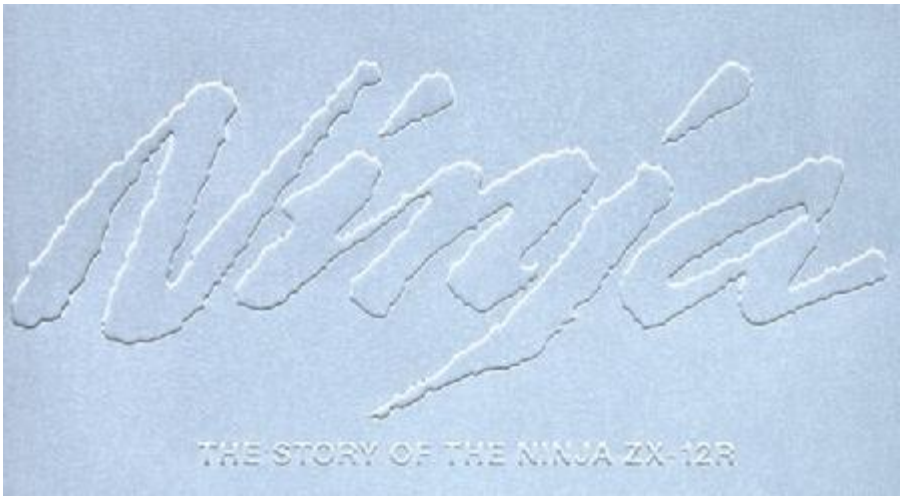

The Ninja Spirit

Of all the machines that touch our lives few leave such deep impressions as the motorcycle. They demand from us such mental and physical commitment - and perhaps less important things like time and money - but give so much in return. Is there a quid pro quo in which this investment of ourselves in these machines is repaid in a currency of emotion? How is it that this motorcycle which responds faithfully to our every command can be so much a part of us, yet remain strangely aloof - retaining a clear individual character with which we feel that irresistible urge to interact? Nothing symbolises such powerful motorcycling emotion more than the brand name Ninja.

Kawasaki Ninja motorcycles take their name from a special class of Japanese warrior, masters of the ninjutsu martial art who were reputed to have the ability to make themselves invisible. Legends trace the origins of the Ninja back to Japanese antiquity, but they reached full prominence during the Sengoku period 1467-1568). Renowned for their stealth, superlative power and grace in movement, they earned an elite status and a fearsome reputation, with the very mention of their name commanding respect and inspiring awe. But there is another significant characteristic which Kawasaki Ninja motorcycles share with their namesakes. They mean business.

The Kawasaki Ninjas have always had a sharper, harder edge, a defining attribute that inspires special passions amongst their owners. Over the past few decades, as like other supersport machines they have become ever more refined and ever more sophisticated, the Ninjas have retained the uncompromising warrior spirit that continues to set them apart from the crowd. The Ninja ZX-6R, ZX-9R and new ZX-12R embody everything for which the Ninja name is famous. Graceful and fluid in movement, yet carrying incredible explosive potential. Tough, loyal...and very aggressive. The Ninjas are motorcycling's last samurai. Machines that will continue to touch our lives, and reward us for our involvement with them many, many times over.

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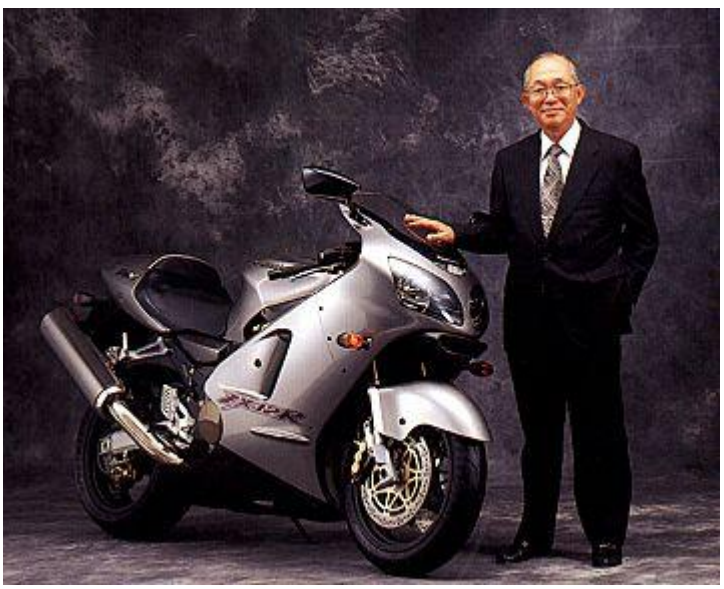
Foreword

It has been a long and eventful thousand years since humankind last shared the excitement of the new millennium. A thousand years of human struggle and triumph, capped by a remarkable century of unparalleled technological achievement. During this century, promoting a harmonious relationship between man and machine has been at the very heart of Kawasaki's operations, and there could be no more fitting capstone to the century for us than the machine which forms the central character of this book - the Ninja ZX-12R. Because nothing symbolises the Kawasaki name better than the Ninja supersport bikes, and the Ninja ZX-12R is a machine which captures the very essence of the Ninja spirit.
But what underlies this special emotion that fires the imagination of Ninja enthusiasts around the world? Certainly it is about dynamic performance, but it is much more. It is a motorcycling ethic, based on a vital balance between machine performance and rider control. It is striving to understand machine dynamics and human motivation, seeking both to master the art and advance the science of motorcycling. it is about the real sense of fulfilment when rider and motorcycle perform together as one, as an expert equestrian astride a thoroughbred horse. About the realisation of a motorcycle's full potential, as measured by the ability it gives riders to express their own individuality and skill. And it is about remaining focused on the excitement and freedom of spirit the riding experience brings to those who choose to ride a Ninja.

With the Ninja Zx-12R, Kawasaki reaffirms its commitment to this intimate relationship between rider and motorcycle. In fact, the ZX-12R really is a machine that only Kawasaki could have built, the ultimate expression of Kawasaki's philosophy, their vast technological depth and also of the strides the industry as a whole has taken during the 20th Century. At Kawasaki, we feel that this is the best performance motorcycle that the century could produce, and humbly leave history to judge.
But simply building the most powerful production motorcycle of the 20th Century was never our primary intention. Our chief goal was to create a truly exceptional new model to lead Kawasaki into the future, one that would achieve an exciting new synergy between various elements of the motorcycle while further enhancing harmony between rider and machine. So while the Ninja ZX-12R puts an emphatic exclamation point at the end of the 20th Century, it more importantly seeks to break new ground, to redefine design and performance standards, and ultimately, to deliver greater rider satisfaction and riding pleasure in the 21st Century.

To all of you who already have the Ninja spirit, and to all of you who will discover this spirit, I cordially welcome you to the new era of Ninja high performance. It is for you, long-time devotees and newcomers alike, that this book has been lovingly prepared. In laying bare Kawasaki's approach to creating this motorcycle, I truly hope that it provides for you both captivating reading and a feeling for the emotion behind the Ninja name, now carried very proudly into the new century by the new ZX-12R.
Enjoy.



Masamoto Tazaki
Executive Managing Director & Senior General Manager Consumer products & Machinery Group
Kawasaki Heavy Industries, LTD.

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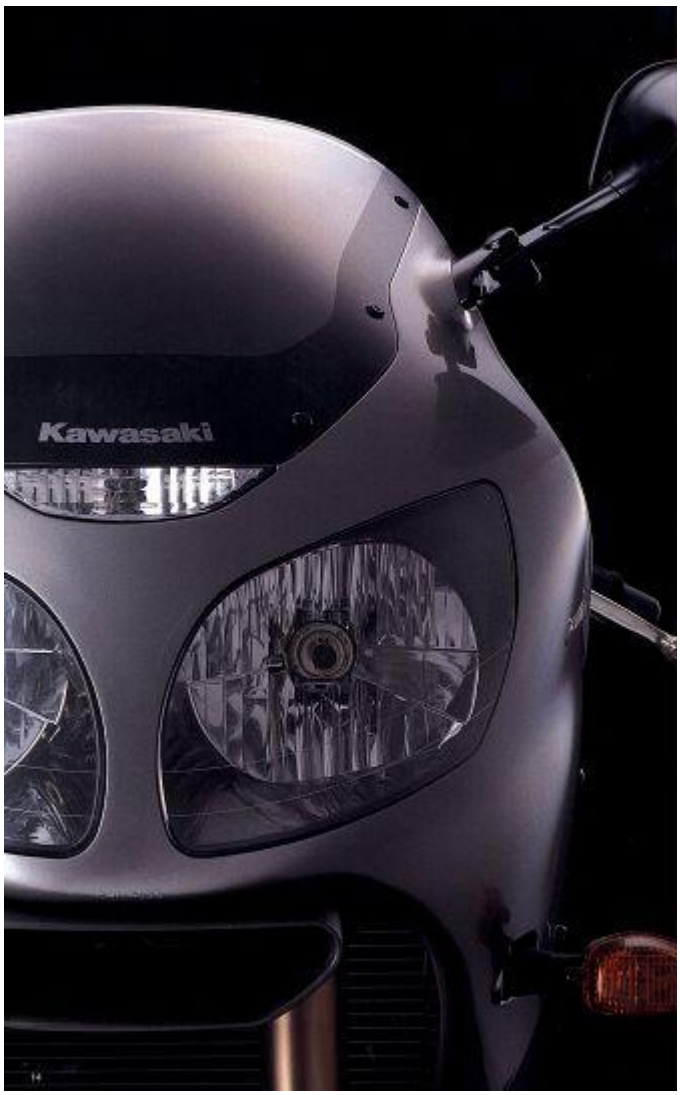
Introduction

In the dynamic world of high performance motorcycle production, the fruits of a thousand hours of toil are sometimes measured in milliseconds on the racetrack. For most riders, the rewards in riding a high-performance machine are more self-evident. Whatever the measure, it is a world in which Kawasaki has traditionally cut an imposing figure, with Kawasaki machines breathing new life into racing and recreational riding spheres alike for decades. But behind the scenes, who breathes life into the machines?

Kawasaki's engineering heritage encompasses aircraft, aerospace and bullet train design and manufacture, and with strong influences from this rich background in high-speed transportation, an edge in motorcycle manufacture showed from the outset. But the formidable reputation built on early models such as the now legendary Mach III and Z1, and enhanced further by modern milestones such as the ZX-9R and ZZ-R1100, necessarily comes also with expectation. That Kawasaki will not only maintain superlative engineering standards, but always strive to go beyond.

Ninja lineage has since the early 1980s embodied its own air of anticipation, and rumours of a new Ninja ZX-12R first began surfacing in early 1998. After more than a decade of dominance, and amongst the inevitable hype surrounding its challengers, Kawasaki's ZZ-R1100, known in some countries as the Ninja ZX-11, could still hold its own. But "holding its own" was never the Kawasaki approach, and the development team's sights were already set on producing a worthy heir apparent to the ZZ-R1100. And as the millennium end neared, there gathered even greater impetus to create a new industry flagship, one capable of establishing fresh standards for the new century.

As with many Kawasaki machines before it, the ZX-12R introduces radically new technology, such as an aluminium monocoque frame - the first ever on a production machine. A completely new 4-cylinder engine outputting quite startling power levels. Housed in a sophisticated aerodynamic package, the roots of which can be traced to the aviation industry.



Behind the gleaming machines in showrooms around the world are the 'unseen warriors' of the industry, dedicated to turning their vision into motorcycling reality. In this inside look at the development process from concept to production, members of the ZX-12R development team provide personal insight into how they went about conceiving, constructing and bringing together the myriad elements of this ambitious project. The comments that appear in this book were excerpted from in-depth personal interviews with key Japanese personnel at Kawasaki World Headquarters in Akashi, Japan between February 1999 and May 1999.

This is the story of the ZX-12R - in the words of the designers, engineers and test riders who created it.

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Chapter 1. Approach.

Concept and team

Responsible for overseeing the ambitious ZX-12R project from inception to production, the project leader reflects on objectives, personnel and working environment.

From the outlet, the Ninja ZX-12R loomed as much more than just another new model for us; it would really be both a culmination and a starting point. By this, I mean it was to represent the essence of Kawasaki's expertise to date, but it would also effectively be the new face of Kawasaki high performance machines. I think we all sensed the importance of the project, so I guess it would only be natural if there had been a little professional nervousness. But actually the pervasive emotion on the floor throughout was excitement. Like we really felt this project was somehow very special, perhaps once in a lifetime for many of us.

At the design stage, the goals for the ZX-12R were quite straightforward: a dry weight of under 215kg, 175+ horsepower without Ram Air, nimble handling qualities, Ninja tuning, unmistakably Kawasaki styling. We saw top speed figures, set as primary goals by our rivals, as incidental. If we looked after the basics, the rest would naturally follow. I think this approach paid greater dividends in the end, and it is satisfying to see comparisons to those machines that we feel in effect placed the cart before the horse. We ended up with a machine that has handling characteristics and other attractions well beyond its incredible top speed capability.

Once we set performance targets for a new machine, we are very reluctant to waver from those goals. If the technology to reach them does not yet exist, rather than lower our sights we will develop the necessary technology. That never-say-die philosophy, more than anything else, I feel, defines Kawasaki supersport machines - particularly the Ninjas. it is what gives them their hard edge. The Ninjas are not for everyone. We're building bikes for riders who can tell the difference. I believe our customers expect nothing else.

Overall, the most difficult hurdle we had to overcome with the ZX-12R was combining lightweight, sporty handling with high top speeds. Achieving one or the other of these goals is not terribly difficult; achieving both is.
Actually, there were factions within the company who questioned the need for a machine this fast and powerful. I had to explain to them that to many riders, a machine's potential is what makes it so alluring, regardless of whether they themselves will ever exploit that potential.

With such a broad engineering base, I think Kawasaki is fortunate to have technology to draw on that really no other Japanese motorcycle manufacturer has. In my position, access to such resources is obviously very useful indeed. But I believe good engineering is as much about people, about interaction, as it is about technology. Looking back, this is what the ZX-12R project was really all about.

I think we allow our engineers a much greater degree of freedom than those at other manufacturers. If they are convinced that their way is the right way, we usually let them have a go at it. I've found this creates the kind of environment which, in the end, produces the best results; not despite the emotional involvement, but because of it.

You see, with all its challenges, frustrations and rewards, this work is essentially a labour of love for the team here. So we actually put more than technology into these machines; we put a piece of ourselves.

Every person on the team has their own perspective, and I guess my job basically is focusing their various perceptions and aspirations, harnessing their ideas. And putting to best use each person's own angle on what the essence of a Kawasaki motorcycle really is, and what the next step should be.

Personally, my overall take is quite simple - Kawasaki bikes, particularly the Ninjas, have always been known as "rider's machines", and I want to ensure that this image remains intact.

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Chapter 2. Styling. Aesthetics and aerodynamics

At 100 km/h the air is a cooling breeze which blows your troubles away and puts a smile on your face. At 200 km/h it becomes a force to lean against as it pulls and tugs at you, whistling shrill melodies around the edges of your helmet. But at redline in top gear, in the upper reaches of hyperbike capability, the rules change; the air is a viscous cocoon of shrieking, tearing sound from which to hide as you paste yourself to the fuel tank and peer through the windscreen at the narrow tunnel opening up before you. And what sounds like the tearing of a huge piece of silk are actually the screams of millions of air molecules being ripped apart by your passage. Welcome to the world of high-speed aerodynamics.

As Japan's only motorcycle manufacturer also to build aircraft, Kawasaki had a wealth of expertise to draw on when designing the ZX-12R's aerodynamic package. Kawasaki's aircraft engineers were involved in the ZX-12R's aerodynamic design from the very beginning, greatly influencing the character of the ZX-12R's final aerodynamic profile. And with a closer relationship than ever before between aerodynamics, chassis and engine, the styling designers had plenty to think about in packaging this Ninja.

On the ZX-12R project Kawasaki designers and engineers were venturing into uncharted territory. They were dealing with a unique frame-engine configuration, and it became clear very quickly that in the realm of hyperbike aerodynamics, a fashion fairing was simply not going to get the job done. The styling team knew their task would involve more than just turning out a great-looking machine. Way more.

Styling a bike is never simply cosmetic. It always involves careful consideration of all structural elements, weighing up alternatives. Optimising, refining, searching for just the right balance of appearance and performance given the design parameters.
This was particularly so with the ZX-12R, as there is such a complex inter-play between the various elements of the bike. For example, the engine uses frame-integrated Ram Air, which in turn impacts heavily on ducting and fairing layout. Also, the engine and chassis are very slim, which naturally has major styling implications.

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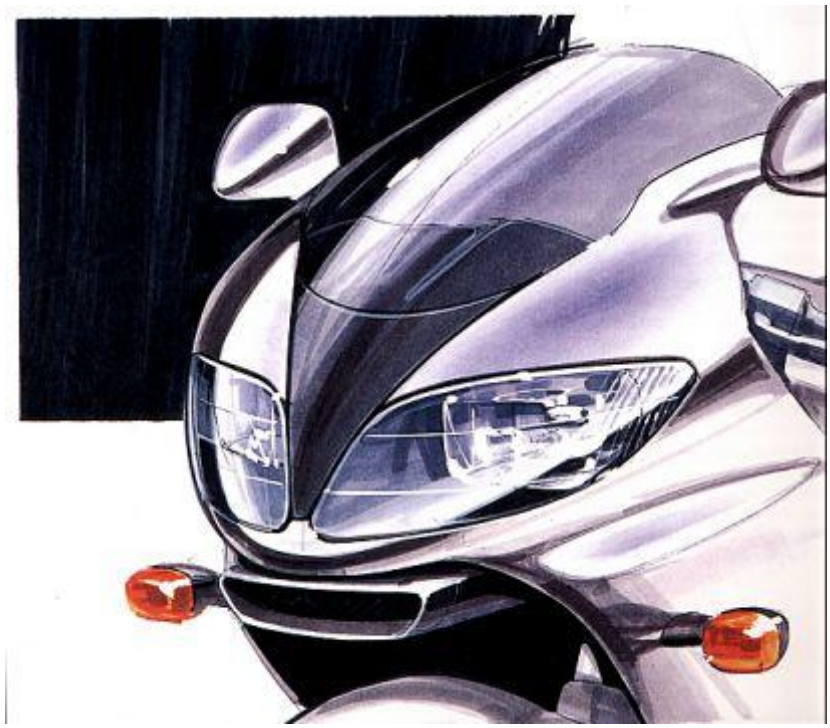

We knew the monocoque chassis presented us with a unique opportunity - to produce a machine that wasn't bulky-looking around the middle, the way big-bore bikes tend to be. With a short wheelbase, we knew we would be producing a very compact machine, but we also wanted the layout to be as uncluttered as possible.

Of course the importance of aerodynamics in styling a machine of this potential simply can't be understated. Having access to technology from Kawasaki's aircraft division made our job a lot easier. Their engineers gave us a lot of help in designing the ZX-12R's aerodynamic package. For example, the small canard-like winglets on either side of the fairing that look like downforce generators are in fact flow separators., preventing the turbulent air coming off the front wheel area from disturbing the laminar airflow along the upper section of the fairing. By physically separating laminar flow and turbulence, the fairing's coefficient of drag is greatly enhanced, enabling higher speeds to be achieved.

One thing we learned on this project is that at high speeds, small things make a big difference. The small, cast-in wind deflectors at the bottom of the fork also play an important role in the machine's high-speed aerodynamics. By deflecting the turbulent airflow coming off the fork and brake area out and around the lower part of the fairing, where resistance is low, rather than allowing this air to flow inward towards the engine, where the resistance is high, they reduce drag.

And those openings along the edge of the under cowl. These are outlets for the low-pressure air inside the cowling. They allow it to be sucked out by the high-pressure air flowing along the outer skin of the fairing, enhancing cooling by improving airflow through the radiator. it's called diffusion cooling, and comes directly from our aircraft technology.

The team soon learned that there was more to developing high-speed bolides than punching numbers into calculators and computing coefficients of drag. After more than 50 years of building high-performance aircraft, the aero-boys had plenty of tricks to teach them.

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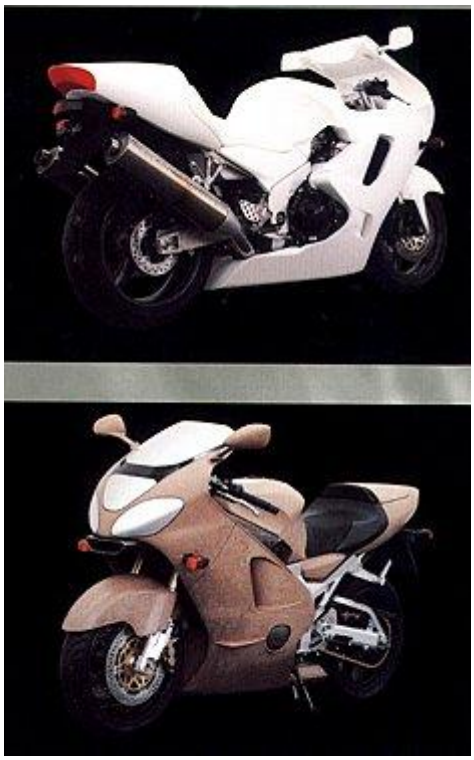

One technique the aircraft engineers taught us was to use drops of oil on the fairing during wind tunnel testing because they leave a track showing airflow patterns. We tried that but couldn't find the right kind of oil that would stick to the fairing. So, we ended up using drops of dirty rainwater which had accumulated on the screen in the wind tunnel. It worked pretty well.

Of course, the new projecting Ram Air intake duct is what everyone notices first. Actually, in the early designs, the Ram Air duct was flush with the fairing. But wind tunnel tests revealed that Ram Air intake efficiency is highest when the Ram Air intake is located forward in undisturbed air, at the centre of greatest pressure. When we moved it off to the side, or behind the headlight there was a noticeable performance drop. And the more we worked with this positioning, the more we liked the way it looked from the front. I personally now think it looks really cool, a unique feature of this bike.

ZX-12R mock-up

We're very happy with the final result. The ZX-12R is very slim and slips through the air with much less effort than the other big-bore speed machines, some of which are so over-faired as to compromise their sporting character.

Chapter 3. Engine.

Power and balance

The ZX-12R powerplant -light, compact, efficient...and very potent. Pumping out around 180 horsepower at the crankshaft, without Ram Air, the ZX-12R powerplant is the most powerful motorcycle engine Kawasaki has ever produced. This all-new liquid cooled, 4-cylinder, DOHC engine features the same bore/stroke ratio as the highly regarded Ninja ZX-9R, and is equipped with Kawasaki's most advanced Ram Air system, a radical frame-integrated design.

Feeding the engine is an electronically controlled fuel injection system which delivers hard-hitting, instantaneous throttle response with environmentally friendly exhaust emissions. Lighting off the mixture in its high-compression 4-valve combustion chambers are lightweight, F1-type plug-mounted ignition coils. These compact coils not only deliver a precisely timed, super-hot spark, they eliminate the high-rpm spark dropout often associated with conventional coils. The ignition system delivers independent timing control for each cylinder pair based on a variety of information supplied to the ignition computer such as crank angle, throttle opening and rpm.

For efficient heat dispersion and long wear, the ZX-12R runs with sleeveless electro-plated aluminium

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cylinders. These thinner cylinders also allow a reduction in the distance between bore centres, for a narrower, more compact engine and reduced crankshaft flex.
And despite the engine's awesome power output, a balancer shaft and a specially tuned all-titanium muffler keep vibration and noise to a minimum.

The target figures spelled it out in black and white: at least 175 horsepower. This, it was calculated, was what it would take to push the ZX-12R to the head of the hyperbike pack. What it would take to build such an engine was something nobody could say.

We knew from the start that we would need at least 175 horsepower. That's on the dyno, without Ram Air. With Ram Air we get about twelve more. So, we're talking about pretty close to 200 ponies. We'd produced 150 horsepower engines before, but never anything as powerful as this. We were very concerned about what would happen when we got into the 170-180 horsepower range.

When designing high performance engines at Kawasaki, we have a formula with which we can determine the ideal bore size for a given displacement. The bore determines valve size, and valve sizes determine camshaft design. The ZX-6R , 9R and 12R all have the same bore/stroke ratio and this is one of the reasons these engines lead their respective displacement classes when it comes to horsepower.

I had just finished working on the ZX-9R when I was given the ZX-12R project. When I saw the target figures for engine output I knew we would be building something pretty radical! My first thoughts went back to the ZZ-R1100, which was our first big bike to use Ram Air. Remembering the joys and frustrations of that project, I couldn't wait to get started.

At first, our main concern was whether we could get enough power out of it. And, since this was to be a flagship model, we didn't want to have that raw feeling that some Kawasaki engines are known for. We wanted it to be very smooth and refined.

Working out the Ram Air configuration was interesting. I think initially the styling designers didn't like the Ram air intake stuck out front like that. But during testing we discovered that the engine put out more power with it moved forward, to the area of greatest pressure. We also liked the way it looked from the front, so we were able to convince the designers to leave it alone.

Once the engine development team got the horsepower numbers they needed, they started on the next major task: civilising the beast, by designing a useable powerband and reducing exhaust emissions without sacrificing power.

The next big hurdle was smoothing out the power delivery. Getting the go-ahead to use fuel injection was a big plus. It eliminated problems caused by speed-induced pressure differentials in the Ram Air intake system. We also decided to go with a balancer shaft. That made a big difference. Now, even at redline the engine is turbine smooth.

We were able to develop a nice, linear power curve. Some manufacturers have been forced to resort to spec ail exhaust devices to achieve a step-free power curve, but we found that with careful tuning of the exhaust system we could achieve the same goal, without the extra weight or complexity.

We also wanted to make the engine as compact as possible, so we developed a new all-aluminium cylinder with sleeveless, electro-plated bores. This reduces the cylinder spacing and makes the whole package narrower. It also results in a shorter, stiffer crank. To make sure it stays together during long blasts, we used carburised connecting rods and forged pistons.

Of course, reducing friction is another way of getting more power. To reduce windage at high rpm we designed a low oil pan to keep the oil from slowing the crank.

Once the thing started putting out serious power we ended up having to use a 12-plate clutch. This also gives a nice, easy pull at the lever.

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Playing a vital role in the engine's development is the engine testing team, putting the powerplant through its paces both on the bench and test track as they work to refine the overall package.

We start with the exhaust ports. After we determine the basic exhaust port design , we have it cast, but with a small diameter. Then we start enlarging it incrementally to find the ideal shape. We do the same with the intake port. We have more freedom with intake port shapes because heat concerns are not a problem with the intakes. We'll make between 200 and 300 different versions before deciding on the final production shape from which the production mould will be made.

Giving the engine its desired personality, what we call in Japanese 'aji tsuke', or flavour, comes from striking the perfect balance between port shapes, compression ratio, exhaust system design and ignition timing. It is not something that can be left entirely to dyno charts. Feedback from the test riders is very important in the tuning of our engines.

On its very first full-throttle dyno run we got 165 horsepower out of it. Of course, we've upped that figure significantly since then. And Ram Air adds about 12 horsepower in the higher speed ranges. If we didn't have noise regulations to worry about we could probably bump it up to about 210 horsepower.

Getting a high flash reading on the dyno is not too difficult. The hard part was ensuring that the ZX-12R's high power levels and high reliability levels were maintained during extended high-speed riding.

Production tolerances of the ZX-12R's pistons and other reciprocating parts are so close that conventional blueprinting techniques aren't necessary. The plated cylinders reduce the distance between bore centres, so we're able to use a shorter, stiffer crankshaft. With side-drive cams we can equalise the length and shape of the intake tracts for more even performance between cylinders.

Overall, one could argue that the ZX-12R engine is a larger, meaner ZX-9R engine equipped with a balancer and fuel injection. But I knew this engine from its birth, watched it develop. I know this engine has its own identity.

Chapter 4. Chassis.

Monocoque and set-up

With the ZX-12R, Kawasaki has succeeded in achieving the, until now, mutually exclusive qualities of high-speed stability and nimble, supersport handling. This was accomplished by developing a revolutionary new aluminium monocoque chassis, the first ever on a production machine.

Why a monocoque? Like all breakthrough innovations, the choice appears quite obvious after the fact. When large-section aluminium spars are wrapped around an already wide, large-displacement In-Line Four engine, the resulting package must of necessity be wide. The ZX-12R's all-aluminium monocoque chassis eliminates these perimeter spars in favour of a large box-section running over the top of the engine.

The frame design surpasses the levels of chassis stiffness and strength associated with conventional aluminium twin-beam frames, but with considerably less breadth. Without the twin beams or other frame elements running around the side of the engine, the fairing can be much narrower, resulting in a much slimmer overall package and significantly lower drag coefficient. Ultimately, it is the combination of a compact, massively powerful engine with this super-stiff and slim chassis structure that explains much of the ZX-12R's high-speed performance.

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The goal for the ZX-12R's chassis team may have seemed simple: create a compact, lightweight, short-wheelbase chassis that offered stable handling at high speeds and delivered supersport handling qualities. Achieving this goal was anything but.

My first memory of a monocoque frame goes back to our KR500 factory racer. I never even saw the real thing, but there was this toy model of one sitting around and I got to looking at it and started thinking. It seemed like an interesting way to build a chassis. I was thinking of ways to slim down the bike because they had a reputation for being kind of fat, or wide around the middle.
Then, one day, I was looking at the huge airbox and air intake on an '89 ZZ-R 1100 and I thought, why not make this the frame? Then we could use the entire upper frame section as an airbox and Ram Air duct.

Originally, I wanted to use a monocoque frame for the ZZ-R 1100, but the idea was nixed by the big bosses. It was probably a good thing, though, because at the time we didn't have the production technologies we have now.
So, when they put me in charge of the ZX-12R project I knew right away that I wanted to use a monocoque.

The monocoque is much narrower than typical twin-spar frames, resulting in a more compact machine with a smaller frontal area. With the box backbone also serving as an airbox, it makes everything simpler and more compact. And because there are no main beams angling sharply out from the steering head, the steering angle can also be increased, making it easier to manoeuvre at low speeds.

At first there was a lot of uncertainty in the production department as to whether we could even build the thing. The production engineers were unsure whether they could achieve the desired accuracy, especially where welding was concerned. No one had ever built a frame like this before, so they had to develop new production technologies. Finally, after much trial and error we discovered that as long as the individual frame components were made to very high dimensional tolerances, joining them together would be no problem.

As the chassis started to come together, we faced our next major hurdle: making it compact and stuffing the whole package into a short wheelbase. Having a short engine to work with was a big help. And by putting the radiator in the monocoque, with its cooling fan above the headers, we were able to pull in the front wheel enough to get a nice, short wheelbase with a weight balance of about 51% front, 49% rear.

Creating a short wheelbase chassis that also offers excellent stability at high speeds took an immense amount of testing. Usually one compromises the other. There is also a proportional relationship between stiffness and stability, with greater stiffness delivering more stability. Of course, a certain amount of flexure is desirable, but with a frame as stiff as this, it is taking place at a very high level.

Developing the pentagonal swingarm was also very involved. Conventional wisdom says the stiffer the

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better, but in reality swingarm stiffness must be balanced against the frame's stiffness. Testing has shown us that swingarm stiffness must be relative to frame stiffness, and we can plot a line which shows just how much swingarm stiffness is ideal for a given amount of frame stiffness. The fine tuning of all this is of course done on the test track, not the test bench.

As the early test data started to come in the team was stunned. The new frame was not only going to be extremely light, but much stiffer than they had ever imagined. Without realising it they had taken a major step in revolutionising the future of frame design. But ahead of them still lay the colossal task of building a machine around the chassis.

During the early stages of development we were very anxious. We thought we had a good idea, but unless it has been proven that's all it is - an idea. It wasn't until we started actual testing that we knew we were on to something special. The frame ended up being about twice as rigid as the ZX-9R frame and almost two and a half times more rigid and much lighter than the ZZ-R1100 frame.

We could have made it even stiffer had we used all rigid engine mounts, but we wanted the bike to be able to cruise comfortably at high speeds with very low vibration levels, so the engine is rubber mounted at the front.

We had plenty of other problems to overcome, too. Finding a suitable drive chain was very difficult. Simply making it bigger is not the answer, because that brings weight and noise penalties. We had to ask DID to make a special chain for us, one with specially hardened side plates, special rollers and precision ground pins. Externally, it may look similar to existing 530 chains, but it's quite different.

Tyres were another area of great concern. It's not easy to design a tyre with both good traction and long wear characteristics - especially with a machine this powerful. It the tyre is too hard, it gives a harsh ride and compromises handling; too soft and it wears quickly. Designing the tyre construction and finding the right rubber blend were very challenging. The 200/50 rear tyre was specially made for the ZX-12R and is, I think, the biggest ever on a production bike.

Involved in everything from stress testing of components to fine-tuning settings out on the test track, the chassis testing team would not only ensure the chassis configuration worked, but worked optimally in widely varying conditions.

Chassis development at Kawasaki consists of both bench testing and road testing. As the development proceeds, feedback from our test riders becomes ever more important.
Our rest frames have adjustable swingarm pivots. We also test a variety of front fork triple clamps with varying offsets and angles, different spring rates and various damping settings. The final production settings are based on the best combination we can find.
We tried to develop a chassis that was as stiff as possible but without the kickback and heavy handling associated with an overly stiff chassis. We built about twenty different frames before finding the right combination.

Most of our test riders are former racers, and they all have their own riding habits, likes and dislikes. One rider may be easier on the brakes than another; one may use a lot of throttle, and so on. When fine tuning the chassis prior to production, we have to take all of these idiosyncrasies into consideration, then add it to the data we get from bench testing and from riders without a race background. Of course, a lot of useful information gets exchanged informally while socialising after work.

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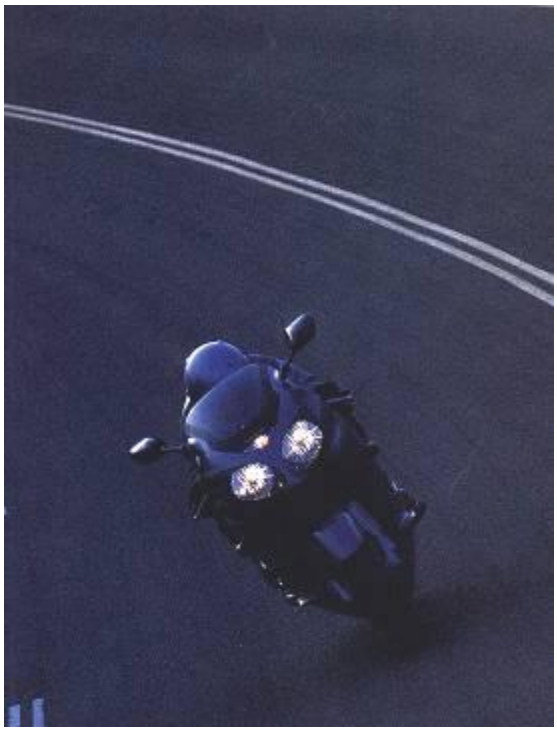
Being a good test rider requires a combination of skills but if I had to nominate one personal characteristic which is indispensable on a project like this, it would be perseverance. For example, we spent an incredible amount of time just developing the rear tyre; it's very difficult to strike the right balance between traction, wear characteristics and ride quality.



You try so many different combinations, so many permutations that eventually when you know it's right, you just know. There's a tremendous feeling of satisfaction when that happens; nut punch-the-air, home-run type stuff, but I think a deeper, more lasting sense of accomplishment. Suffice to say, we are very proud of how the ZX-12R turned out.

Chapter 5. Test Riders.

Precision and instinct

The look great on the drawing board - greater still in our imaginations. But in reality few of these "revolutionary" machines ever get built, and those that do seldom make it to production. Either they're too expensive to produce, too heavy, too weird, or they just plain don't work. Proving what works and what doesn't and displaying rare skill and courage in the process, are the test riders.

To many of us, the test rider's work seems a strange amalgam of dream job and nightmare assignment - of course we would all love to ride bikes for a living, but who in their right mind relishes hanging it on the line on untested machines, day in, day out?
It is no co-incidence that many test riders are former racers, and there is a striking calmness about their reflection on this highly-skilled profession. But by their own admission, their matter-of-factness off the track regarding the feats they are called on to perform can belie the emotion that they actually feel when they turn the key and head for the banking. One thing is for certain - they possess a special affinity with the motorcycle that simply clocking up riding hours cannot bring.

Taking the powerful ZX-12R through track testing would call on all the considerable skills of the Kawasaki test riding team, and because the project was breaking so much new ground, would ask even more of them than usual.

Able to judge settings to the millimetre or degree just from track feel, read slight sway of minute vibration and sum up the impact of intricate adjustments faster and more reliably than any technician with calculator in hand, the chassis test rider's input was vital in determining the final configuration and settings for the radical new chassis.

Achieving both high-speed stability and responsive handling was very difficult. We tested a tremendous variety of frames, swingarms, triple clamps, tyres and suspension settings before coming up with the final package. But what makes the job really difficult is that whenever one component is altered, all the other

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settings change, too. For example, about midway through the test protocol we found that steering feedback was improved with a wider fork pitch. But as soon as we changed that, we found that the tyre profile, which had been fine before, wasn't working anymore, so we had to develop a new tyre. We spent an awful lot of time designing the right tyres for this bike and I would caution riders about changing tyres in an effort to improve its performance.

When we're not riding we completely disassemble the high-mileage test mules and check every part for unusual wear. This includes magnafluxing, X-raying and other forms of crack testing. If any problems are found, we get together with the engineers to find a solution.

Bikes which are top secret are never tested on public roads, security on closed courses is tight, lots of looking over shoulders. By the time they get onto the streets in some disguised form, often word of them has already leaked (or been leaked) to the press. I'm a rider, and I find all the cloak and dagger stuff a little bemusing, but when you pull on the helmet and climb on a new machine, you really can't afford to let any of it distract you.

In some ways it feels similar to the ZX-9R, but the ZX-12R is more muscular. In fact, in the first monocoque chassis we used a ZX-9R engine and it handled pretty well. Then we dropped the ZX-12R engine into it and discovered that it wasn't nearly stiff enough to handle the enormous power. of course, too much chassis stiffness is no good, either. It makes a bike feel wooden and unresponsive.
So since it was a totally new kind of frame with an all-new engine, we effectively had to start from scratch. The only way to get it right is then to spend endless hours flogging it on a test track. With many more hours after that talking things over with the engineers until they understand just what the bikes are telling us out there.

The biggest difficulty was achieving a combination of high-speed stability with quick, responsive handling performance. If all we wanted was high-speed stability we could just stretch out the wheelbase, like some of our competitors. But then you lose that responsive handling quality. Our test frames used an adjustable swingarm pivot to determine the ideal squat/anti-squat characteristics.
The production chassis is considerably different from the early test bikes, especially in the suspension department. I

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suspension settings can make a big difference.

Testing is often as much art as science. For example, a test configuration might perform fine in warm conditions, but then doesn't work in the cold - go figure. Even though this is my twelfth year as a test rider, the raw potential of the early prototype machines still took some getting used to.

Beyond trying to establish a kind of personal connection with the test machine itself, relationships with the rest of the team also play an important part in the testing process. I had some, well, disagreements with the engineers, because sometimes the bike didn't behave the way they calculated it would. But ultimately there is a lot of mutual respect, and despite the pressures and occasional flare-ups that are part and parcel of testing, things are generally ironed out very amicably.

Working with the engine development team, the engine test rider's job was to give the massively powerful motor those characteristics that cannot be revealed by dyno charts alone. In the final analysis, he would determine the engine's personality.

My job is to assess the engine's overall power characteristics. At first, it didn't run nearly as well as I expected it would. You kind of have a feeling about how a 180 horsepower engine should feel. The early bikes didn't have it.

Gradually, though, test by test, we got the motor to run really well. It's so smooth now that even at top speed it doesn't feel at all stressed, like it's actually going much slower. The efficient aerodynamics are one reason it doesn't feel so fast, the other is that it doesn't exhibit any overt tendency to lift the front wheel when you whack open the throttle. But it still has that aggressive character for which Ninjas are renowned.

At the later stages of testing, we usually do one lap at full throttle followed by four laps at 80%. This cycle gets repeated many times. But when we take out a new machine for the first time, naturally we have to build up speed gradually before we start to test the machine really hard.

Nothing compares to the anticipation of testing a machine as powerful as the ZX-12R. Unfortunately, whether we're testing scooters or hyperbikes, our pay remains the same. But being known as one of the ZX-12R's test riders is a nice reward in itself.

They can get a lot of good chassis data through bench testing, but we have the final word. There needs to be good understanding and communication between engineers and test riders, and of course the approach needs to be very professional. But at the end of the day, to maintain a workable rapport amongst all the seriousness, I think it's also important to try to retain a sense of humour. For instance, if the discussions with the engineers get too heated, I just offer them the keys and ask them to see for themselves what it's doing on the banking. That usually settles it!

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My thoughts out on the test track? The ZX-12R seemed to me to be about 20 km/h faster than the ZZ-R1100. In some ways it feels like a bigger, faster ZX-9R, in other ways it is a completely different animal.

Test riders are constantly looking to define, and then refine, a bike's character. So a good test rider has to be able to read a bike's idiosyncrasies, and diagnose problems quickly. The good ones seem to have a special sense. We use a lot of former and current racers as test riders. That's probably one reason our bikes have the distinctive character that they do.

It's very hard to describe the "Kawasaki feel" we try to design into the bikes. I can't put it into words. You have to ride a Ninja to understand.

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Specifications:	**ZX1200-A**
Engine type	4-stroke, liquid cooled In-Line Four
Displacement	1,199 cm3
Bore x Stroke	83.0 x 55.4 mm
Compression ratio	12.2:1
Valve system	DOHC, 16 valves
Carburation	Electronic Fuel Injection
Ignition	Digital
Starting	Electric
Transmission	6-speed with Positive Neutral Finder
Frame type	Press backbone (monocoque), aluminium
Rake/trale	23.5 degr/93 mm
Suspension, front	Inverted 43 mm cartridge fork adjustable for preload and 12-way rebound/12-way compression damping
Suspension, rear	Bottom-Link Uni-Trak with gas-charged shock, adjustable for preload and 18-way rebound/20-way compression damping
Wheel travel, front/rear	120/140 mm
Tyres, front/rear	Tubeless radial, 120/70 ZR17 (58W) / 200/50 ZR17 (75W)
Brakes, front	Dual semi-floating 320 mm discs with dual 6-piston calipers
Brakes, rear	Single 230 mm disc with opposed 2-piston caliper
L x W x H	2,080 x 725 x 1,185 mm
Wheelbase	1,440 mm
Seat height	810 mm
Fuel capacity	20 litres
Dry weight	210 kg
Colours	Candy Persimmon Red / Metallic Midnight Purple, Metallic Phantom Silver / pearl Cosmic Grey or Candy Lime Green / Metallic Midnight Purple

Closing Message

Some may think that the positioning of this message at the end of the book is fitting - that marketing people always feel that they simply must have the last word. But let me say that I think it appropriate for an entirely different reason; I believe that the opportunity to bring the Ninja ZX-12R to market truly represents a happy ending - for all those who love motorcycling, and certainly for us here at Kawasaki.
It is really through the initial labours and tribulations of the designers, engineers and test riders, whose story rightly appears ahead of this message, that such a marvellous machine could be made a reality and presented to the world. Many don't make it that far, marvellous or not. So I finish by paying tribute to these people, and indeed to the motorcycling community as a whole, to whose heartbeat ultimately we march.
And as we treasure the memories we have of the ZX-12R project and enjoy the sharing of them with you, we hope that this book will serve as a lasting memento for yourselves, family and friends to enjoy for years to come.
So essentially, we end this book where we began - with matters of the spirit. Because this is something you can't really encapsulate for those who don't know the feeling, the emotion, that riding a Ninja can bring. it is something to be experienced. And then experienced again and again.

May all you experiences be good, and your riding pleasures great.

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