points:

- **PL for Position:** You get points as soon as you complete the scenario (i.e. achieve more than 1000 points), but only if you don't finish on last position. The more players you leave behind you, the more PL you gain. This means that you can make the most points in games with many players.
- **PL Bonus for beating high ranked players:** Try to beat players with a high PL. For each player behind you which is ranked higher in the global leaderboard, you get bonus points (depending on how much more PL he/she has).
- **PL Bonus for crushing your opponents:** You get a PL Bonus if you achieve a much higher score in the current scenario than the player directly behind you. If you are not first, your score is still compared to the player behind you, but you can only get as much of a Bonus as the player in front of you. That means, if the player in front of you is pretty close and did not get a Bonus, you will not get one either.

If your overall Power Level exceeds 100 Points, getting more points starts to become more and more difficult. This makes sure that the differences between players doesn't get too big and that the Power Levels don't reach insane numbers, like 9000, easily.

5.4 Strategies

Multiplayer strategies are completely dependent on the game settings. But the most important thing in the beginning is that you know what every slider and setting does. Without that knowledge it can become very frustrating to lose again and again without even having built a working engine.

In **non-hardcore scenarios** it probably is a good strategy to rush through the tabs pretty quickly, only doing rough adjustments, and **running your first test very early**. So you can compare your engine to the stats and limits and get an idea on in which direction you have to develop your engine. So in the next iterations your adjustments will become smaller and smaller until you have a working engine. From that point on, it is just about quickly trying out different modifications to the engine and seeing if your score improves or not. Set priorities on one or two stats (probably those with high weight) and try to make a high score.

In **No Failure** modes it's all about **safety** in the first runs. Especially go for low compression, short stroke and a low RPM limit. After the first test run you can estimate better how much stress the engine can take and go for higher values in (reasonably small) steps again.

A **limited number of tries** makes it even harder. The less tries you have, the more you have to **think** about what settings you choose. This is basically all about experience, judgement, risk management and a bit of luck. If you have enough time, you can calculate cost, weight and man hours on your own before pressing the start button. **Double-check hard limits**, especially the fuel type, and be sure to not mix cast iron and aluminium block/head (MTBF penalty!).

6 Final Words

The Engine Designer is complex and this tutorial can only scratch the surface of the nearly endless possibilities. I hope this helped you to improve your engine designs and to find your own style of building engines. As I mentioned in the beginning, **experience** makes a huge difference, especially in Multiplayer.

One final thing: Please post your **constructive feedback** in the Automation forums. Let me know which explanations are missing or which parts are difficult to understand. It would be very much appreciated!

Der Bayer (Martin)

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