

# THE ART OF ACCELERATION: EXPLORING THE PAST, PRESENT AND FUTURE OF STAGE TUNING

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**Abstract.** *It is obvious that for a modern engineer in the automotive industry today it is important not only to have basic knowledge, it is necessary to constantly learn and develop as well. A modern driver strives to get the maximum power and performance from his car, not causing significant harm to nature and the environment in general, and therefore he must have a notion of how to do it in the right way. In this issue the engineers and the workers of tuning companies will help him, however, it is quite important for the car owner to understand at least the basis of what he wants from his car and how to achieve this and not to be deceived. The purpose of this article is to convey to the reader what is Stage Tuning and what is its essence, how to improve the car to get the best of it, while leaving it safe for nature and people.*

**Keywords:** *automobile, performance, stage tuning, improvement*

## **Introduction**

Each car owner aims to achieve maximum power and speed from it. However, the factory settings of the car do not allow the driver to achieve more results than those indicated in the vehicle passport. Nevertheless, there is the opportunity to improve the performance of the car using various engineering machinations. It is about stage tuning packages that can significantly improve the characteristics of your favorite car.

Every year the idea of car staging is becoming more and more popular, the automotive tuning industry is rapidly developing and engineers are finding more and more ways to improve the customer's cars. It is important to note that the so-called stage tuning package for one car cannot always be suitable for another. This is the art of stage tuning - to find the best way to improve a car's performance. In this article I'm going to introduce you to the art of car tuning and tell you more about its past, present and near future.

## **Tuning And Staging – A Quick Look at The History:**

To start with, to know more about stage tuning it is necessary to define these terms. Car tuning [1] is the modification of a car to optimize it for a different set of performance requirements from those that was originally designed to meet. Most commonly this is a higher engine performance and dynamic handling characteristics but cars may also be altered to provide better fuel economy or smoother response. The goal of tuning is the improvement of a vehicle's overall performance in response to the user's needs.

**Stage tuning** [2] describes how various upgrades and enhancements are made to the vehicle. Each stage depicts a different level of upgrades that are fitted as a set. For instance, stage 1 represents the most basic level of performance upgrades, while stage 3 represents the most tuning you can do to your engine.

Now we can move on to the history of Stage Tuning [3]. The history of stage tuning is closely tied to the evolution of the automotive industry, dating back to the earliest days of the automobile. Tuning has essentially been an intrinsic aspect of automobile ownership, driven by two motivations: to adapt the automobile to individual needs and to satisfy the aesthetic desires of the owner.

In the early automotive industry, its customization focused on the practical needs of owners, namely the modification of engines, suspension and transmission to improve performance. As the automotive industry developed, tuning became more influenced by aesthetic desires. The Hot Rod, which was created during the Prohibition Era, exemplifies this shift by combining a modified appearance of the cars with improved performance.

To avoid detection during prohibition, alcohol smugglers altered vehicles by improving their engines and maneuverability. These modifications, eventually, established a unique car customization style that combines savage and performance.

Prohibition-era hot rods had a significant impact on automotive customization, leading to a tuning culture that focused on horsepower, suspension, and unique aesthetics. These modified vehicles have had a lasting impact on this style remaining popular.

Racing has been influenced by modified smuggled cars leading to organized events such as NASCAR. A lasting impact has been made by the history of stage tuning, which is rooted in practical modifications and driven by aesthetic desires.

Hence, the history of tuning is full of interesting facts. From alcohol smuggling to innovative technology and, finally, chip tuning. Car drivers have always been improving their cars and there are certainly many interesting modifications ahead.

### **What Includes Certain Stages?**

Now, being aware of the origins of Stage Car Tuning, we can move on to the main topic, namely, the definition and description of each of the tuning stages - from a stock car to an infinite number of modifications [4-6].

- **Stage 0 – Zero Tuning**

Although this level is not included in the classic list of stages, nevertheless, it is important to talk about it in a few words. Stage 0 indicates that no modifications were made to the vehicle which is exactly what was identified from the factory, in other words, the stock car.

- **Stage 1 – Chip Tuning / Tuning box**

Stage 1 is a stage of minimal car performance upgrade, best known as chip tuning. It consists of optimizing the ECU (Electronic Control Unit) of the engine using special software adapted to the engine and customer preferences. The result is a significant increase in engine power and torque: turbocharged engines from 20% to 40%, and atmospheric engines from 7% to 10%.



**Figure 3. ECU Chip Tuning**

Stage 1 is based on the fact that any engine with electronic control of fuel supply and ignition (injector gasoline or modern diesel) works according to a certain program. In simple words, at every moment of operation of the engine, it should receive a metered portion of fuel and a time-precisely normalized spark on the spark plugs (in petrol engines). Using several sensors, the ECU takes into account information on speed, load, temperature and the like, and accordingly determines the moment and time of the ignition of fuel injectors.

The plant ECU has a program that is the result of a compromise between guaranteed engine power, its environmental friendliness, economy and durability. But most engine models can adjust the program towards more power and torque - but at the expense of other mentioned indicators.

Of course, the new program for Stage 1 changes valve debugging in the boost system, but structurally the engine remains the same, with no parts replaced.

Note that only the control programs of ECU change, but it is strictly forbidden to touch «iron».

It is also important to mention here that the owner of the tuned-up car often gets problems with the reliability and durability of the powertrain: premature failure of the turbine, the valves are nailed down, the pistons are destroyed and burned. But usually, these risks for each engine and each program are known, so the owner should ask them in advance.

The most interesting thing for car owners is that for tuning the first stage there is ready-made software, written for specific models of engines and repeatedly tested on them. In Moldova, there are certain car tuning companies, that are specific to the stage improvement of car characteristics, many of them focus on Stage 1. Among the most popular tuning studios in Moldova can be identified Dieselok, Seven Force, CarDream, TopTuning, Rivals and so on. Besides, everyone knows international tuning companies: ABT, BRABUS, Hennesy Performance, Mansory, MTM and so forth.



**Figure 4. Audi TTRS Rivals Tuning**

Thus, to increase car performance, it is often enough to rewrite the ECU program to gain more power and torque. The programs of this stage are quite standard, they have been tested and laminated hundreds of times already. Hence, Stage 1 is great for daily use.

- **Stage 2 - downpipe, intercooler, sports air filter, possibly upgrade turbocharger/ upgrade compressor kit**

Stage 2 is an addition to the first stage of tuning. It consists of optimizing some parts of the car: a less restrictive exhaust system, sports filter, large intercooler. The second stage involves further increase of the engine efficiency by extending the range of maximum torque and power. For this purpose, the inlet and outlet systems are modified by increasing the diameter.

In terms of intake, air ducts with a larger diameter and a minimum number of turns for airflow are installed. The intercooler is replaced by a more productive intercooler, a low-resistance filter is installed and air is provided from the cold area outside the bonnet.

No less work on the outlet. Additionally, extend the diameter of pipelines for exhaust gas removal, they make as much as possible direct. The catalyst is removed or, instead, a special sports catalyst is installed.



**Figure 5. Stage 2 Package for Volkswagen Golf, Audi A3 TT 2.0 TFSI**

The ECUs are also listed, but unlike Stage 1, there are no finished programs at this level - there are too many options for combinations of input and output parts of different types. True, the tuners have certain blanks, which after replacing "iron" are customized for each specific engine.

So, on the second level, the car owner gets high performance, the car becomes more aggressive and sportier, although it becomes more capricious - increased fuel consumption, faster wear parts, which cost expensive repairs or complete replacement of the details, and even the engine itself. Anyway, the car still can use public roads.

Stage 3 - engine reinforcement, complete exhaust system, modified intake/airflow

Stage 3 involves significant changes to the engine and the replacement of more components. The new turbine and an even more efficient intercooler are installed, providing a more efficient engine cooling system. Not uncommon - the exhaust manifold of a more advanced design. Accordingly, the performance of the fuel system is added - through a new fuel pump and injectors that can feed more fuel into the cylinders.

Tuning "third level" allows you to shoot from a fully civilian 1.5-liter engine up to 300 horsepower. For the realization of the obtained power and torque, the clutch and gearbox, drive shafts of wheels and the like are strengthened. Performance will be close to the physical limits of the engine.



**Figure 6. Stage 3 Package - VAG**

For Stage 3 as well as for the previous one there is no finished software (chip tuning), everything is handpicked depending on the car, parts and desired characteristics, but sets of parts - it is not uncommon. However, it is much more rational and more profitable to pick up the necessary parts, rather than buy the finished parts.

The tuning on the third-state car is still suitable for daily use, but the fuel consumption will be huge. These vehicles are often used on a racing track or participate in motorsport competitions.

- **Stage 4 - custom ECU, nitrous oxide injection, methanol conversion, displacement increase, crate engine**

Opinions on how many Stage Tuning Packages there are vary in different sources. I suggest that there are 4 stages. Stage 4 is the last stage of tuning, which has no final point - the ability to improve performance and modify the car is infinite. Fantasy has no limits; in this case, the owner can change everything.

Most often, such highly modified cars are used for driving on a race track and for participation in automobile sports competitions, they are not designed for use on public roads - it is prohibited. Cars are transported by tow trucks to the race track.

### **The Future Trends of Stage Tuning**

The world is constantly changing, this also applies to the automobile world. Nowadays electric cars are becoming increasingly popular, so there is a reasonable question - what will happen with stage tuning soon? Of course, a classic car with an internal combustion engine will not soon be lost, but tuning companies already need to adapt to modern realities and find ways to increase the performance of electric cars. Shortly, there will be tuning studios, specific to electric vehicles, there will be new stages of tuning, but this is a question that needs to be thought about now, and for new engineers - this is the space for experiments.

### **Conclusion**

Taking everything into consideration, looking at the history of the appearance and development of car tuning can be concluded that for the modern driver, Stage Tuning Packages play an important role. For many car owners it is important to get the best results from their car, the best performance. Although previously only those who participated in sporting events could tune cars, now this phenomenon has become very popular. Even for daily use state tuning has many advantages.

However, both drivers and automotive engineers need to be prepared for the upcoming changes associated with the spread of electric cars, and thus need to adapt to changes in the near future.

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