Identification of the problem

Like most 'new' things, this was also discovered by accident. Lots of owners of turbocharged cars ditch the stock exhausts and catalysts in search for "easy power". Tuning books and experts all agree that the best exhaust (for a turbo) is no exhaust **at all,** thereby shifting the planet's wealth towards manufacturers (and fitters) of trick exhausts. These all follow similar macho rules: Bigger diameter pipes, elimination of the cat, and chopping off anything vertical that can impede the airflow. It all makes sense, until proper measurements are made.

As we've seen elsewhere on this site, simply ditching the whole stock exhaust for a 'high-flow' unit will indeed give measurable power gains. Most people assume that's because the turbine now 'breathes' better, it has less 'backpressure' impeding it, so it spools quicker and faster.

Thankfully not everyone is easily hyped by the "dyno results" of marketing brochures and glossy magazines. We now know that the ***real*** reason behind the significant power increase is the runaway boost conditions that the engine is now experiencing: the wastegate cannot control boost adequately any more, and at around max-torque revs it cannot bleed enough gases. The result is a boost spike, and thus more bhp on the dyno! This is easily proven on a good dyno, and when boost is re-adjusted to max out at the same level as before, then the free-flow exhaust gains are less spectacular.

But here's a weird phenomenon: a discerning punter did a dyno run before/after fitting a cat-

replacement pipe. Naturally he expected to see exactly how many horses the dreaded cat was robbing from him .
The result didn't make sense at all. With the cat replacement pipe (and same max boost), the engine was making ***less*** power. He repeated the measurements to make sure that heatsoak etc was not distorting the figures. But no - the cat (with all the passages and extra surfaces etc) was actually helping the engine make more power.

How could that be? There's no question that the cat was a restriction. There was also no question that the replacement pipe didn't let the engine make as much power as the cat did. There was no oxygen sensor downstream of the cat, so the engine management didn't know that the cat was missing.

Two theories were investigated: One was that the cat impeded flow, thereby keeping the first part of the exhaust hotter, and hot gases flow faster than cold ones.

The second theory was that the location and internal volume of the cat cavity was precisely engineered to somehow 'accelerate' the gases. This acceleration was so effective, that not only did it negate any flow problems from the cat's honeycomb structure, but it performed better than a straight piece of pipe! Fascinating theory. Creating a replacement pipe with and internal shape and volume as the OEM showed that this theory was correct.

The exhaust had a tuned length.

Tuned length exhaust

All books and experts claim that when it comes to turbos there is no such thing as tuned length. Of course there is a difference from the normally aspirated engine which responds to tuned intake and exhaust lengths. These actually help the flow of the normal engine by creating a negative pressure wave in the collector to help suck the next pulse out. The turbo has this hot housing and impeller stuck in the way so the pressure build prior to the turbo negates any benefit derived from the a tuned length and collector.

But could it be that we'd like to have some form of pulse tuning for turbos?

What we want to achieve is high speed flow on exhausts that are designed for low RPM torque propagation. The idea below is similar to the ***velocity stack*** modification circulated in Japan a few years ago. It's also related to exotic theories of ***register plates***, via which mythical street turbos produce vast amounts of power...

We have to remember that the exhaust gases can reach velocities of several hundred miles per hour. So they won't be running as smooth as pouring water slowly out of a jar. In fact, even pouring oil out of a bottle too quickly can upset the flow and end up in gallops of oil all over the place. If smooth flow can suddenly turn funny in such low speeds, what chance do the exhaust gases stand?

As the turbo is running high boost, there is a stream of air molecules trying to get the hell out of there. The exhaust has only a fixed volume, but as the revs go up, more and more molecules try to squeeze out. In a properly designed system, these molecules will act like footsoldiers during a well-rehearsed attack. In a slap-dash system they will be more like passengers running out of a burning Tube station.

Looking back at the exhaust valves, there is no such chaos. There are pulses relative to the small exhaust valves and ports (compared to the volumes of gases we flow), but everything is combed nicely by the turbine. Any opportunity for pulse tuning is smeared out by the chopping action of the blades. So now we're left with cooled down, smoothed out ex-pulses, trying blindly to find their way out into the atmosphere via the silencer. As they further cool down, they decelerate rapidly and as they tumble into one another there's congestion and chaos.

What we need is to re-create some pulse tuning, because marching soldiers flow better than headless chicken. We want to do this without introducing extra baffles and obstacles - we're trying to accelerate flow, not make it worse.

Enter the ***expansion chamber***. It's quite like a two-stroke expansion chamber, but here we want to harness the *negative* pulse, rather than the positive one (two-stoke uses positive pulse to ram unburnt gases back into the exhaust port).

If we get this chamber in the right size and position (after the turbo) then there will be just enough impetus created by some of the gasses passing straight through to cause a small area of continuous negative pressure... this is enough to reshuffle the rest of the gases and give them sufficient pulsing to stop the congestion.

The concept is simple...we're effectively creating some deliberate and controlled disruption! There must be no abrupt restrictions after the chamber so all silencers must be of the absorption type and all bends must have an increased cross-sectional area (Any tuners worth their salt will know how to apply the formulas for deceleration of gases)

Now you know...