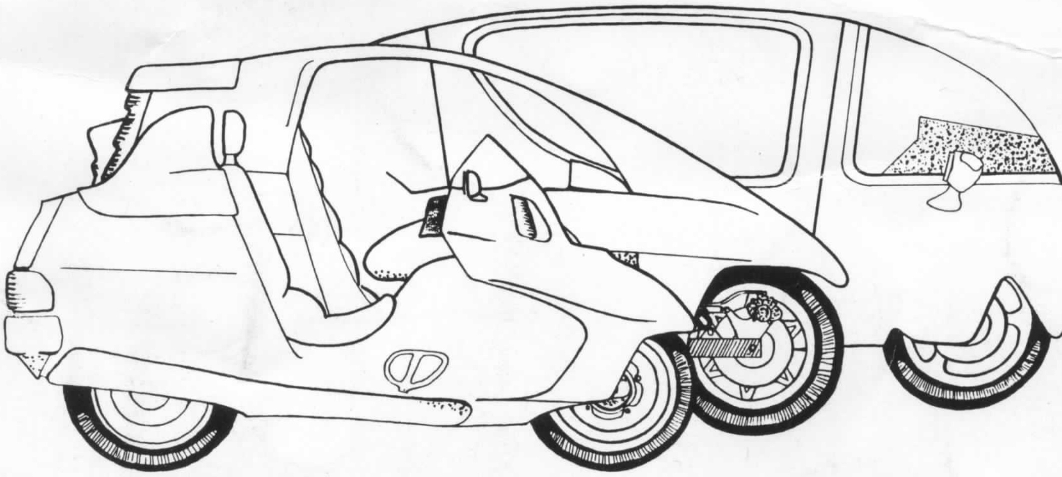

what ever happened

a review of feet-first two-wheeler developments

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by Royce Creasey

what ever happened

Written and published in 1993 by
Royce Creasey
31 Gratitude Road
Greenbank
Bristol BS5 6EH

Drawings by Boris Sayers
Designed and produced by Ingrid Oesten

Photographs:

John Bruce's BSA	-	Tim Holmes, Classic Mechanics
Malcolm Newell's 'Sev'	-	Patrick Gosling
Graham Fryer's Velocette	-	Royce Creasey
Difazio/Creasey 'Banana'	-	Ingrid Oesten
High-Tech Ducati	-	Patrick Gosling
High-Tech Voyager Prototype	-	Andrew Birch
SCL Voyager	-	David Goldman
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High-Tech Voyager crashed	-	Royce Creasey

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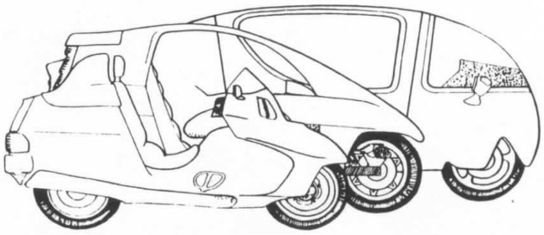


Credits

Since 1986, indeed since the beginning of the eighties, a great number of people have given assistance to the FF production project that my partner Ingrid Oesten and I have run. Some did this in the course of their work, but all went beyond the mere commercial in contributing time, ideas and actual hardware. We got as far as we did, developing our prototype designs to the point of production by a manufacturing company, because of this assistance. I am pleased to be able to take this opportunity to embarrass these people by mentioning as many names as possible. Buy them a beer if you run into them!

Alan Baker
Chris Baker
Alan Blake
The Blezard Family
Andy and Susanne Burch
Maria Clarke
Simon Creasey
Jack Difazio
Graham Fryer
Tim (Harry) Harrison
Richard Heydenreich
Bill Gamieon
Paul Hobbs
Steve Kane
Ross Kinnear
Ken Leaman
Henry Mayhew
Paul Mercer
Malcolm Newell
Mike Nicks
Barry Nurse
Jürgen and Edith Oesten
Tony Palanca
Ken Pollock
Daniela and Horst Przuntek
Tim Roberts
Boris Sayers
Ian Smail
Nigel Stevens and Robert Ewin
Bob Tait
Tim Holmes
Dave Taylor OBE
Mark Udwin
Mark Verden
Bob Winsper

Introduction

A number of people have contacted us this year, curious to discover what has been happening to feet-first two-wheelers since we published our Information Pack in 1986. The result is this review. It reflects our main interest during the late eighties by concentrating on our Voyager project. This was already under way in 1986 but the more interesting phase, the transfer to production and the production vehicle launch, came at the very end of the eighties. We also include material provided by Arnold Wagner about his Ecomobile. This made the transfer to production during the eighties as well but survived the experience and has gone on to production success for Peraves AG, its manufacturer.

The review is generally less technical than the Information Pack. This is because a large part of our eighties experience concerned non-technical developments. Like Peraves AG we were chiefly involved with the multitude of non-technical activities essential to the progression of any innovation. We've been spending time with suit wearers of all sorts; the industrialists, the civil servants and even the odd lawyer. There is a chapter about the business of innovation in general. Everybody learned a lot about this subject in the eighties but there hasn't been anything like as much technological progress. The 1990 Ecomobile is surprisingly similar to Malcolm Newell's Quasar from the late seventies.

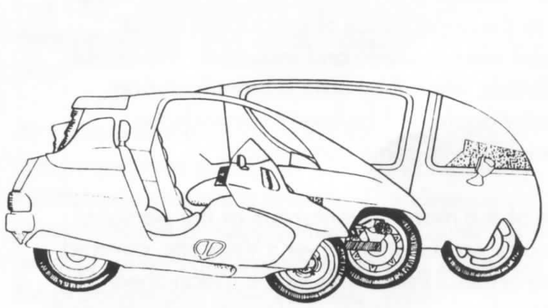
Nevertheless we've included the technical argument for feet-first two-wheelers, re-written and backed by line drawings. The sections in the 1986 Information Pack intended for other constructors, designers and innovators, have not been included. At that time a number of one-off vehicles existed and it seemed possible that more might appear. This has not happened to our knowledge and most effort during the eighties has involved relatively conventional production development by commercial companies.

From the British perspective this process has been a failure. A production version of the Voyager design was launched at the 1989 Motorcycle Show and orders were taken but the manufacturers failed to obtain production finance and no vehicles were produced beyond the five production prototypes. Prolonged attempts to rescue the project eventually ran into the British recession and the project was finally terminated earlier this year.

Prospects in this country have remained bleak for an engineering project of this scale. In 1990 making contact with all the companies in the UK we believed capable of making motor vehicles took about six months. This year it took two days. No doubt the steady run-down of local industry over the last twenty years will be halted, even reversed, one day. We would be the first to argue that the bottom of a recession is the very best place to start investing in new products. Any investor who agrees is most welcome to contact us!

The conclusion to be drawn from events to date however is that the feet-first two-wheeler will probably join the long list of innovations developed as prototypes in this country that go on to production success elsewhere. The British repeatedly allow this to happen so it must be assumed no-one minds too much.

Enthusiasts for better products can be relieved that the Ecomobile has done so well and hopeful that Peraves AG will go on to produce a wider range of vehicles. This might cause the big vehicle manufacturing companies to finally wake up and in another eight years you may be able to catch up with FF news by just picking up a newspaper. Maybe!



So what did Happen ?

By 1986 there were several strands of FF development, motivated in most cases by a desire to see the idea in production. The most visible was still the Quasar, backed by the 'built to order' FF one-offs that Malcolm Newell produced after Quasar production ended with the failure of the parent company. Malcolm built more FFs than anyone else put together in the eighties.

Another strand was represented by the prototypes I was working on as part of a production project and there were other, similar projects. Also, unknown to us then, Arnold Wagner in Switzerland had an Ecomobile prototype running and was starting the long struggle, against Swiss and German red tape, needed to get them onto the road. Apart from these more or less commercial projects there were a number of individually produced one-offs, ranging from slightly modified motorcycles to 'clean-sheet' FF designs. These were built for a variety of reasons, a few just to satisfy curiosity, several for commuting and one even reached the racetrack!

The following eight years have seen the natural development of those strands. Many have disappeared. Some almost survived. Only one, the Ecomobile project, continues in production. Despite this high casualty rate very considerable progress has been made since 1986 in promoting the idea of feet-first two-wheelers. This has fitted well with a general increase in awareness of traffic realities and I believe that the main obstacles to the appearance of production FFs at present are economic and industrial. No doubt the British, when they have a manufacturing industry again, will be keen to provide the Ecomobile with some competition!

One of the more adventurous of the personal one offs was Graham Fryer's Velocette, covered in the original Pack. This was a 'clean-sheet' FF design closely related to my Ducati prototype and it performed very well. Viewers of the BBC TV 'Top Gear' programme in 1988, that featured the most, different FFs ever assembled, will have seen it sporting a silver nose section. Graham ran this vehicle throughout the eighties, eventually replacing the Velocette engine with a unit from a Honda 500 V4. He is now considering which engine to use next and has built his own double-wishbone front suspension.

Many of the other one-offs still exist. Some, like the fearsome Z1300 Phasar also featured in the 1986 Pack, have gone abroad. Others are parked in sheds while their owners grapple with the problems of making any one-off perform at acceptable levels of everyday reliability. It is difficult to construct a vehicle that is not simply a collection of brought-in parts. We can expect solo FF builders to continue to be a rare breed.

A number of people attempted to take the idea through to commercial production. These ranged from John Bruce's plan to produce modified CN250 Honda motorcycles, as a very low cost FF for commuters, to our own 'Voyager' project. Despite a wide range of techniques and designs we mainly demonstrated that the British aren't very good at getting ideas into production, which we all already knew. I was exclusively engaged in the Voyager project for much of the eighties so I will outline the specific process that led to the Voyager show launch at the 1989 Motorcycle Show in Birmingham.

This project started in the late seventies. Study of the Quasar had shown that the layout had advantages over other forms of two-wheelers which would allow a production vehicle to compete with both motorcycles and small cars. This is a huge market and my first tactic was to contact an existing vehicle manufacturer and convince them of the market and profit potential.

This required a convincing prototype that I was not then equipped to build. In addition the Quasar front suspension, basically a motorcycle type, was not satisfactory so I was eager to fit a better system. This led me to Jack Difazio of Frome, Somerset. Jack then built specials that used his patented 'Centre-Hub' double wishbone system. He agreed to build an FF prototype with the intention of then going on to offer examples for sale, rather like Malcolm Newell's Phasar operation that was starting at the same time. Jack produced two vehicles by 1986 of which the better known is the 'Flying Banana' owned for a while by the journalist Paul Blezard. Both vehicles featured on the 'Top-Gear' programme mentioned above.

I was not able to use this CX500 powered machine for demonstration purposes after Jack decided to discontinue the project and after some delay I produced my Ducati prototype. This was built to be shown to manufacturers as a 'proof of concept' demonstrator and it had no refinements or styling. It performed splendidly, most notably at BMW's test track in München where it demonstrated its safety superiority over motorcycles the hard way. In-between worrying manufacturers it filled in by combining general transport duties with high entertainment levels. As detailed elsewhere, this vehicle's career was prematurely ended by engine failure.

The engine could have been repaired but by the mid-eighties it was clear that no-one was arguing about the technical merits of the layout. The concept didn't need proof. Contact with major vehicle manufacturers had revealed that these big organisations were simply unable to react to new ideas like the FF, even though their own prototype engineers liked it. The chapter for innovators has more on this subject.

This required a change in tactic. "If we can't join them we'll beat them". The next best option was to find a manufacturer, outside the vehicle industry, with the capacity and the will to take a vehicle project on. A more sophisticated demonstrator was required for this, making clear the sort of product we had in mind and allowing close costing for people lacking specific vehicle experience. The result, after stripping the Ducati for components and the usual period of labour, was the Voyager prototype.

Its worth digressing briefly to describe the reasons for the Voyager specification. Our objective was to achieve profitable production for an FF two-wheeler. A simple way is to assemble a vehicle with an astounding performance which justifies both a high price and various convenient compromises in practicality. There is always a market for astounding vehicles. This was known as the 'Ferrari option'. The other route requires the high initial investment needed for a more complete production vehicle. This 'Ford option' is more practical and cheaper to make in volume. In deciding between the two options we considered the limited and unknown market for two-wheel 'Ferraris' and that the 'Ford' was a better way of using the ability to compete with small cars and motorcycles. Finally we noted that while everyone has heard of Ferrari, Ford has made rather more money...

Having chosen the 'Ford option' we needed a design maximising the ability to replace small cars and motorcycles, embodied in a simple and profitable production package. I believe the Voyager prototype, built in eighteen months, was a fine example of such a design.

From the outset the Voyager prototype had a strange career. A fortunate contact saw it debut at the Essen Motor show in 1987 with its own rotating stand. BMW were also there, exhibiting one of their non-functioning FF styling exercises. Unfortunately it was in another hall and the German media failed to connect the two vehicles. However, we were paid enough for the display to replace the dummy engine with a real one and while that was assembled Voyager went straight to the Motorcycle Museum in Birmingham. The progression from show launch to museum piece in one move may be a record.

As might be expected from a machine constructed out of another working machine, the Voyager prototype was reliable more or less out of the box. There were some early problems with the cooling system, due to lack of familiarity with the engine, but the only failure in its career was a broken throttle cable at 9,000 miles.

This utility proved to be an important feature. As a result of our progressing attempts to make contact with manufacturers we faced increasing demands to travel to meetings and demonstrate the vehicle. One of the very first duties of the prototype was the courier work needed to keep up with the paperwork. Later on it proved that commuting seventy miles a day could be really enjoyable and the two-seat facility was highly popular. Most important, it succeeded in its main objective, to convince a manufacturer that it was a product worth exploiting. It was seriously damaged in 1988 in a collision with an errant Fiat 132 , demonstrating unsuspected levels of rider protection. This event is detailed on the last page.

At the time of the accident the Voyager production project was getting up speed and repairing the damage was not a priority. The Voyager production design was defined as a 'Tourer' as a result of surveys of potential customers, based on the prototype and other vehicles. While FF enthusiasts with direct experience clearly valued the unique combination of comfort with high performance, people without this familiarity tended to relate the heated cockpit and comfortable seat to a moderate, touring performance.

For this reason the launch vehicle was equipped and presented as a tourer, although it was confidently expected to reveal a much fuller picture for its owners. There were well-advanced plans for a 'Public Service' version for paramedics and police, with a similar option for the breakdown and courier businesses. This 200 off 'Limited Edition' design would have been followed by a more fully productionised version with the full range of sports, touring and utility options common to models of any vehicle.

In the event the Voyager project was halted shortly after the 1989 N.E.C. show launch, when the manufacturer failed to find production finance. During the next two years we made strenuous attempts with the other interests involved to find a buyer for this very complete production project. This, 1990-1992, was however a period of deep recession in British Industry and several of the companies we talked to no longer exist. One went into liquidation during our negotiations! The project was finally terminated fairly recently and the five production prototypes are currently for sale to the highest bidder.

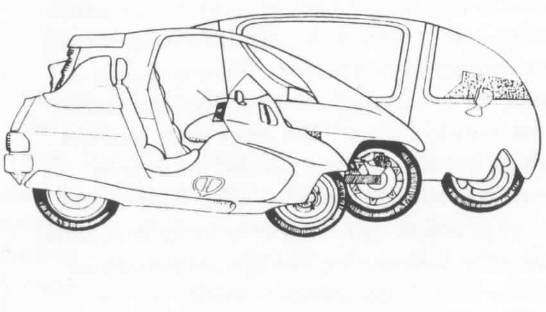
The vehicle I am now creating from the components of the Voyager prototype also uses new parts, some surplus to the production project. It naturally incorporates a full re-design to further improve the packaging of components and reduce size. I hope the result will provide many years of enjoyable transport. This Reliant/Moto-Guzzi package is now obsolete for production purposes although we may hope that the 'two-wheel sports-car' concept that Voyager represented will be developed further in the future.

While British production attempts failed in the eighties Arnold Wagner and Peraves AG succeeded. Avoiding the problems that await the British innovator but doubtless meeting and solving plenty of others, they have taken their 'Ferrari option' Ecomobile through to successful production. Their five production prototypes were seen on that 1988 Top Gear programme. Despite a price beyond anything ever before contemplated for a production two-wheeler, and a specification uncannily like a longer, heavier, 1978 Quasar, they have now sold more than 50 Ecomobiles. Only the Sheffield Simplex Neracar of 1928 beats this with over 2,000 units.

Unless that is, you count the Honda CN250 'scooter'. The FF movement has its own purists and there is some argument as to whether this is a proper feet-first two-wheeler. It is questionable whether the minimal backrest provides 'secure seating' and Hondas have certainly concentrated on distinctly scooter-like characteristics.

Between Honda's stretched scooter and the Ecomobile which is classed as a 'Cabin-Motorcycle' there is a large range of options to address a huge transport market. Peraves have shown how a straightforward assembly of components in a striking shape can command a high price, exactly as the Quasar did in the seventies. The Voyager outlined the potential for more modest, mass production vehicles that could compete on price as well as performance. Industrial and financial inertia is increasingly the only obstacle to further FF production.

Peraves' comment in their own material that they are talking to other manufacturers is significant in this respect. They will be as aware as anyone of the limits of the market for the Ecomobile. A move towards mass production, which in turn means a move towards cheaper, more accessible vehicles, is an obvious development. It will be interesting to see who dares to be first with such a product. Japanese or German ? Perhaps a Swiss design company working with German capital and Japanese components in Eastern Europe - or Taiwan. It is possible that the feet-first two-wheeler will disappear, a forgotten dream of the late twentieth century. It is much more likely, on its track record alone, that better and better examples of the type will continue to appear. Eventually a motorcycle manufacturer will have to start making them out of embarrassment!



The Reason Why

1. A body will remain at rest, or in uniform motion in a straight line, unless acted upon by a force.
2. The force required is proportional to the mass of the body and how much it is accelerated or decelerated.
3. Action and reaction are equal and opposite.

Newton, three laws of motion.

A feet first two-wheeler has a low-mounted seat and seat back like a car. Park any half-decent example in a city street and it soon becomes clear that the main advantages of the idea are obvious to all. For a start it's clearly comfortable. Secondly it's parked. Plenty of people who stop to look also regard body work and a heater as long overdue additions to two-wheels. It was the lack of these features in many cases that got them into four wheels.

All the surveys we've done back this up. Motorcyclists universally rate Comfort, Handling and Safety, in that order, as primary requirements. Car drivers want the same but assume that comfort is a standard feature. Riding a motorcycle is one of the most strenuous activities available. Add winter weather and it becomes a major test of endurance. Because the rider sits on top of the motorcycle, any body work fitted adds to its frontal area. It's possible to ease the pain but only at the direct expense of performance.

The motorcycle, the Motorised Bicycle, is possibly this century's greatest industrial monument to tradition over design. It is certainly exciting wrestling with the deficiencies, surviving the risks but the main objective of motor vehicles is simply to provide practical transport. The failure to do this has sentenced the motorcycle to specialised minority markets. Only the ultra-utility two-wheeler really works. The Honda 50/90 is the most successful powered two-wheeler ever. The FF layout aims to return two-wheelers to a more useful role.

Onlookers are right to assume that a comfortable seat, with a backrest is better than sitting astride a bench. All orthopaedic evidence absolutely supports this common-sense perception. This 'comfort' is more than just the major reduction of muscular effort due to the rider's body being held up by the seat back. The secure seat at the heart of the FF layout leaves the rider's hands free to operate the controls and this adds to up to a real extension of the control envelope. The result is an ability to cope with situations that would upset most motorcycles. Falling off a motorcycle in the middle of a control emergency is a real problem, best studied at leisure on race-track videos. It's obvious, but important, that its much more difficult to fall out of a full seat!

Getting the seat low, as well as comfortable, is justified by the aerodynamic advantages alone. A rider on top of a motorcycle causes about 20% more drag than the same rider sitting at car driver height. The body work needed to protect a motorcyclist adds further to drag and fuel consumption. Frontal area is the main cause of drag at vehicle speed levels. Motorcycles with body work also suffer from instability. They are just the wrong shape.

Technically it's very difficult to get the 'Centre of Pressure', the point on the body work through which the force of the airflow acts, to fall behind the 'Centre of Gravity', the point on the vehicle through which the entire weight of the bike acts. This is essential for stability, even in still air. Motorcycles also have a problem with lift at the front end.

None of this is a problem for the feet-first layout. Apart from the reduction in frontal area it allows a good Centre of Pressure and Centre of Gravity relationship. Body work can be fitted without causing drag, stability or lift problems. Aerodynamic efficiencies similar to cars have been achieved without wind tunnel development.

The good aerodynamic qualities make body work inevitable and the degree of body work can extend to the point where, like the Ecomobile, it has become the vehicle and the cockpit is exactly as civilised as a modern car. Alternatively, at a small cost in comfort, a smaller and more agile vehicle like the Voyager can compare well with a modern sports car. Any Porsche or Ferrari owner can tell you: Performance does not require suffering!

Body work adds passive safety to the active safety improvement of a secure seat. When all attempts at evasion have failed and an impact occurs, body work around the rider prevents exactly the type of serious leg and head injuries common to motorcycle accidents. No funds are available for safety research but accident experience with both the 'Cabin Motorcycle' and the 'two-wheeled sports car' has demonstrated crash protection approaching car standards. A large car will protect it's occupants well but smaller vehicles are better for everybody else. At the very least the FF layout provides much better protection than a motorcycle.

All these advantages in comfort and safety would be irrelevant if the vehicle handled as poorly as a motorcycle. Only fit and able people can muster the effort needed to hustle a big motorcycle through curves at the rate achievable with ease in a modern car. Even at low speed larger motorcycles are cumbersome compared with small cars. Bad conditions, snow, wind, just rain at night will demand skill and extreme care.

These handling deficiencies are almost entirely due to the high Centre of Gravity of the motorcycle and rider. This relates entirely to the seating arrangement, rider on top of machine, which causes so many other problems. The mechanics of two wheeler handling must be considered to see why the height of the Centre of Gravity is so crucial. First however we must define what good handling is.

Two-wheelers stop, start and steer by acting and reacting against the ground. They are not ships or aeroplanes. The wheels, which do all this work must stay firmly on that ground, with enough load to maintain grip, to achieve good handling performance. Once the wheels leave the ground no other handling qualities matter.

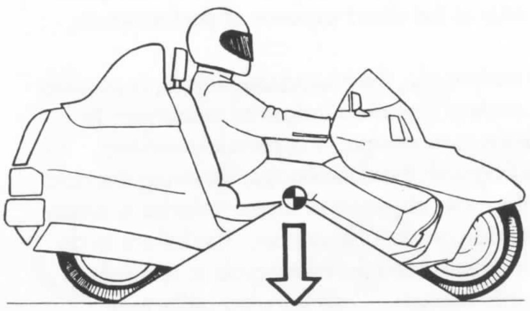
Next any vehicle should be basically stable, reacting obediently only to control inputs from its operator. Inputs from the road should be detectable only as a control aid, as useful feedback. Operator effort should be low and proportional, with brisk vehicle response and minimal feedback. Operator skill should be reserved for dealing with the road situation, not vehicle idiosyncrasies!

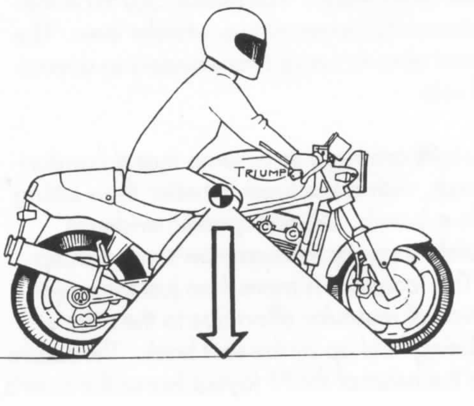
Finally, these predictable and safe conditions should be maintained throughout the widest possible performance envelope. Final control loss should be progressive as possible.

Two wheelers are unique because they steer by banking from side to side. They balance and steer by moving the Centre of Gravity about in relation to the tyre contact patches, by acting and reacting against them. Any two-wheeler running down the road is constantly shifting its Centre of Gravity.

It's the dynamics of this process that defines how well a two wheeler will meet the requirements of good handling. The process is controlled by the laws of motion kindly provided by the late great Isaac Newton and detailed above. These apparently simple rules define all physical relationships this side of Einstein. The Centre of Gravity, the point that the whole weight of the vehicle acts through, is the 'body' we must consider.

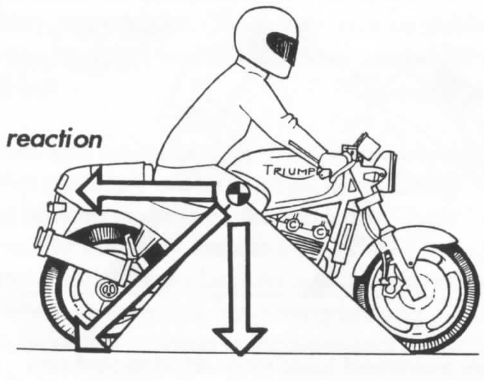
At its simplest any two-wheeler can be reduced to a triangle, standing on its base. At the apex is the Centre of Gravity. At the two lower corners are the points of contact with the ground, the two tyre contact patches. The two sides of the triangle represent the lines of force through which the Centre of Gravity of the stationary vehicle can act and react against Planet Earth.





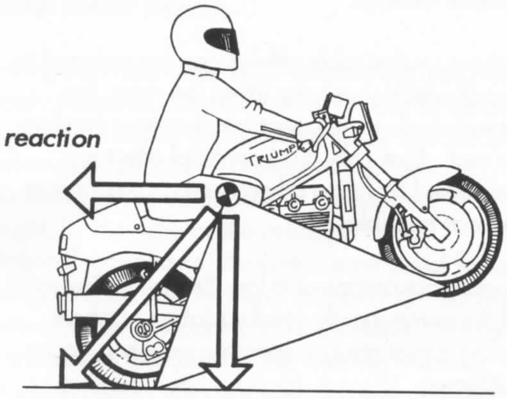
Keeping the wheels on the ground when a two wheeler is at a standstill is easy enough. Gravity acts on the vehicle's Centre of Gravity and the resultant load is shared out between the two contact patches. The actual line of force is the combination, or 'Vector' of these two loads and is vertically downwards. No problem there!

When the vehicle accelerates, the CG resists the change in motion and reacts against it. The addition of this force to the vertical force of gravity causes a new vector that will slope to the rear.



When the acceleration is exactly equal to gravity ('1G') this vector will slope 45 degrees to the rear. Braking has the effect of making the vector slope to the front in exactly the same way.

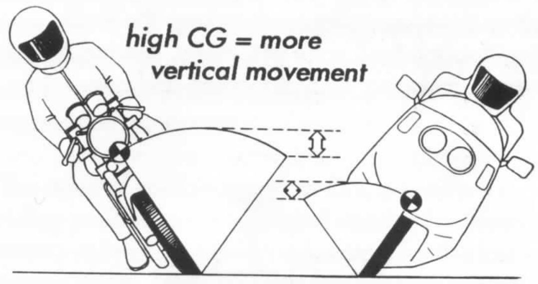
Modern tyres, brakes and engines provide higher acceleration and braking forces than this, even road vehicles can achieve 1.5G. This means the vector can have a shallower slope than 45 degrees. If the distance between the two contact patches (wheel- base) is short enough and the Centre of Gravity is high enough, the vector will go outside the sides of the triangle, which will begin to topple over.



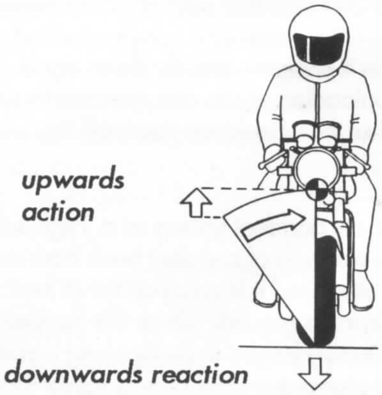
Most modern motorcycles can lift the front wheel under acceleration and the rear under braking.

If the wheels are to stay on the ground, safely loaded under acceleration and even emergency braking, the wheel base needs to be long with the Centre of Gravity close to the ground. If the wheel base is much longer than that of a large motorcycle there will be a loss of agility. A low CG is really essential for any two-wheeler in-tended to be stable and agile in urban streets.

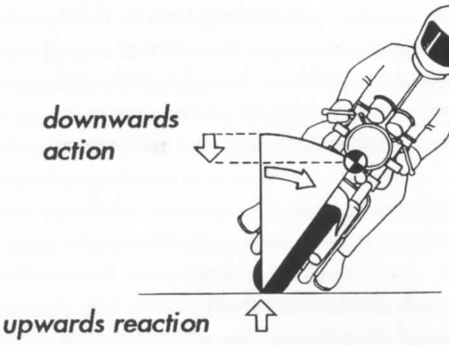
Keeping the wheels on the ground whilst banking from side to side, can also be a problem. Looking at the triangle from the front or rear while it is banked from side to side shows the Centre of Gravity moving up and down. It can be seen that a high Centre of Gravity has more vertical movement than a low one and it follows that a larger force will be required for a higher Centre of Gravity.



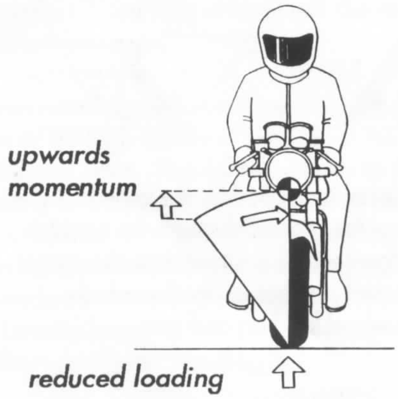
The upwards force is applied by the vehicle reacting against the ground through the contact patches. The front wheel is turned into the corner, forcing the contact patches under the vehicle. This increases wheel loading and grip.



When downward movement is needed however, gravity is the only force available and the triangle must be encouraged to fall over. This can be done by turning the front wheel out of the corner, moving the contact out from under the vehicle, or by the rider moving on the two-wheeler. In effect the Centre of Gravity is put into a degree of free-fall. This reduces the reaction against the contact patches, and therefore wheel loading and grip, by the same degree.



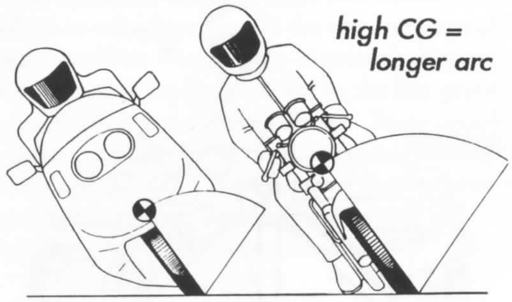
Although there is an increase in tyre loading when a two-wheeler banks upright, due to the upwards movement of the Centre of Gravity this mass also gains upwards momentum. It has been forced upwards and it will tend to keep going. When the two-wheeler reaches the upright position this momentum tends to keep the mass, acting through the Centre of Gravity, moving on upwards, reducing the tyre loading and grip.



If the vehicle then banks rapidly down again these two unloading effects can combine to such an extent that the wheels can come off the ground.

The motorcycle accident known as a 'High side' is an extreme example of a violent bank from one side to the other and it is common for at least one wheel to clear the ground. Once this happens the Centre of Gravity begins to move along a path dictated by momentum and gravity rather than by reacting against the ground: it goes ballistic The motorcycle also tends to rotate rapidly round the Centre of Gravity. This effect can be studied in slow-motion video under the heading of 'Big Accidents'.

The requirement for stability and low control effort can be met by minimising the distance the Centre of Gravity must travel when the two-wheeler banks fully from side to side. Reducing the distance travelled acts like reducing the mass to be moved, it takes less effort. This proportionally reduces the effort needed. Look at the triangle from the front again, at the arc the Centre of Gravity makes as the vehicle banks from side to side. The length of the arc increases as it gets higher. A longer arc means more movement of the Centre of Gravity for a given amount of bank.



More movement takes more effort to start and stop. A vehicle with a high Centre of Gravity will be harder to bank through a turn, in a given time, than a vehicle where it is low. It will feel heavier to control regardless of the actual weight. This is why a heavyweight like the Quasar could handle so well.

A high Centre of Gravity causes big variations in wheel loading and can even lift wheels. All inputs and reactions need higher forces, increasing control effort. This amounts to a serious narrowing of the control envelope, where the limits of wheel contact, tyre loading and rider effort are reached sooner rather than later. When the edge of the control envelope is passed, control is lost. Two-wheeler handling performance quality is directly related to the height of the Centre of Gravity.

All these undesirable effects can be reduced to insignificance simply by fitting the rider, the heaviest single component into that low, comfortable seat. Naturally this beneficial effect is accentuated by fitting other, heavy, components as low as possible.

A further advantage of a low Centre of Gravity and the consequently small variation in wheel loading is that good suspension quality is easier to achieve.

This logical combination of a low Centre of Gravity, with secure seats and efficient aerodynamics, as in the Quasar, the Ecomobile and John Bruce's BSA, provides excellent all-round performance even with the motorcycle-style front suspension used on these vehicles. Further improvement in handling quality is however available.

Good handling also requires good steering. The rider should be able to make any steering movement, large or small, fast or slow, which will be transferred faithfully to the front wheel. There should be no lost movement, no flexing and no tendency to overshoot. The system must be stable with any feedback limited to the level needed for good feel.

The fork-type suspension common to motorcycles, whether telescopic or leading link, flexes badly under braking and heavy steering loads. Even the massive Earls fork fitted to the Quasar squirmed under heavy braking and it is only early rear wheel lifting which, by limiting braking force, hides this problem on conventional motorcycles.

These traditional motorcycle front suspension systems add to this flexibility by fitting the suspension, whatever it is, between the steering head and the wheel. Any steering effort must pass through the suspension and this means that the free-play needed for the suspension joints becomes free-play in the steering.

Having added lost motion to flexibility these 'Steered Suspension' systems go on to finish the job with a tendency to overshoot and feedback uncontrollably. The mass of the suspension, including springs, damper units and structure must be accelerated and decelerated in every steering movement. This is a considerable weight that requires much more force to move than is needed just for steering.

Moving the mass away from the steering axis has exactly the same effect as raising a vehicles centre of gravity, it further increases the force needed to start or stop a control movement. The steering gets heavy. A force applied to this steered weight, by the rider or the road, produces rotational momentum which needs an equal force to stop. When flexibility and free-play are added uncontrollable feedback can easily result. Steered Suspension is the cause of the steering wobbles for which motorcycles are justly famous. Conventional motorcycle steering is a decisive step away from the basic requirements of good steering.

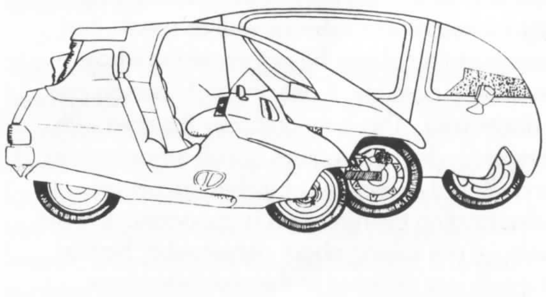
It is not difficult to avoid these problems. The 1928 Neracar managed it and the system patented by Jack Difazio of Frome nearly twenty-five years ago embodies all the qualities required. Jack's 'Double-Wishbone' system was used and developed, under a Bob Tait patent, by Malcolm Newell for his Phasar FFs and myself for the Voyager FF. The Bimota system is similar in principle but less strong and more complex.

There are a number of other systems such as the Yamaha 'Arm and Wishbone' copied from Tony Foale's QL project and the 'Double-Arm' system used by the ELF racers of the last decade. History records a number of other innovative ideas dating back even further than the Neracar.

The common key feature of all these systems is that they do not steer the suspension. Instead of fitting the suspension between the wheel and the steering like a motorcycle, the steering goes next to the wheel and the resulting assembly is suitably suspended, like a car. Only the wheel is steered, minimising the steered weight. The suspension free-play is not part of the steering and there is no flex due to the use of forks. The result is light, stable steering that is unaffected by braking or suspension movement.

The result of combining a low CG, a secure riding position and suspended steering has been encouraging engineering innovators for the last twenty years. Low CG, feet-first vehicles outperform existing two-wheelers and are a fully competitive alternative to the small car in ordinary use. They offer a reduction in congestion and fuel consumption and improvement in comfort, handling and safety, without demanding undue skill or effort from users.

As a general vehicle type feet-first two-wheelers render motorcycles obsolete and will replace them if financial, industrial and regulatory obstacles are overcome.
There are no technical problems.



If nothing happens, nothing ever will (Chinese proverb)

Everyone knows that the British are great innovators. Study the business in detail however and it's easy to conclude that the world knows about British innovators because so many of them leave Britain in frustration. It's not necessary to be an innovator to realise that what we're really good at here is maintaining the Status Quo. We employ large numbers of public servants with no other visible function. This preoccupation with the last century is probably the cause of the creativity. Innovators are people who can't stand things as they are!

Unfortunately for FF innovators (and Un-fortune is the word!), the idea is uniquely relevant to the industrial concentrations of Northern Europe. This is the place in the world where the population density is high enough and rich enough to cause serious traffic and environmental pollution, yet the cities are close enough together for a small two-seater vehicle to be suitable. Britain suffers from this problem, just like Germany and France, but has a comparatively liberal approach to experimental vehicles. Certainly a good place to carry out prototype development. It's the next step, the progression to production development where there are problems.

These problems relate principally to the need to make contact with Industry and the State. Anyone with a radio set will have noticed how keen our glorious leaders are about being seen promoting innovation. It takes a rather more sensitive instrument to detect any positive action, on the part of the leaders or their servants. Similarly Industry constantly reminds us of its search for novelty and the new product. In reality these two institutions are the greatest obstacles any innovator will face in this country.

The reasons are simple. State institutions and large companies tend to be seen as complete entities. It's natural to assume that there will be a decision centre, a production plant, sales departments and so on. It's easy to assume that company spokespersons listen as well as speak, that communication about the activity of the whole operation is possible, if only the right person can be discovered. This is theoretically the case with the most modern companies but all organisations are really just collections of individual people. Understanding their interests is important. On the whole we are talking about people who, having not made any mistakes at their job interviews, have gone on not making any mistakes since. The easiest way not to make mistakes is not to make decisions, or indeed much else.

This is a well-known problem of all large organisations but innovation makes it easy to justify doing nothing. For the State any change in the Status Quo means a change in regulation. Any change in regulations means work for civil servants in writing them. Each word will then be pored over by lawyers and horrid innovators, all looking for loopholes. If there is a loophole, or some technical lapse, the Minister will take flak. This will pass smoothly and efficiently onto the head of the unfortunate author. How much more sensible to avoid re-writing regulations and force reality to adjust instead!

All vehicle designers have experienced this. The D.o.T.'s lack of interest in technology in the late sixties permitted unsuitable GRP ('Fibre-Glass') fuel tanks on motorcycles that leaked and occasionally caught fire. This generated flak from the media that so scarred the psyche of the D.o.T.'s regulators that they refused non-metallic fuel tanks on motorcycles right up to the introduction of the Single European Act this year. Non-metallic fuel tanks have been used in cars since the early eighties, offering a much higher safety standard than metal tanks. For this refusal to change something they received much flak from innovators, including this one. This causes less concern than flak from the Minister.

As I write this the D.o.T. is getting itself into another complicated situation with the definitions of cars and bikes, again as a result of avoiding new regulation. The fact that the new regulations arose in another European country that has introduced the concept of the 'Cabin Motorcycles' to cover vehicles the Ecomobile will not help. The E.C. is, if anything, more anti-innovation than the D.o.T. and in any case they are barely talking to each other. We will be doing well if the D.o.T. re-discovers the difference between cars and bikes in this millennium!

Industry also has easy reasons for doing nothing new. It costs money. The money takes a long time to come back. Very often it disappears for ever. The ability to lose large sums of money is strangely exciting when business is booming and a significant part of the finance available for innovation is money someone is trying to lose for tax purposes. There will be no expectation of the project succeeding and once an appropriate amount has been spent the plug can be pulled regardless of the progress of the project. Finding a company that really wants to make a new product, actually intends to use its profits, is the first step.

The problem for all innovation however is the perception amongst European companies that being first with a new product is not the way to make money. There is plenty of evidence to support this idea, Jack Difazio was clearly speaking from experience when he told me 1981 that no-one ever got rich by being first. A little later in the decade a development engineer with a major European motor manufacturer explained: "We don't like to be first". They aren't.

Another problem, specific to the FF, can be described as the 'Dreadnought' syndrome. In 1905 Britain ran the worlds largest navy, but had built HMS Dreadnought, a steam-turbine driven battleship that rendered all previous designs obsolete. Should they keep quiet, hoping no-one else built dreadnoughts and outclassed them - or replace their entire, huge fleet ? The Royal Navy, under Lord Fisher, bravely decided to equip with the new design of ship, just maintaining supremacy at sea against other modernised navies.

The FF two-wheeler renders motorcycles obsolete and threatens a large part of the small car market. FF production would directly impact on product sales in both markets and requires a Dreadnought-style decision by a car or motorcycle manufacturer. So far none have shown the courage or foresight of the Royal Navy.

The lack of assistance available from Industry and State is a real obstacle. It is obvious that without industrial support there is little chance for innovative industrial projects. Similarly the refusal of state institutions to provide support for innovation, by objective analysis, validation or promotion, reduces the chance of any new ideas being taken seriously.

Faced with these barriers the British innovator must adopt a very definite approach. The presentation of any innovation must be as faultless as possible. All avenues must be covered. The innovator has to do all the talking, answer all the questions. No-one else knows how to deal with innovation. A company making luxury touring vehicles will not understand that your sporty demonstrator could also be made as a tourer, unless you exhaustively point it out.

The whole development route for an innovation must be planned, from development of the prototype confirming the performance envelope and identifying prime qualities, to the levels of production expected around year five. No-one else will have a clue. Full colour projections produced on visibly up-market software will be welcomed. Concentrate heavily on profit projections, this is the main meat of any presentation.

If these details are attended to with grim attention to detail it is at least the case that personal factors such as class, accent or appearance are irrelevant. If the idea is sound, and soundly presented, you could be green, with orange hair. The lesson here is that the innovator is not as important as the innovation. It helps to keep this in mind.

When an innovative package is assembled it must be correctly addressed. Choose companies carefully. Look for track records in making similar new products. Find out about the finances. Yes, go to the library and study company records. Once a suitable target is identified, close in. Do you know anyone who knows someone on the main board ? Chance connections, luck, are essential in making contact at this level but such good fortune is the best way forwards.

Next, try and analyse who the main competitors are. Is any of them open to a suggestion that making a product is safer than not ? Are they afraid, after all of being Last ? There are no rules in this game but keep in mind that you might spend the next ten years working for your chosen company.

Meticulous study and eventual identification of target companies needs to be followed by an approach custom-tailored to each one. This is exactly the method used by the financiers of Formula One car racing. These people raise millions every year so that thirty or so single seat cars can be driven round in small circles very quickly. You can do better than that. You'll have to, innovation just does not match the TV audience for F.1!

This brings us to the media. The media loves innovation. It's put at the end of news programmes to cheer people up. Foul-up on a TV demo and they'll replay the mistake for ever, for laughs. The media can be handled but unless you are about to announce a full production launch, with products on sale that day, it is best avoided completely. This is because most media interviewers pride themselves on their ignorance. They believe this gives them real objectivity. They also believe that their audience is stupid so that intelligent questions must be avoided at all times. You will be asked the same stupid questions for a decade.

There are some simple solutions if you must use the media. First, maintain absolute control over the event. Expect to get paid unless you are actually selling something retail. Arrive with a clear idea of what you are going to do and do it. Decline outright to pull any silly stunts invented on the spur of lunch, and most important, answer any questions on any subject with the answers to the questions you have already chosen. You know how to do this, you've been watching politicians do it all your life.

When people do start to listen, especially when they insist on buying you lunch while they listen, they may be the wrong people. There is a whole industry seeking to make money out of innovation, trying to get hands-on with some of those tax loss deals. The standard scam is to convince the rude and uncultured innovator that a haze of smart suits, expensive office equipment and documents with fine print is essential if a new idea is to make the leap to production.

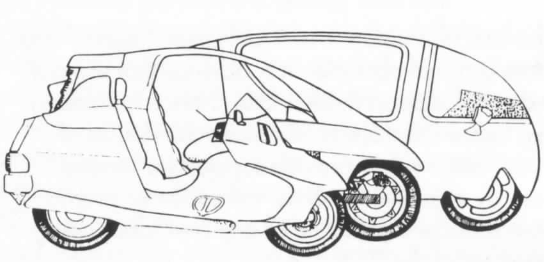
It's essential to avoid all this. In this world anyone can talk to anyone. Is there any point in talking to people who only work in suits in expensive offices and are trying to lose money ? No. Keep your objective clear. It's all a confidence trick. You just need to have the confidence to insist that you are right and the world is wrong. This isn't too difficult as the world obviously is wrong, so just concentrate on the simple business of explaining the facts directly to your chosen victims.

Explain that you don't expect to own anything by the end of the day, that you are giving the idea away. Industry likes owning things. Do No work without pay, anyone will accept free labour without obligation and a manufacturer that can't afford the innovator can't afford the innovation. Copyright all sketches and work late only on your own account.

I think the above hints and tips may be useful to innovators. Everybody has to find their own way through the maze but there are common threads. One factor that seems to be pretty much the same whatever the idea is the time scale. Ten years is a good time for an idea to move from concept to production. Twenty years is not unknown. Five years of constant preaching at least is required before the average suit-wearer will dare to listen to what you're saying. If your sole unremitting objective is to get your ideas into production you may succeed, eventually. If you want to get rich you're in the wrong business!

You can see now why most sensible innovators leave the country. Individuals can cut out the whole process of developing their innovation and simply keep the prototype for their own use. There's a whole culture based on designing and making vehicles for fun. This is an eminently sensible solution for someone with a better mouse-trap. Trap mice with it. And you never know, a rich person may turn up one day, take one look at your idea and all your troubles will be over. You will have been turned into a handsome frog.

For the people who feel that others should share in their good fortune, that the world urgently needs new products to meet new challenges, there is an alternative. Unlike any advice I can give you, based on my own experience, this is a proven route to production for even the wackiest ideas. It definitely works. It is the Way to Go. What's more you can end up with a small fortune. You want to know more ? Be lucky, start with a Large fortune.



John Bruce's BSA

This vehicle was a originally a standard A50 BSA, an everyday 500cc parallel twin dating from the early sixties. In 1981 it was converted by John Bruce to FF layout by cutting and shutting the standard frame and lengthening the rear suspension fork. An underslung fuel tank was fitted under the seat. Body sections were supplied by Malcolm Newell and are similar to those used on a number of Malcolm's prototypes.

The BSA front brake and forks quickly proved inadequate for the loads that could be applied by a securely seated rider and the Yamaha forks and brake that replaced them can be seen in the photograph. A Yamaha rear wheel was fitted at the same time. In this form the vehicle covered considerable mileage, including trips to the Bol d'Or race and some years of urban commuting. As a riding experience it is a big improvement on a BSA A50!

John went on to build several other prototypes on the same basis of converting a standard motorcycle by changing the frame, rear fork and fuel tank. These were based on the Honda 250 and 400 'Dream' and 'Superdream' motorcycles which had a suitable layout for this treatment. These vehicles were intended as a low cost commuting option and were certainly the cheapest and quickest way of producing an FF two-wheeler from available parts. A number of other individuals used this approach to make themselves FF specials, often at very low cost, simply to try the idea out. The current trend towards 'mono-shock' rear suspension makes this simple conversion very easy structurally and the re-location of airboxes and exhausts usually provides the main difficulty.

This BSA is interesting because it allows the advantages of a lowered seat to be experienced without distraction by other innovations. Like the very similar 'low-rider' custom style it is an elegant demonstration that a low, secure seat brings big improvements in comfort and stability. John's design goes on to demonstrate the multiple advantages of body work in weather proofing, safety and aerodynamics. In both cases however, BSA or low-rider, the steered front suspension is clearly the main limitation to handling performance . This vehicle made clear the benefits of integrating the three elements of seating, body work and front suspension in the FF layout.

Data: Wheelbase 59" (1.598m)
Weight 380lbs (172kg)
Engine 500cc BSA

Malcolm Newell Z1300 'SEV'

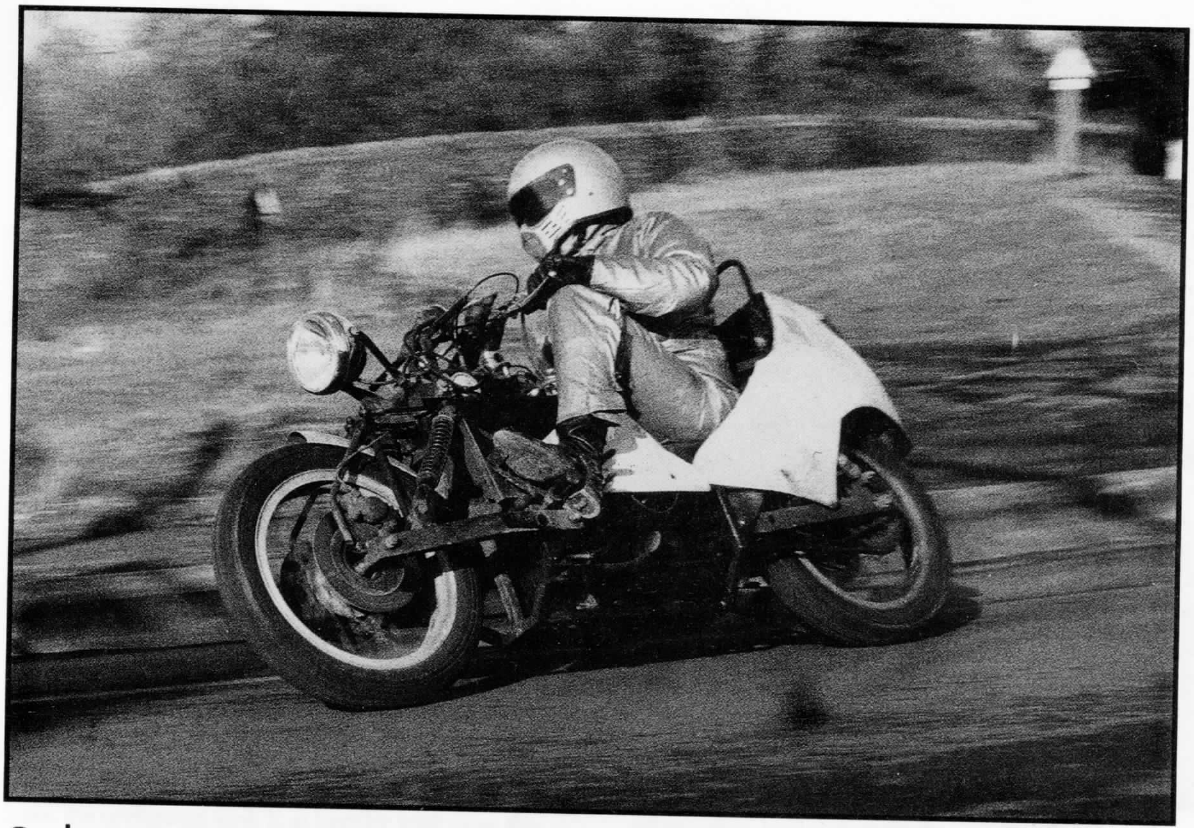
When the Quasar production project was ended by the failure of the production company (Romarsh Electronics Ltd.) in 1981 Malcolm Newell went on throughout the eighties to build more one-offs to order. This Kawasaki Z1300-powered FF was the first of these and was built with the support of Cibie, whose 'S.E.V.' logo gave this vehicle its name. Malcolm chose this power plant because he was keen to explore the high-power FF spectrum.

Technically the SEV 1300 was very similar to the Difazio-built FF that appeared shortly before it. Both vehicles were single-seat adaptations of production motorcycles but unlike the BSA A50 FF, only parts of the original frames were used, mainly to make easy engine mountings. Both vehicles also used a form of 'suspended steering'. The SEV system was designed by Bob Tait under his patent on an 'offset' steering axis, which improves the 'feel' of the steering. This design was used on all the vehicles Malcolm built with suspended steering and is still available. Although a 'double wishbone' system like the Difazio design, it is quite different in detail and construction, with much more steering lock.

Malcolm built a second Z1300 powered FF (The 'Thirteen') that used a complete Quasar body shell. This second vehicle may have a slightly higher top speed and it was for speed that these two FFs are chiefly notorious. The aerodynamic improvement in both cases was sufficient to allow over-revving in top gear and they could be cruised at 140 mph (220 kph). The SEV, seen here, was timed on the British Motor Industry Research Association banked circuit at 160.1 mph (256.16 kph) in 1981. At the time this was a record for road going motorcycles. The SEV 1300 had several owners during the eighties, making a deep impression on them all! Towards the end of the decade it emigrated to Australia.

After these two vehicles Malcolm went on to produce several similar Honda-powered versions, using both Gold Wing and VF 750 units. Many of these used complete Quasar bodyshells like the 'Thirteen'. He also experimented with Yamaha, Hesketh and Norton engines. In addition to this range he introduced a motorcycle conversion similar to John Bruce's BSA but based on the LC two-stroke Yamaha range. Although the original motorcycle forks were used they were supported by a system described as 'Twin Head Steer'. This used links to connect the outer ends of the extended front wheel spindle to a transverse arm, behind the front wheel, that was connected in turn to the handlebars. Apart from providing more direct steering these links also absorbed braking loads and prevented front fork flex. There are similarities between this system and BMW's current 'Telelever' system.

Data: Wheelbase 68" (1.727m)
Weight not available
Engine 1300cc Kawasaki



Graham Fryer's Velocette

Graham Fryer was part of a group of enthusiastic Velocette owners and by the end of the seventies he had developed a collection of Velocette engine components into a new version of the 500 Venom that had a squish-head and 560cc. This was an impressive motor and when he found himself in difficulty keeping up with the Difazio FF with its CX500 engine the obvious solution was to put the Velocette power-train in an FF chassis.

The separate engine and gearbox of the Velo power train lends itself well to the FF layout. Graham was able to move the gearbox rearwards and avoid the long final drive chain run required for the BSA A50 FF. Also the very narrow engine does not intrude into the riders' leg space. Vibration was however fairly severe, a common problem when a heavy but flexible motorcycle frame is replaced by anything stiffer.

This Velocette FF, like the Difazio and Kawasaki duo, also had a close relation. In this case it was the Ducati FF, built at much the same time. Both used Difazio front suspensions and had chassis made from square tube steel. Both were also single-seaters. The Velocette and engine and gearbox however, in deference to their fragile casings, were not used as structural parts of the chassis.

Performance was reported as an improvement over anything Velocette had provided. Graham's FF provided some splendid competition to a number of other designs and accompanied the Ducati FF to a memorable open day at the Mallory Park circuit. This sporting use was taken further when he began to compete in Velocette and Vincent Owners Club race meetings. FFs are illegal in motorcycle racing because of the essential seat back but Graham's relaxed approach to racing allowed the club to ignore this minor difficulty for some time.

Towards the end of the eighties the Velocette engine was losing out on power to more modern multies and spares were becoming a real problem. It is worth noting however that unlike almost all other motorcycle engines fitted to FFs the Velo engine did not object to the sustained high speed that the FF layout allows. Graham's solution was to fit a V4 500cc Honda engine, giving a useful performance hike at the expense of some reliability. The lack of any remaining connection with Velocettes or Vincents proved too much for the racing clubs and Graham was not invited back. He has built a re-designed versions of his Difazio front suspension, with greater steering lock, and is currently considering future engine options.

Data:
Wheelbase 60" (1.524 m)
Weight 374 lbs (170kg)
Engine 560cc Velocette

Difazio/Creasey FF 'Banana'

This vehicle, and one subsequent example, was a collaborative effort between Jack Difazio of Frome and myself. Jack patented his 'centre-hub' suspended steering system for motorcycles in 1969. He fitted this system to customer motorcycles and occasionally incorporated it in complete one-off motorcycles, throughout the seventies. By 1981 he had made 150 units. The system is a 'double-wishbone' system with all the features needed for good performance. Although all the systems were hand-made, the only real criticism of this originator of modern front suspension is that it lacked steering lock with only about 20 degrees each side.

By 1980, having experienced the Quasar, I had concluded that better performance would be available from a vehicle with less size and weight and a better front suspension system. The problems of motorcycle-type 'steered-suspension' as used on the Quasar were well known and the Difazio system was an obvious solution. It had already been considered for use on a version of the Quasar. Jack Difazio was interested in exploring the FF layout, which he agreed suited his front suspension.

The 'Banana' that resulted was an experiment for both of us. We chose the CX500 engine because it was compact, had shaft drive and there was a crashed example in the workshop. In practice the package was a success. The comfort, handling and safety was a clear improvement over not only a CX500, but most of the two-wheeled opposition. This FF, despite its single seat and the lack of anything like a production finish, was the breakthrough in convincing many people who found the weight and size of the Quasar intimidating. The journalist Paul Blezard bought the machine from Jack and became a considerable enthusiast, using the Banana to introduce the FF experience to a wide group of people.

From the start the Honda parts of the package complained. The carbs were upset by the changed airbox, cured by fitting an SU carb on a new manifold. The drive shaft couldn't cope with being extended and throughout the eighties various re-designs were tried which may now have succeeded. The engines don't like being used so hard and it's currently on engine number five. The extensive 'proof of safety qualities', which I started with a crash in the Isle of Man in 1981, continued in various hands for most of the decade and eventually proved too much for a chassis that was vestigial to start with. After many years of ownership Paul Blezard sold the rather battered Banana to Bob Winsper, an aircraft technician, who plans to re-condition the entire vehicle.
We haven't seen the last of this one!

Data:	Wheelbase 67" (1.752m)
	Weight 490lbs (222kg)
	Engine 500cc Honda

High Tech 450 Ducati FF

This was the first vehicle for which I was entirely responsible. Designed as a 'Proof of concept' demonstrator to show potential manufacturers the advantages of the FF layout, it was intended to make those advantages absolutely clear without excess size, weight or complexity. Where the Banana had clearly improved on a CX500 the Ducati FF was intended to clearly improve on a Ducati. It was the first attempt to combine the low, secure seat with minimum size and weight and the crucial suspended steering system.

The chassis was quite simple, the Ducati power plant was a structural part and the vibration problem was alleviated by the extensive use of rubber mounting. The front suspension system came from a 1972 750cc Difazio Suzuki special. There were two innovations of note, one being the constant-tension drive chains achieved by using a centre chain connecting the engine to a double idler sprocket running on the rear fork pivot. A rear chain ran from this sprocket to the rear wheel. The sprocket carrier also had a cam that drove a mechanical fuel pump to carry fuel from the underseat tank to a header tank over the carburettor. Although this all worked, I am not alone in believing that chain drive has no place in the transmissions of modern motor vehicles.

The second innovation was more significant and features on all my subsequent FF designs. This is the trigger throttle, operated by the rider's right index finger. The Banana had shown that the secure seat and efficient front suspension eliminated the need to keep a firm grip on the handlebars. This made the firm grip required merely to hold the twist grip open noticeable and objectionable on long journeys. For this reason the Ducati was fitted with 'pistol-grips' with the trigger throttle to provide low-effort, precise control.

This proved an immediate success. There was no conversion problem and all the people who have used this throttle control have praised it. Apart from the reduced effort, the trigger throttle and front brake can be used together, making down changing quicker and easier. It also allows emergency braking to be applied noticeably earlier than a twist grip control. Despite these advantages proposed legislation on motorcycle controls looks likely to make the twist-grip throttle mandatory for production vehicles.

The Ducati engine proved to be another motorcycle engine that objected to sustained high speed use, suffering big-end failure after 9,000 miles. Ducati specialists regard this as a good mileage but no ex-Velocette owner could regard this as satisfactory and, as mentioned elsewhere, 'Proof of concept' had not proved enough. The Ducati engine was promptly sold to a real enthusiast and components not used in the Voyager prototype have joined my extensive FF scrap yard.

Data: Wheelbase 58.5" (1.486m)
Weight 450lbs (204Kg)
Engine 450cc Ducati

High Tech Voyager Prototype

The Ducati was intended as an uncompromising proof of the FF concept. This 850 Reliant-powered demonstrator was intended to be an equally uncompromising proof that a small, lightweight and practical FF could also feature heated, two-seat comfort and all the details regarded as essential in a mainstream vehicle. The performance was related to the class of car it was intended to replace, the Ford Sierra, Vauxhall Cavalier range, but with all the improvements in fuel consumption and running costs to be expected of a feet-first two-wheeler.

It was also essential that the vehicle demonstrate the practicality of production. For this reason all the major components needed to be examples of current production practice combined in a straightforward package that would cause no production problems. Where the Ducati had shown that the idea worked the Voyager needed to show that there was money in making it as well.

This consideration was responsible for the choice of power train. The availability and suitability of the Reliant 850 engine and the Moto-Guzzi gearbox and transmission literally made this production project possible, eliminating the need for the heavy investment needed to produce a new engine or gearbox. The Voyager project went Active when we confirmed that the engine and gearbox did indeed go round the same way!

The 850cc Reliant engine is not regarded with any great respect by motorcyclists used to much higher outputs but it is capable of substantially better performance than it is allowed in the Reliant three-wheelers. Reliant were perfectly happy with our plan to extract 60 bhp at 7,500 rpm and claimed that the engine was safe to 9,000 rpm. The engine has a long and respectable history as a car racing engine in the 750 racing club formula where it is known for reliability. In addition to these useful capabilities this British engine is remarkably cheap to buy and is the smallest engine of this capacity and sophistication we were able to find.

The Reliant engine was modified to accept the Moto-Guzzi flywheel/clutch assembly and connected to the gearbox with a cast alloy adapter plate that includes chassis mounts. The moderate power increase over the three-wheeler specification was achieved by fitting a Piper stage 2 cam with stronger valve springs. A '4 into 1' exhaust system with tuned primary lengths completed the engine modifications and experience showed that there was sufficient power to

justify fitting the higher final drive gearing from the Moto Guzzi 'Convert' range. At a minor cost in initial acceleration this allowed relaxed high speed cruising with excellent fuel economy.

The chassis followed the same structural principle as the Ducati prototype, but the larger, very stiff Reliant/Moto-Guzzi assembly allowed the elimination of much of the structure. This was reduced to a frontal assembly, which attached to the Reliant engine mounts and cylinder head, with a rear structure fitted to the adapter plate and gearbox. There were ancillary tubes on each side to complete the structure. All the structure was made from steel tube and folded sheet bronze-welded together.

The front suspension, steering, hand-controls and indeed the very great proportion of the components came directly from the Ducati and as a result the Voyager prototype was completed relatively quickly. The total build time was a few days under eighteen months and took 1600 man hours of actual work. The use of the Difazio front suspension from the Ducati on this slightly longer vehicle proved to be a minor inconvenience but a re-design of the front suspension was always seen as essential for production purposes.

Body work was made using the same technique as the Ducati, carving and shaping polyurethane foam forms that are then covered in hand-laid glass-fibre. The process of flattening, polishing and painting the resultant surface is fairly laborious but the technique allows a completely free choice of shape while providing a stiff, lightweight body section. It also gives very good crash protection and can be readily repaired or modified.

When compared with the Ducati much more care was taken over the styling. Apart from a general need to make the vehicle easy on the eye it was felt that the 'space-age' styling of contemporary FFs was intimidating. The Voyager shape, inspired somewhat by the Bluebird record breaking car, was intended to appear familiar and comfortable. Similar efforts were expended on achieving a good finish although this was less successful in terms of the upholstery at least. The paintwork however was applied professionally by a friend, a low-bake urethane/acrylic in British Racing Green, and the deep, indestructible gloss astonished me daily!

Performance was very satisfactory. Engine performance was probably limited by the standard inlet arrangements but steady improvements were achieved and a top speed approaching 140 mph (220kph) had been reached by the time of the accident that ended this vehicle's career. Cruising speed, acceleration and fuel consumption were also comfortably ahead of the target four-wheelers.

Despite the higher maximum and cruising speeds the character of this vehicle was rather more sedate than the Ducati's. The very basic Moto-Guzzi shaft drive system imposed limits on the handling performance, as it does on all two-wheelers and various other components would have been improved had development continued. This is also true of Sierras and Cavaliers!

This vehicle's most significant quality however was that it was a successful demonstrator. Many companies saw it and commented favourably on the prototype even when they declined to take up the idea. Eventually however it succeeded in its main purpose and convinced a manufacturer that a production example could be an attractive and profitable product.

For all these reasons this vehicle was regarded with considerable affection. The carefully collected assembly of automotive parts was largely undamaged by the accident and even the Difazio hub has been repaired. A complete restoration of the Voyager prototype is impossible simply because prototype engineers are incapable of building the same thing twice.

This vehicle, when it eventually emerges from the longest build period yet, will take this particular package another step onwards. Options left unconsidered during the production project will be explored. Any chance to make it smaller, lighter and quicker will naturally be taken. Although the Reliant/Moto-Guzzi power train is obsolete as a production design and no longer very credible even as a demonstrator, I look forwards to many years of pleasant motoring with this first, and last, Voyager.

Data: Wheelbase 63" (1.600m)
Weight 530lbs (240Kg)
Engine 850cc Reliant

SCL Ltd. Production Voyager

When the decision was made to seek production of a 'Ford option' FF, in the early eighties, the best way appeared to be with an existing vehicle manufacturer. Such a company would have sources for all the diverse components included in modern vehicles. Considerable expertise would be available in production engineering and design. Providing these elements takes a large proportion of the costs of a 'green field' production and we expected that any company with automotive experience would find our project attractive. We were, after all, offering something costing less to make than a cheap car that could be sold for more - to the same customers.

When this approach produced no result we sought the green field option, looking for a company without automotive experience. This implied an increase in the start-up costs of the project as time is spent assembling competent teams at all levels of design and production. Inevitably the result is a reduction in the sophistication and complexity of the product.

Had our FF project needed to compete with fully developed vehicles from the major motorcycle or car manufacturers we would have been in some difficulty. Fortunately the combination of comfort, handling and safety was still unique and the arrival of computer-aided manufacture had transformed low-level production costs by the mid-eighties. This meant that a very low level of production was commercially viable and that a very simple vehicle, with quite moderate performance would be acceptable.

The Voyager production design consequently closely followed the prototype. The same price and reliability questions that led to the choice of the Reliant engine, Guzzi gearbox combination were equally relevant to the 200-off limited edition production design. The chassis system was also very similar although every effort was made to simplify and improve. Mig welding also replaced the obsolete Gas-Bronze welding used on the prototype.

A new 'double-wishbone' front suspension was designed, using Bob Taits patent, with an offset steering axis and using castings to minimise weight and cost. The production prototypes had wire wheels laced to the alloy hub but fabricated alloy wheels were considered for the production versions. The hub design provided the same essential features of low steering inertia and high structural stiffness as the Difazio unit. It also had ample steering lock with 35 degree each side and a wheel that could be removed by releasing six bolts. The design used a forged steel 'axle' and a car suspension ball joint to achieve a very low component count and weight.

Another divergence from prototype practice was the use of a conventionally formed fibre-glass body. The original shape for this was made in the same way as the prototype, by carving foam, but once a flat polished surface was obtained a mould was taken for the production bodies instead of applying the glass fibre needed to make the shape permanent.

Under the plastic the structure followed almost exactly the same layout as the prototype. There were front and rear structures, with detachable side rails and ancillary structures for the seat and hand controls. The front 'footbox', an integral part of the prototype front structure was made separate and extended, taking note of the lessons learned in the prototype accident which pre-dated the design of this part.

The need to accommodate two '90 percentile Males', the vehicle engineering standard, also required design changes. The prototype used a standard 'Le Mans' rear fork and this was changed in the production design to the 'Californian' unit which is 3.5 (90mm) longer. To avoid this being added to the wheelbase the single radiator used on the prototype, in front of the engine, was replaced by two small radiators and the engine was moved forwards 3 inches (75mm) This allowed about 4 inches (100mm) to be added to the seat space within almost the same wheelbase as the prototype.

SCL, the Welsh electronics company that took on the project, set out to build five production prototypes backed by full jigs and drawings, with the equally important parts, sourcing and pricing lists. South Wales at that time was quite well supplied with engineering companies and there was less trouble sourcing parts in the area than expected. The attitude of traditional automotive suppliers was however an eye opener to a company with experience mainly in the new electronic industries. Companies happy to give away single items for prototype use were reluctant to deal with production orders of less than thousands. This bizarre inability of some companies, all well-known, to sell their own products to people who want to buy them is not limited to the British. Both Italian and German companies treated requests to buy stock items with extreme suspicion. It is certainly easier to equip a prototype vehicle with parts from scrapyards than it is to buy a supply of the same parts, new, from the manufacturer.

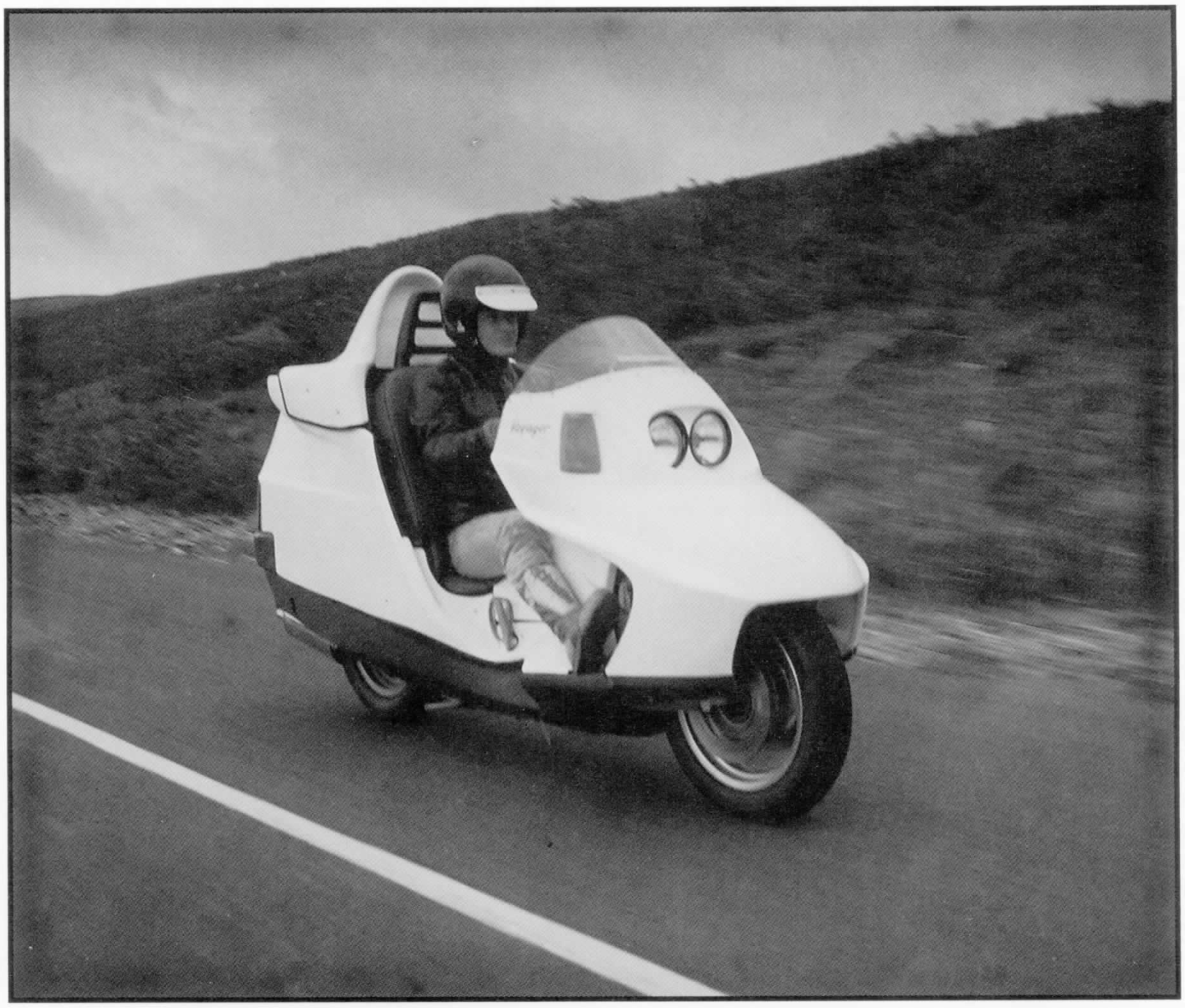
One negative aspect of the isolated location of the factory in a small village in Powys, was the amount of travelling required to visit suppliers. The attractive rural location was preferable to anywhere in the industrial midlands but time would have been saved if there had been a higher concentration of local automotive companies. Finding staff would also have been easier, simply because of the higher population density.

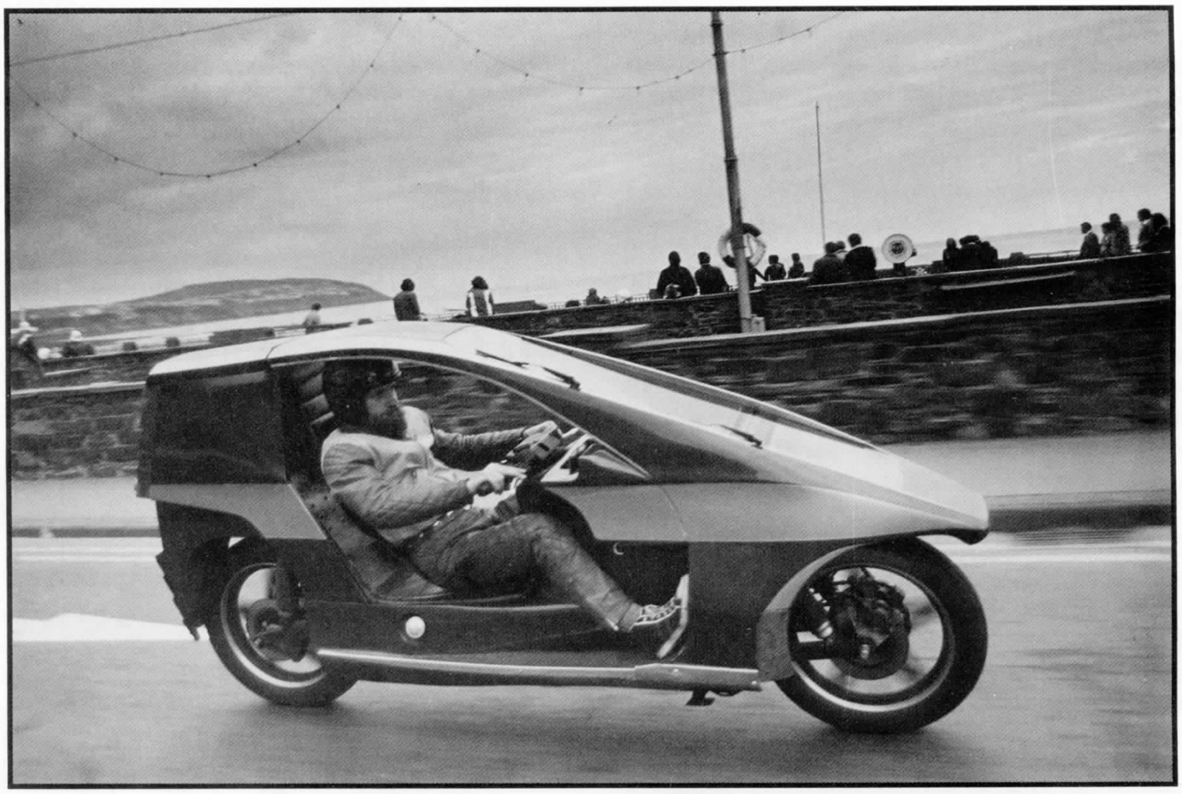
Despite the unconventional location and the lack of track-record in vehicle production the production project was completed in good time for the 1989 NEC motorcycle show, with all press deadlines met. This was done with funding levels described by a Ford engineer as 'insufficient for a new door handle' and a team of seven people.

Only one vehicle was road-registered by show time and it was in a completely undeveloped state. Despite the consequent lack of a reliable tickover or balanced suspension, the basic virtues of the FF layout, comfort, handling and safety came through well enough to make a favourable impression on both press and private testers.

The five people lucky enough to be the new owners will need to complete this development but will then enjoy the most advanced 'two-wheel sports car' currently available.

Data: Wheelbase 63.5 (1.612m)
Weight not available
Engine 850 cc Reliant





Quasar

This vehicle, the progenitor of all modern FFs, has been extensively described in the last fifteen years. Despite its striking shape it is a relatively primitive example of an FF two-wheeler in that it uses 'steered-suspension'. The system in question is usually called 'Earl's fork' by motorcyclists and is a form of leading link fork suspension where the link pivots across the rear of the front wheel. This system allows reasonable stiffness and strength, felt to be a problem at that time if telescopic forks had been used, but it has immense rotational inertia and requires very heavy steering to stabilise. Despite this it is still possible to generate a low-speed steering flutter in a Quasar although the huge stability of the vehicle renders it unimportant.

Another problem related to the use of a Reliant gearbox, with an external conversion to a sequential, positive-stop gear-change. Properly set up the gear change was bearable but it could never be described as quick. Also, as mentioned above, the weight at 700lbs was unprecedented at that time. Bringing one to a standstill, feet securely braced to support it was always an exciting moment, especially on gravel! Despite all this, the stability and control provided by the layout was certainly good enough to make long-term motorcyclists like myself think again about the whole basis of two wheelers.

In the context of this review the most interesting thing about the Quasar is how similar it is to the Ecomobile, the first successful production FF since the Quasar. The use of motorcycle type suspended steering by both vehicles is probably most significant, the Ecomobile using standard BMW front forks. The similarities go further. Both are far larger than motorcycles, have windscreens with wipers, and a roof. Both are driven by four-cylinder, in line engines with shaft drive. The structures, although quite different in material, are peripheral, exoskeletal rather than the core structure with external body work used on smaller vehicles. I have no doubt that Malcolm Newell would have used composites for his structure had it been available.

I believe that a much smaller and more agile vehicle like the Voyager will ultimately prove more popular than these very large two wheelers, but I may simply be wrong. The question is whether travellers value the enclosed car-type cockpit more than the agility that removing the roof and several feet of wheel base can provide. Look at the Quasar and the Ecomobile and a picture emerges of the cabin motorcycle of the future. Incapable of passing through congestion or parking anywhere, like a smaller two-wheeler, its main attraction appears to be providing the 'closer to flying', two-wheeler riding experience, in combination with car levels of luxury.

The Ecomobile would obviously be more agile if it was smaller, like the Quasar, but it is equally interesting to consider whether the Quasar would have been more successful, less intimidating, if it had featured 'landing' wheels like the Ecomobile...

Data: Wheelbase 77" (1.955m)
Weight 680lbs (308kg)
Engine 850cc Reliant

Ecomobile

The following text and photo was kindly provided by Arnold Wagner of Peraves AG, the designer of the Ecomobile.

The Peraves Ecomobile cabin motorcycle was designed to combine the motorcycle's driving fun, agility and low operating costs with the practical usefulness of cars. Using a composite monocoque structure, high-tech motorcycle components and digital-kybernetically supervised servo outriggers, ECO has become a technical success from beginning. In spite of footdragging officials and endless red tape production has passed the 50 mark and vehicles are now homologated in Switzerland, Liechtenstein, Austria, Germany, Japan, Czechia and Sweden, with France, Luxemburg, Canada, Belgium and USA to follow soon. Commercialisation will increase with an already tripled assembly capacity, longterm subcontracts and the realisation of another assembly facility in the EEC. Two major 2-wheel-manufacturers have shown interest in joint-ventures to develop a smaller and less sophisticated vehicle of similar concept in the subcar price bracket, a mutual memorandum of understanding is due to be signed soon. Meanwhile the ECO, herald in the superquality-highperformance-longlife-class, continues to outsell production by combining sportscar-performance, bubble car consumption and ultimate head-turner effects. Futuristic appearance goes with high practical value, average annual mileage of 17,500 and fleet leaders 150,000 plus.

Arnold Wagner.
Peraves AG, Oberfeldstrasse 53,
CH-8408 Winterthur, Switzerland

Data: Wheelbase 115" (2.925m)
Weight 970lbs (440kg)
Engine 987cc BMW

Sorry mate - didn't see you (A survivor speaks)

Safety was not the main attraction for the FF innovators of the early eighties. Most were, and are, ready for anything that looks fun. Really it was the ideal of going faster, of going beyond the limits of motorcycles in particular. Inevitably there were accidents as new limits were found.

It took little time for people who had been crashing motorcycles for decades to spot a big difference when crashing an FF. It didn't hurt. Of course luck has a part in this. Accidents are events where anything can happen. However, as experience built up it became clear that real advances in safety were possible.

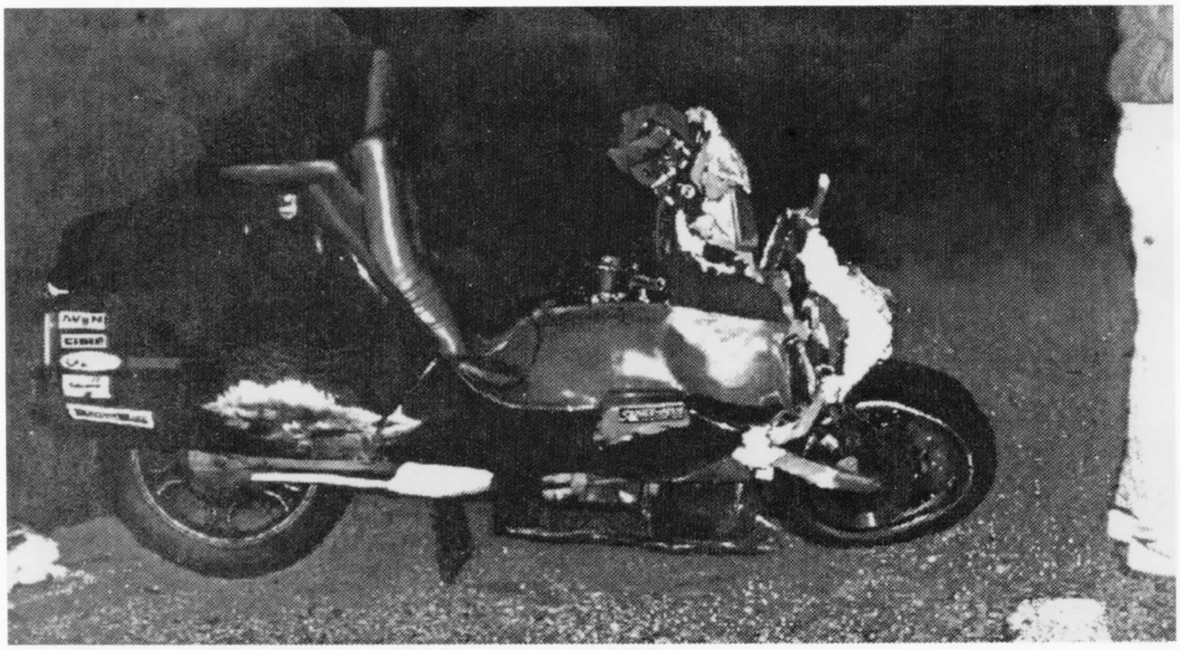
Some advances came from improved agility and control. Accidents could be managed better and damage limited. We added passive-safety features like a padded cockpit and collapsible steering. These were to protect against the common low-speed urban accidents that injure motorcyclists. We didn't expect much beyond this with our minimal 'two-wheel sports-car', The 'Cabin Motorcycle' Ecomobile has also shown an ability to keep riders safe in sliding and impact accidents.

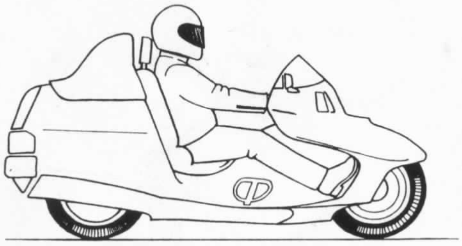
The Voyager accident, with an impact speed of about 50 mph (80 kph), is interesting for this reason. The speed is outside normally survivable limits, even for seat-belted car passengers, with the impact between the front wheel of the Voyager and the left-hand rear wheel of a car crossing its path.

Passive safety features worked well. Although the designed collapse of the steering and front structure was well advanced, no injuries were casued by rider impact with the cockpit. The performance of the front suspension was more significant. In a major impact this Difazio Double-Wishbone system was expected to collapse downwards under the vehicle. This raises the front of the vehicle, placing crash-padding between the rider and the target vehicle, hopefully preventing fatal head injuries.

The suspension collapsed as expected, down beyond vertical, levering up the front of the Voyager. However the well-supported Difazio hub passed far more energy into the car than expected. The axle buckled and partially ripped from its mountings. At the same time the rear of the car was lifted by the Voyager front end. The energy transfer to the axle, combined with the lift, spun the car180 degrees about its front wheels, out of the path of the Voyager and its rider altogether. I was that person, very surprised to walk away with grazes and a stubbed toe.

Even if the target vehicle is not removed entirely there will be some acceleration, reducing the riders impact. This is a basic safety feature of double-wishbone front suspension, not shared by telescopics. More, paid, research is needed to define the effect but I recommend that, next time, dummies be fitted in the two-wheeler as well as the car!





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