Ernst Fuhrmann’s requirement to develop a significantly updated GT race car in 1977, would present a number of challenges for the Porsche race department. Just to make things interesting, the new car was to race in a class in which they had not competed for almost a decade. But the subsequent work resulted in the creation of one of Porsche’s universal favourites, the 935/2.0 ‘Baby,’ a race car that Norbert Singer and his team could be justly proud of.
In 1977 Porsche competed in the World Championship of Makes, but many of their customers participated in the very popular domestic Deutsche Rennsport Meisterschaft (DRM). This series was divided into two classes, one for the up to 2-litre cars and one for the over 2-litre cars. The bigger class was dominated by customer 935s, where Ford and BMW found themselves out-classed, and so the other manufacturers turned their attention to the sub-2-litre ranks. With more manufacturers in this ‘smaller’ category, this had the effect of drawing the attention of the media and the public away from the larger displacement class where the 935 was king. To pour fuel on the fire, Ford and BMW said that this was where the ‘real racing’ was happening, and that Porsche was unable to compete in that class because they did not have a 2-litre race car.
This jibe did not sit well with Ernst Fuhrmann, who as Chairman of Porsche, took on the challenge and instructed the motorsport department to build a car that could compete in the 2-litre class of the DRM. This presented Norbert Singer with a couple of headaches, because Porsche did not even have a 2-litre production engine at that time, and the 2-litre DRM class had a very low minimum weight that would prove a real challenge for the 911 to get down to. Fortunately for Porsche, it was in just such circumstances that Norbert Singer thrived.

It would be helpful at this point to take a step back and to explain how the 935 came about in the first place. The Porsche 934 was a turbocharged race car that was eligible to race in the Group 4 class, where externally, only the fender width could be modified to take wider racing tyres and wheels. In 1974, Porsche developed a lightweight turbocharged 911, the
Carrera RSR Turbo 2.1, a model which had benefitted from Porsche’s turbo experience in the 917/30 Can-Am developments. When the new regulations were eventually published in 1976, Porsche found that they could substantially modify the 911 for the Group 5 class, the new higher class for all-out race cars. This resulted in the formidable 935 model, which pretty much swept all before it.

In an interview with the author back in December 2015, Norbert Singer cheekily revealed, “We started with the 935 in 1976 when it was clear what we could do. It was based on a 911 of course, and the regulations allowed a lot of things where, let’s say, we found a good interpretation which the FIA people had not really intended.” Where the regulations for example stated that the fenders were free, Singer took this literally and he smoothed the fender line to follow that of the front bonnet. This meant that the headlamps could be relocated to the lower fender position, one of Singer’s favourite aspects of the 935. The term ‘silhouette’ too was not clearly defined in the regulations, and this allowed greater freedom in other areas. What the FIA wanted to avoid, were the ugly wheel arch extensions found on some of the Group 4 cars, and so the rules were more flexible for the Group 5 racers. Thus was born the 935, a model that was to determine the shape of Porsche’s GT race cars for almost a decade.

The 935/2.0 concept

To meet the challenge laid down by Ford and BMW, Fuhrmann’s determination to compete in the smaller capacity class led to the creation of the 935/2.0, or ‘Baby’ as it is affectionately known. This new ‘Baby’ race car was packed to the gunnels with clever features that would combine to make this car really fly.
Norbert Singer, who had only started at Porsche as a young engineer in the racing department in March 1970, took over the Carrera RSR project at the end of 1972 demonstrating his swift rise up through the ranks of the department. Singer, though, was no ordinary engineer, and when an opportunity in the Porsche racing department presented itself he chose that over a career in space science, which may help to explain some of his ‘out of the box’ thinking.

The most popular DRM race was at the Norisring, with easily 100,000 in attendance, and despite the extremely tight timeframe that Singer faced, it looked like they could still make the deadline, although it would not be easy. Singer explains, “On the one side there was the engine development, but on the other side we also had to develop the car, and so we had to
make everything lighter. The minimum weight was 730kg, which is pretty hard to get down to with a production based car. We took every piece and looked at how we could make it lighter, because we only had to race for one hour, not 24 hours. That was always what our basic thinking was, would it last for 24 hours, but this was just a one hour race.

Norisring, 3 July 1977: The #40 Martini Porsche 935/2.0 was driven by Jacky Ickx in the DRM ‘200 Meilen von Nürnberg’ but unfortunately the car scored a DNF at its first race

“We lightened a lot of parts and in the end, it turned out that we were too light, we had it down to 715kg and so we were 15kg below the minimum weight. We had heard that our competitors, Ford and BMW, were over the minimum weight. So, we had to add 15kg of lead to get the weight up, but because the Norisring had a very open paddock, everybody could walk around and look in the cars and we didn’t want to show them that we were underweight. We decided to hide the extra weight and so the idea was to melt the lead and
fill the longitudinal crash barriers in the front. You couldn’t see it, but you couldn’t take it out either (laughs), but it was okay, this was the game.”

Norisring, 3 July 1977: The #40 Martini Porsche 935/2.0 with mechanic Klaus Bischof in the hot seat at the DRM ‘200 Meilen von Nürnberg’

The 935/2.0 engine

Complying with the 2-litre class limit, meant that the Porsche 6-cylinder boxer engine would have to undergo a serious displacement reduction programme. With the 1.4x forced induction multiplier, this would mean that the engine displacement would have to fall to around 1.4-litres, to keep the calculated displacement below 2-litres. The man charged with that responsibility was Valentin Schaeffer, as Singer reveals with some humour, “For an
engine man, if you have the power, then everything is fine!” Schaeffer did indeed come up with the goods, as the 1425cc 6-cylinder boxer engine produced 370bhp at 8200rpm.

One of the advantages of Porsche’s individual cylinder and head configuration, meant it was a relatively simple matter of reducing displacement by installing the appropriate sized cylinders. There was, though, no option of developing an altogether new engine with a bespoke crankshaft, as Singer confirmed, “It was not possible to make a new crankshaft in the time we had, and so we had a decision to make. There was certainly an advantage where we could make big changes to engine capacity in a very short time. But on the other hand, I think that ensuring the stiffness of the engine was not so easy and being air-cooled, no 4-valve technology was possible, so there were some handicaps. Importantly, we had to get
the parts in time to make this smaller displacement engine, this was also a big challenge. But from the displacement side, it was pretty flexible.”

One of the hallmarks of the 935/2.0 ‘Baby’ is its single-barrel, canon-sized side-exiting exhaust pipe. In the 2.8-litre 935/77, the turbo air was cooled by means of an air-to-water intercooler, but this system came with twin radiators, ancillary plumbing and pumps, making it all quite heavy. In the interests of weight saving, it was decided to fit an air-to-air cooler for the single KKK turbocharger in the 935/2.0, but the question was where to collect the air for the cooling system. Singer didn’t want to fix external scoops to the body that stood out in the airflow, as this would add drag, so instead air was collected through the two neat scoops just behind the rear side windows. Collecting the air and having the right
amount in order to make the intercooler efficient was a lot more difficult than it looked.

Norbert Singer explains, “This was a very tricky thing. Normally you cannot force the air through the intercooler because the pressure difference is not big enough between the entry and exit points. So, on the exit of the intercooler we used the exhaust to create lower pressure, and this enabled the air to move through the intercooler [more efficiently]. As soon as you have a certain [air] speed you lower the pressure, but when the exhaust is on full throttle, for instance, you have maximum airflow and so you will also have maximum cooling. The higher the speed the lower the pressure, and when you connect the intercooler with a tube to the exhaust outlet, you suck the air out of because of the low pressure. This
principle we call jet cooling, and that is why we had only one big exhaust to get all of the exhaust gas through the one pipe, and to help the intercooler.”

The 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) photographed at the Porsche Museum, Stuttgart, Germany in May 2017. This image shows the large, single exhaust outlet

The 935/2.0 body

Norbert Singer faced the challenge of getting the car’s weight down to 730kg, but for a steel production chassis, this was no small task. However, the rules required that only that section of the production tub between the two bulkheads had to be retained, which meant that the front and rear bodywork could be dispensed with. The floor too was removed, and the remaining part of the tub was attached to a very rigid aluminium frame.
The 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) photographed at the Porsche Museum, Stuttgart, Germany in May 2017 and showing the lightened front chassis section

The exterior of the body was similar to that of the 935 (1977), except that it was narrower due to the car having smaller tyres because overall performance was down on its bigger brother. Gone were the front radiators, instead the low-level inlets, in-board of the front lights, were just to cool the front brakes, with a hot air exit located just behind the wheel arch on either side. It is interesting to note that the air inlet behind the driver’s door is larger than that on the right side (when standing behind the car). Norbert Singer explains, “The bigger one [driver’s side] was for the engine oil cooler and the smaller one was for the gearbox cooler.”
The 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) driver's side showing the larger engine radiator cooling inlet

The 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) passenger side showing
the smaller gearbox radiator cooling inlet

The Carrera RSR Turbo, the car that preceded the 935, had air scoops protruding from the engine lid/rear wing structure which clearly created drag. A much neater solution was created for the 935/2.0, which saw discrete air intakes located in the rear wing structure just behind the rear windows, or C-pillar. On the one side, the air inlet fed cool air to the turbo, on the other side it cooled the engine compartment. Norbert Singer explains, “The Carrera RSR Turbo had a scoop on the outside for the air intake, and [with ‘Baby’] we learned that this was a good idea but maybe we could improve it. So, it is like developing the car part by part, and in the end this was the solution.”

The 935/2.0 had probably the neatest little external rear view mirrors to be found on any race car. The mirror itself, which was small, was housed in a streamlined and aerodynamic tunnel that started half-way up the front bonnet, running along the top edge of the fender, and ended just in front of the windscreen. Singer laughed, and said, “The regulations said that you had to have two mirrors and we had two mirrors, but you couldn’t see very much! The drivers said that they really couldn’t see, and I told them that they were so far ahead, they didn’t need a mirror. This was an aerodynamic trick, you could see a little bit but not much, but of course you also had the interior mirror.”
The 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) photographed at the Porsche Museum, Stuttgart, Germany in May 2017 showing one of the token-sized exterior mirrors

Hard to miss are the large, red or orange dayglow wheel inserts. I questioned Norbert Singer about these, thinking that they served to reduce air turbulence around the wheels, thus creating a better aerodynamic airflow. He corrected me, “Well, there are two things here. It might improve airflow a little bit, but when you make it really flat, then you can improve the drag. But on the other hand, it works a bit like a fan extracting hot air from the brakes, and it really worked, because the temperature of the callipers was down by 15 or 20°. It lets the air out because you have lower pressure on the outside because the normal airflow is from the inside to the outside.” A good deal of the hot air from the brakes and wheel hubs also escaped through the large air outlets that formed the back of the front wheel arches.
(Above) The 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) showing the wheel fan for extracting hot air from the brake callipers; (Right) The hot air extraction vents for the removal of hot air from the wheel arch
The 935/2.0 aerodynamics

The Porsche 935 was of course created to compete in Group 5 racing. This group was arguably the most innovative, exciting and highly competitive in the history of GT racing. Group 5 was also known as the Silhouette series, where one might imagine that GT race cars were required to retain the silhouette or outline of the production model from which it was derived. This though, was not strictly true as Norbert Singer explains, “This was not precisely defined, it was not in the regulations that you had to keep the silhouette. We called it a silhouette regulation because silhouette cars had to look similar to the production model. But there was no definition of a silhouette in the regulations.”
Group 4 allowed for production cars to be prepared as race cars, and the teams were allowed to affix much wider wheel arch extensions, which led to some outlandish, even ugly, race cars. With Group 5, the regulations allowed the shape of the fenders to be free, thereby encouraging the creation of a more aerodynamic solution and avoiding the unattractive wheel arch extensions.

The 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) photographed at the Porsche Museum, Stuttgart, Germany in May 2017

This regulation that allowed free shapes of the fenders, played right into the hands of the Porsche 911, because the car had no front radiator grille, and the lights were in the fenders as a matter of original design. Singer again, “When you look at a Ford Capri or a BMW 2002, the front fender is very narrow because in the front they had the grille with the headlights in the grille, but the Porsche had its headlights in the fender. Because it gave us
much more freedom than the others, we could use this part of the regulation to our advantage because the front fenders of the 935 are very wide.”

As regards the rear window of the 935, this was another stroke of genius by Singer. The regulations required the original rear window to be retained, as Singer pointed out, “This was the first time we used this on a race car. The regulations said you had to retain the original rear window, but there was nothing written to stop you making a double window, and so we had the original window underneath.” A second, or outer window, was created over the top of the original window which could be clearly seen from the outside, but importantly it improved the car’s overall aerodynamic shape. “This was just for a better airflow to the wing,” he added.
Rear three-quarter view of the 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) photographed at the Porsche Museum, Stuttgart, Germany in May 2017

A close look at the trailing edge of the rear fender, will reveal a small lip that runs vertically from the base of the fender to just below the rear wing structure. Although this was not a new concept for Porsche, its benefit baffled the best brains in the aerodynamics world at the time. Singer again, “This is a very special phenomenon, it is a kind of rear spoiler which increases the downforce but which does not have any influence on the drag. Yes, it sticks out, but it works perfectly.”
Rear vertical spoiler on the 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) photographed at the Porsche Museum,
Despite the near vertical shape of this lip, or spoiler as Singer called it, how this could positively influence downforce is an obvious question on the lips of many motorsport enthusiasts.

Singer starts to illustrate this on a photo of the Porsche 935/2.0, “This is very complicated, but when you have an airflow over a certain shape and it ends but the airflow has no defined cut-off point, then it increases the drag because you create vortices. When you have the air moving along the side of the car and you also have air coming out of the wheel arches, you have a lot of dirty air and vortices around the back end. With that spoiler, on the one hand, you define a cut-off point. On the other hand, you help the airflow underneath the car, increasing the efficiency of the wing and the rear spoiler, so it is a very complicated system.”
Rear view showing the rear wing structure with the vertical side spoilers on the fender trailing edge of the 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001)

The question on my mind was, did the increase in downforce occur because of this vertical spoiler, or did it increase downforce because it cleaned the air and allowed the wing to work?

The answer is not straightforward, “For the downforce, you have to look at the whole system, the airflow that you create at the whole back end of the car. This spoiler has a big influence on the airflow and therefore doesn’t just explain the cut-off point, the cut-off point is for the drag, but not for the downforce. You have a really big horizontal vortex that you create across the car width, and this just makes it wider giving you more downforce but no change in drag.”
So, who came up with that idea, was it Norbert Singer? He laughs, and adds modestly, “I was doing all the wind tunnel work.” Pushing harder, I wanted to find out what had inspired him to try this, because there was no precedent?

“This is a long story,” he started out. “Normally with all of these fantastic ideas, the endpoint of a development is not the result of sitting there and thinking we will make a spoiler and that is it, forget that! You work on the car and you study the airflow and you try different things. You want to make more downforce and less drag of course, so you have a Gurney flap and you have spoilers and so we said let’s put a small spoiler here, so step-by-step you are developing it. Obviously, you expect a result, and sometimes it is just the opposite of what you expect. So, it is not just an idea sitting there and I think maybe we try this or maybe try that, it is just a step-by-step development.
935/2.0 Baby (chassis #935 2 001) photographed at the Porsche Museum, Stuttgart, Germany in May 2017

“This feature worked because the length of the fender and the angle at the back. You have a certain width at the back and if you make it smaller, or if you make it too sharp or if it is parallel, it doesn’t work. That is why, when we worked with that car, we tried to understand the airflow and the pressures, it was not just a case of having a fantastic idea, it is just a process of step-by-step development,” Singer explained.

Racing

Due to the extremely tight deadline set by Ernst Fuhrmann, the car arrived at Norisring virtually untested.
Norisring, 3 July 1977: The #40 Martini Porsche 935/2.0 was driven by Jacky Ickx in the DRM ‘200 Meilen von Nürnberg’ but unfortunately the car scored a DNF at its first race. When they arrived at the Norisring on 3 July 1977, it turned out that the turbo pickup was not very good. This would ordinarily not be a problem because the Norisring consists of just two long straights, two hairpins and a fast ‘S’ in the middle. But they also had problems with the gear ratios because this project was done in a hurry, and the correct gear ratios could not be sourced in time. In order to compensate for the wrong gearing, the 19” wheels had to be replaced with 16” diameter wheels. In addition, the driver, Jacky Ickx, who had qualified the car in thirteenth place in the 2-litre class, suffered from extreme heat exhaustion in the race and had to stop, as the cockpit cooling was wholly inadequate. “It was quite a disappointment because it was the biggest race. And Ford and BMW said, now you see this is real racing,” Singer added.
Norisring, 3 July 1977: The #40 Martini Porsche 935/2.0 was driven by Jacky Ickx in the DRM ‘200 Meilen von Nürnberg’ but unfortunately the car scored a DNF at its first race. Porsche went back home and they knew they had a lot more development to do on the car. Singer continued, “We went home and we knew that we had a big programme ahead of us to improve the car and the engine. Then Fuhrmann came in and said, ‘Okay, your next race is Hockenheim.’ It was about three weeks later, and so I said, ‘No, no we have a big development programme and we cannot make Hockenheim.’ He said, ‘You have to go to Hockenheim, you have to do whatever you can.’”

The mechanical fuel injection pump was tested and once the ‘pick-up’ problem was identified, Bosch was brought in to rectify the system. A process that would normally take many weeks of testing was cut short by finding a compromise that worked and the pick-up was sufficiently improved across the rev range. On the car side, due to the lightness of the
complete body package, the torsional stiffness had been compromised, and so Singer and his team stiffened the car as best they could do in the two weeks they had to work on the car.

Hockenheim, 30 July 1977: The #40 Martini Porsche 935/2.0 was driven by Jacky Ickx who won the DRM race in grand style. Here he is being chased by a group of seven BMWs and Ford Escorts in the early stages of the race

Although Hockenheim had no hairpins, it did have slow corners as Norbert Singer recalled, “In practice, Jacky Ickx was 2.8 seconds faster than the rest of the world (laughs). And when we finished the race, the gap to the second car was nearly a minute after 20 laps of racing, so everybody was happy. That was what we could do in three weeks.” In fact, apart from the second and third placed cars, the Porsche 935/2.0 ‘Baby’ had lapped the entire field when the chequered flag came down.
In closing

The Porsche 935/2.0 proves just what ingenuity exists in the racing world. The innovative solutions that were found on this race car would not be seen on GT racing cars today, because the regulations ensure that all entrants comply with the formulaic requirements laid down by the FIA. To some extent one needs this, but were the authorities to relax their determination to ensure that all makes perform to the same level, irrespective of the vehicle description or layout, then some of the magic element that existed all those years ago, could return.

A front three-quarter view showing the striking lines of the 1977 #40 Martini Porsche 935/2.0 Baby (chassis #935 2 001) photographed at the Porsche Museum, Stuttgart, Germany in May 2017
If engineers like Norbert Singer and others had not pushed the regulations to the limit, we would be all the poorer for not having seen cars like the Porsche 935/2.0 and others performing so well against all the odds. Motorsport engineering is all about innovation, creativeness, pushing boundaries and revolution. This race car, the Porsche 935/2.0, is a perfect example of that.

**Technical specs – Porsche 935/2.0 (1977)**

**Engine & gearbox**

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**Gearbox** 5-speed synchronised manual transmission, with locked diff depending on circuit

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### Suspension
Front: independent suspension with wishbones and McPherson spring legs; Rear: angled aluminium trailing arms, progressive coil springs and Bilstein gas/oil shock absorbers

### Wheels
Front: 275/600 x 16”; Rear: 350/700 x 19”

### Hubs
Centre-lock hubs

### Dimensions & weight

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*Written by: Glen Smale*

*Images by: Virtual Motorpix/Glen Smale & Porsche*