THE GIBBS STORY IN BRIEF

By Simon Carr

The Gibbs Aquada is neither a boat with wheels nor a waterproof car, it's something quite new, a quantum leap from what we have now, a new category of vehicle. It is new in the way that jump jets were new: the first Harrier could not only fly at speeds approaching the speed of sound it could also hover over the ground like a helicopter. So the Aquada operates in two very different ways: it planes like a speedboat on water and on the road performs like a sports car. It doubles the utility of the car and thereby represents the single biggest automotive development for a century.

There have been many attempts to make amphibians, dating from (and in a couple of cases preceding) the invention of the motorcar. There have been twelve hundred amphibious vehicle patents filed, and quite a number of the major car companies have tried their hand at amphibious vehicles. None achieved any real degree of success.

So it is fair to say that Gibbs Technologies has produced the first amphibian designed and built to go fast on land and water, as well as complying with all automotive and marine regulations.

And who wants an amphibious sports car? There's more than one answer to this. The most obvious use is recreation: exploring the Greek islands, the Great Lakes, the Florida Keys, the Everglades, water skiing off St Tropez. This machine drives down the M4 and, in a sudden diversion, can take you up the Thames into the most beautiful and secret parts of the English countryside. The Aquada gives the freedom to move easily from one medium to the other without towing a trailer, without having to return to where you parked.

Second: There are implications for urban transport in the congested cities of the world – from London to New York. Waterways were crucial to the development of many cities – colliers, liners, clippers, warships, barges, water taxis all played their essential part in the growth of their city. Over the years, transport systems took more and more of the traffic onto land. The waterways remain, naturally, but they are virtually empty.

A daytime journey from residential Chiswick to commercial Canary Wharf takes between one and two hours by road; by river, even in rush hour, it takes twenty minutes. The same sort of ratio can be applied to journeys in Manhattan, Paris, Sydney, Singapore, Shanghai and Auckland. So there may be more significance in the Aquada than is immediately apparent: it may have the ability to move urban property prices. It won't be the first time vehicles have done so.

There is a third use more abstract than the others. The essence of the Aquada is a new technology. It's innovative and protected by over sixty patents. But ultimately it is capable of transforming most motor vehicles into amphibians. As the technology becomes more productionised, customers may be able to order the amphibious option of the car they want in the same way we order air conditioning and four wheel drive now. As there are sixty million cars a year manufactured this represents a very large, new market – the first fundamental product innovation this mature market has known. Consequently it is hard to assess the full potential in this new development.

Alan Gibbs is one of New Zealand's most inventive businessmen. In his early days he studied engineering and in his first commercial venture built a prototype (though never took into production) New Zealand's first indigenous motorcar. He began business life in manufacturing and over the years have made a very wide range of products (bricks, brassieres, television sets, stoves, and crockery).

He has run his own merchant bank defending companies against hostile takeovers and executed takeovers of his own. He was a half-owner of New Zealand's largest retail car dealership. He put together the management buy-out of the country's biggest publicly-listed freight company and retained a fifty per cent share in it. He was a driving force behind the introduction of Sky television to New Zealand. Most significantly, he co-led the syndicate that purchased New Zealand Telecom and set about a massive restructuring programme. The company ended up with half the staff it had inherited, enormously increased productivity, much reduced prices for the customer and a share price that quadrupled in five years.

This is the man who represents the driving force behind the project.

Gibbs had a holiday property where the tide went out a mile. He built his first amphibian in 1995 so he could drive out of the water without a tractor and trailer. While this amphibian could go fast on water it could only go walking speed on land. Wanting to go faster on land he discovered a wheel raising concept being shown in an art gallery. It was an exhibition of local requirements and Terry Roycroft's invention that elegantly indicated a solution to the problem of reducing drag on water.

The ideas fermented and in 1996 Gibbs commissioned British firm Lotus to undertake an engineering viability study. They reviewed the concept and produced the view that it was technically feasible.

If you want to build a new motorcar to the international standards where would you start? A good place might be the world's automotive capital. That is: Detroit. This city is host to every major car company in the world.

Gibbs in Detroit took the first practical phase of the project. The creative work, as it might be called, the conceptual work. The brief was simple but its terms were strict.

They were to build an amphibious car that would perform both road and marine functions without compromise that could drive off the road into the water and be planing within ten seconds while carrying three passengers, thirty kilos of luggage and a full tank of petrol.

The conflicts: The fundamental problems of amphibious technology were considered. For instance, the aerodynamic forces that operate on the road are the opposite of what are wanted on water. The bow of a boat lifts; if the same architecture were applied to a car, would not the car flip? Especially when travelling at three times the speed of a boat on water? How would the cooling work? A car's engine bay is open to the road: at speed, the rush of air takes much heat away. A boat's engine bay isn't open to the water to anything like the same extent (there is the issue of sinking); the engine running at full power generates the equivalent of a hundred single bar heaters. How would this heat be ducted out of the car? If you suck air in how do you stop water getting in at the same time?

And then there were a myriad of regulatory problems to be resolved as well.

The regulations for cars are very prescriptive. So are the boat regulations. Both are comprehensive. Frequently they contradict each other.

For instance, No green light is permitted on a car but a green light is compulsory on a boat (it indicates the port side). Red lights mean the starboard side of a boat but the back of a car. A white light shining backwards from the mast is mandatory on a boat but rear-facing white lights are forbidden on a car. The position of the lights, the angle they're set at and the point at which they meet are strictly specified one way for a car and another for a boat. If the Gibbs Aquada was to be a viable, fully productionised consumer product these differing requirements had to be reconciled.

The first practical testing programme began. Gibbs had to discover the essential physics of the project. How much power to push how much weight with how much drag? An amphibian is weighted down with five hundred kilos of suspension, road frame, wheels and axle weight. Boats were far lighter than this. How much of a floating brick would it be? How hard would it be to get the craft up on the plane? The power delivery had to be unusually robust – cars use peak power very rarely and for very short periods; the amphibian used peak power on water quite ordinarily. How would the power take off cope with that? No one knew; these questions had never been asked before. And how was the power train to drive the wheels and the jet? What kind of engine out of all the engines available was the right one? How would it be packaged, what kind of decoupler would switch power from one mode to the other? Would it be a street engine or a marine engine? Every issue had to be resolved to the standard of whichever set of regulations was the more demanding.

Around this time, *Neil Jenkins* a highly talented automotive engineer had heard about the project in England; he bought himself a ticket and went to visit. When he saw the video he was ravished. He told Alan Gibbs that whatever happened he wanted to be associated with the project, even to the extent of taking the first distribution rights for Britain. As it happened, his role would be more significant. He would merge his business with Alan's and become a shareholder in the new project.

Jenkins' career had begun in aerospace; his background was in lightweight vehicles and structural analysis. He had worked on the Tornado, and had been a senior figure in the team that built the XJ220, the Jaguar super car. His aerospace experience helped him provide the first genuinely amphibious concept in the production process.

He came up with a unique hybrid design for frame and body which took care of the road and marine functions in separate ways. The frame by itself was not stiff enough for a road structure; the body by itself was too flexible for a boat hull. But put together they achieved precisely the stiffness and strength required, for the lowest possible weight. It was a brilliant solution to a major problem.

At the same time, the team produced a completely original design combining the suspension system with the machinery that retracted the wheels. The wheels of the proof-of-concept vehicle had been retracted by means of a long, torsion bar. This was replaced with a seventeen-valve suspension system driven by oil pressure. And one strut combined spring, damper, bump stop device and retraction system. Between this and the hybrid structure the project was well on its way to the sixty patents it filed.

The power train difficulties had been solved for the time being, and this allowed the concept development of decoupling the engine from the wheels and attaching it to the jet. A power take off flange from the gear box switched power to the marine drive.

The concept work was more or less complete. The physics of the project had been established. The architecture of the car was agreed. The design was at a good intermediate stage. The geometry of the wishbones and their interaction with the wheels was settled. There were gaps in the project but the internal structure, the frame, seating, suspension, wheel retraction and power train were packaged into a body shape. It was more than an idea but less than a product. Now it had to be engineered.

The project needed a culture of low volume manufacture, and no such culture exists in America. In fact, there are only two places in the world where such a culture does exist. Turin in Italy, and the Black Country in England. At the beginning of 1999, the project moved to the UK.
The new production plant in Nuneaton had originally been a sewing factory. It's a huge, bare space with a few cabinets and thousands of square feet of wooden parquet production floor, well lit from above by huge skylights.

Jenkins took on the role of Managing Director. He had begun his engineering life in the Stress Office of British Aerospace where he was taught everything there was to know about designing for light weight.
He went on to work for Rolls Royce and Jaguar. He has designed bespoke cars which retailed, or perhaps more accurately, sold for £5 million. He also played a key role in the development and production of the Jaguar XJ220.

It was Jenkins who brought together a core team for the XJ220's body systems. This was one of Britain's most prestigious not to say most successful low volume projects in recent times. It was conceived by Jim Randle and executed in part by Neil Jenkins, Pete Dodd and Mike Giles, all of whom have played a central role in bringing the Aquada into the world.

Jim Randle was the engineering director at Jaguar in the late 80s and early 90s; he was also the director of Jaguar Sports. In these capacities he presided over many new vehicle projects and brought his enormous experience to bear on all facets of car development but particularly in the areas of ride, handling and suspension systems. Indeed, it was he who designed the rear suspension for the XJ40. Jim also holds a position as professor of engineering at Birmingham University.

Pete Dodd began his career at Jaguar as an apprentice in the 1960s. As a founder member of the Jaguar Saturday Club he was heavily involved in the creation of the XJ 220 Super car with Jim Randle.

He became the engineering manager for that project and eventually went on to become general manager of the Bloxham Facility, then of Tom Walkinshaw's Engineering Division (responsible for the Aston Martin DB7, Volvo 850 R, Saab Sport and many concept vehicles).

Towards the end of the 90s Pete joined TWR FI Engines as the General Manager later on becoming a Director of that Division ,with the responsibility to supply F1 engines to the ARROWS team. Pete Joined Gibbs in late 2000 as General Manager for the R&D facility in Nuneaton.

Mike Giles spent eighteen years at Jaguar, joining as a Project Engineer in 1974 and rising to Chief Engineer of Vehicle Services and was responsible for a very wide range of vehicle projects, vehicle and system testing and engineering solutions for Jaguar models. Ultimately he was directly technically responsible for fourteen major vehicle programmes.

In 1992, he left Jaguar to become Head of Vehicle Technology for GKN Technology and two years later moved to LDV and as technical director he led a joint venture with Daewoo for a completely new range of developments, managing a team of over a hundred engineers and projects worth up to £55 million. Mike Giles joined Gibbs Technologies in 2000.

In addition, they recruited a team of 70 other outstanding engineers. It's a team of supreme generalists with uniquely specialist skills, a combination that is rare anywhere in the world.

Styling

Knowing how demanding consumers are, and taking on board previous styling criticisms of amphibious vehicles, Gibbs insisted this car was to be a world class design. He decided to run a blind competition, and invited a number of the world's top designers to participate.

They were supplied with a design brief. The brief went out with sixty-five specifications. Eight weeks later the designs were evaluated. Several of them had dash, and all had style. But many of the serious amphibious issues had been taken too lightly. They were conventional car designs not amphibious car designs.

So the surprise winner was not one of the big Italian brand names but Steve Bailey, the designer who had been working for Neil Jenkins for the previous five years. Seamless integration of the technical constraints was critical to the style of the vehicle. It did not want to be styled as a car on water, nor a boat on land, but as a new high speed amphibious product, which equally balanced both marine and land functionality. This has been achieved.

Frame and body shell

One of the most important conflicts in the design centred on the different ways that cars and boats handle load. In boats, load is distributed fairly uniformly. When it's planing, the back third of the hull takes the load evenly. When it goes into a sharp turn, the stresses distribute themselves smoothly over a wide area of the hull.

For a car, all the forces are taken into point loads, into the suspension mounting points. This is almost the opposite of the way a boat distributes load: the initial burst of acceleration up onto the plane, the smooth turns, the slap, slap, slap of a boat in choppy water present a series of very different problems.

Neil Jenkins: "We created a very simple bonded frame to take all the point loads – the engine loads, the crash loads. But the space frame was very weak in torsion. It was like a wet bus ticket." It's true, the frame by itself feels uncertain when you push it; only when it was integrated into the hull does it achieve its extraordinary stiffness.

The result is a frame and body hybrid which performs in a uniquely amphibious way, splitting the load-carrying between frame and body. On the road the frame takes the loads at certain specific points and distributes them into the body shell.

On water, the loads go the opposite way – the water hits the hull and the loads are distributed into the frame.

The first amphibious challenge has been met with a brilliantly amphibious solution.

Hull

The Aquada is heavy for a boat; it's short for its weight. The hull therefore presents quite a small hydrodynamic surface. Management of the marine performance is both difficult and critical.

"No consultants had the science to tell us how a fifteen foot hull would work with huge cut-outs amounting to a quarter of the hull. Had we wanted a battleship with sonar bumps all over its underneath, they could have told us the drag to within two decimal points. But this was entirely outside the range of knowledge of the world's experts."

Neil Jenkins says that Gibbs solved most of the hydrodynamic problems himself. "It was mainly Alan tackling the process in a systematic way. Whenever we went heeling into a corner, the trailing wheel arch was digging into the water. We would go through a systematic process of observing exactly what was happening at different speeds and adjusting the strakes and chines."

The Aquada's hull has pushed out the frontier of research on small boat hull design.

Suspension and Retraction

The single most unusual piece of engineering in the Aquada is found inside the wheel arches. It's a strut, a single strut, but it conceals a revolution of compactness, of multi-functions.

So the strut acts as a self levelling spring, a shock absorber, a bump stop. It's a device for raising ground clearance by two or three inches. And finally it is the device used to raise the wheels out of the water. It's all controlled by computer via seventeen valves for the hydraulic system.

Powertrain

Thirty years ago this project would have been impossible: the power to weight ratios have improved enormously over that period. They are using a standard engine of just 2.5 litres because that's all we need to develop a hundred and sixty five horsepower. It's not a lot today but it's four times what ordinary cars had thirty years ago, and it's the same weight.

Jet

The Aquada gets nearly a tonne of thrust out of a jet which is half the length and a quarter of the weight of what might ordinarily be expected. It's got the biggest intake ever known for a two-tonne boat and develops power enough to suck stones as big as your fist through four feet of water. It throws a hundred cubic metres of water a minute out of the back of the impeller.

Conclusion

The result of all this effort, ingenuity, experience, determination and – let it be said – investment is an amphibian that is beautiful to look at, satisfying to drive, and possessed of a unique quality.

It offers an experience that words do not describe: no matter how well prepared, people are astonished when they see what the amphibian does. What might be usefully said however, is that for quite a substantial part of the automotive market, the Gibbs' team's creation doubles the utility of motor vehicles.

Gibbs himself is careful about claiming too much for his vehicle. But the technology that underlies the Aquada gives a new dimension to automotive development.