WIG - What Are You Waiting For?

Graham Taylor
Hypercraft Associates.
23 Wyndham Avenue, High Wycombe, Bucks, England.

ABSTRACT

There is a great deal of waiting going on in the marine transport industry:
- *Passengers are waiting for their ferry to reach its destination*
- *Commerce is waiting for important packages to arrive*
- *Commanders are waiting for their troops to hit the beach*
- *Smugglers are waiting for a gap in coastguard patrol*

Meanwhile, Operators are waiting to see if WIG vehicles really do take off, and Investors are waiting for someone else to take the first risk.

That's a lot of waiting.

Current WIG vessel technology can certainly address these areas. But getting the technology to work is only half of the problem; getting the business to work is the other. This paper discusses the steps that need to be taken along the road to commercialization of WIG from technical, commercial, civil and military perspectives.

INTRODUCTION: WHAT IS WIG WAITING FOR?

WIG offers something special in so many ways. We are used to the idea that the faster a vessel goes the more power is needed. WIG breaks this rule. Many 'conventional' vessels can exceed speeds of 50 knots, but it is known that to make them go faster still requires more power. Up to 50 knots a WIG is to all intents and purposes a conventional vessel, operating in the conventional marine envelope. But at around 50 knots it begins to make its transition to ground effect, and once that is reached it can turn power off and yet accelerate further.

The problems of WIG are inside people's heads:

- The idea of riding on a dynamic cushion of air
- The idea of switching power off to go faster!

WIG is still waiting for people to get their heads around this; even though the Russians/Soviets proved the concept so dramatically through the Ekranoplan programs of the 1960 – 80s.

So what are we all waiting for? It can take a generation to get a new idea adopted. No truer word can be said about the marine industry. It is hard to find another industry which evolves more slowly than ours. Perhaps this is due to the long life cycle of the product, or because the conservatism, entrenched views and risk aversion that held back Turbinia and the Hovercraft still exist today.

WIG is not the only frustrated technology. Many of the other brave new concepts currently being explored (and some presented at this conference) have been around for a decade or more. Unfortunately this means that the cutting edge of marine technology can often be rather dull by the time it reaches the outside world, and those people at the forefront must aim for longevity if they dream of seeing their idea adopted, a point on which Sir Christopher Cockerell once remarked.

1. PROBLEM FORMULATION – WIG?

1.1. Governing Equations:

Which came first?

- The Chicken, or the Egg?
- The technology, the product, the manufacturer, the operator, the industry or the market?

The answer is they all did. They are closely interrelated and interdependent. Normally, when things change incrementally we do not have to address such a fundamental question. But WIG is so far away from the normal paradigms that people in the adjacent areas do not recognize it or identify with it. It must stand on its own. So, for WIG to be commercialized successfully, all the parts of the

jigsaw from the technology through to the market must be created at more or less the same time. WIG is also a 'disruptive technology' [Ref. 1,2] and it is a fair bet that many of the players who will ultimately be involved in WIG are not major players in the mainstream marine transport business today, so it is pointless to wait for the conventional marine sector to catch on.

WIG therefore represents a new product, a new market and a new industry. For it to be successful the Technology must work, the Manufacturing company must be viable, the Operating company must be viable. It must also mean something to the ultimate customers/users in the civil and military markets. Let us explore these interrelationships further, starting with technology.

2. THE TECHNOLOGY

2.1. Technology Base

There are several technology houses around the world, notably in Russia, Germany, China and, more recently, Korea. Each has a good set of attributes. Those that have caught this authors' attention are:

- Cometel El 7 'Ivolga' from Russia, a Type C class WIG with a broad range of capability [Fig. 1]
- The prototype developed by Korean Ocean Research and Development Institute (KORDI). Information on this project was released January 2005 [Fig. 2]. Program discussed later.
- HoverWing, by Fischer Flugmechanik/AFD Airfoil Development Germany (FF/AFD) [Fig. 3]

Fig. 1: *Ivolga EL-7, Russia, Type C WIG capable of free flight*

Fig. 2: *Prototype developed by KORDI*

FIG. 3: *The HoverWing 2VT 2 seat technical demonstrator in 1997. This was a scale model of an 80 seat concept **

The author has been working closely with Fischer Flugmechanik for several years and presents some details of the HoverWing below, because of its unique qualities.

HoverWing is particularly notable because it is a second-generation technology that comes from a stable which has already produced the worlds first WIG vessel to achieve a Certificate of Class for passenger transportation by ship classification societies Germanischer Lloyd (Dec 2001), and Lloyd's Register (May 2002) [Fig. 4]. That vessel was based on FF/AFD's first generation technology which has since been sold to another company (with the AF8 001 craft) and will go into series production. The second-generation 'HoverWing' technology has been retained by FF/AFD for separate commercialization.

Fig 4: *First-generation Airfish 8/Flightship 8, eight passenger vessel launched in 2001*

A HoverWing technology demonstrator, the HW2VT, was launched in 1997 and successfully proved itself in over 3,000 km of trials [Fig. 3]. It was a manned scale model of a projected 80 passenger seat vessel to satisfy the requirements for operation on the Baltic Sea. The HoverWing concept improves upon some of the characteristics of the first generation technology, and is notable for several key features:

- Lift-off Aid
- Blended body/lifting body
- Maneuverability

Fig. 5: *Bow of HW2VT showing retractable skirt*

To reduce the imbalance between installed power needed for takeoff and for cruise, the HoverWing incorporates a patent protected lift-off aid in the form of an SES type air cushion under the hull (this feature is even more important from a commercial viewpoint than a technical viewpoint, because installed power is one of the main cost-drivers for both manufacturer and operator). For takeoff, 7% of the propeller stream is diverted and guided between catamaran hulls to produce a static air-cushion, which reduces displacement of the craft by 80%. By means of skirts, as used on SES craft, the static pressure can be maintained until take-off [Fig. 5], whereupon the craft makes a seamless transition to ground effect cruise mode, after which skirts are retracted. This feature reduces the installed power by approximately 45% compared to non-aided takeoff [Fig 6].

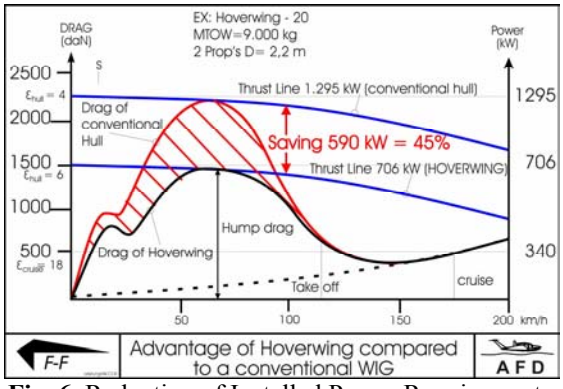

Fig. 6. Reduction of Installed Power Requirement due to HoverWing principle *

HoverWing steps away from the 'stick with wings' aircraft configuration used in other design houses by combining the lift-off aid system and catamaran hulls with a blended lifting body centre hull shape. This centre section contributes 40% of total lift in ground effect. At the same time it offers a very large internal payload volume. The approach also enables a highly integrated mechanical construction with masses and lift forces in close proximity. This minimizes bending stresses, which in turn minimizes airframe/hull weight. With bending stresses minimized in this way, the wings and tail of the HoverWing can be made to fold (for docking) using simple mechanisms [fig. 8].

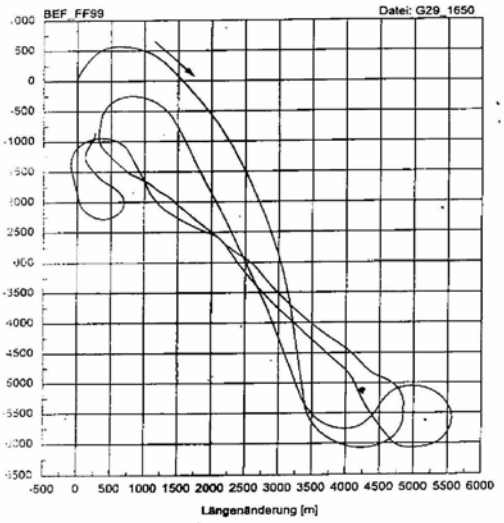

Fig. 7: *Manoeuvrability - GPS track of HW2VT trials with turns of less than 300m radius* *

Fig. 8: *HW-20 concept showing blended/lifting body and wings folded. **

The maneuverability of HoverWing is impressive. The Lippisch-based configuration allows it to fly at sufficient height to perform banked turns of less than 300m radius while cruising at 90 knots, without subjecting the passengers/crew to uncomfortable G forces [Fig. 7, Fig. 9] In addition a direct height control system enables the cruise height to be adjusted without altering pitch, by means of special flaps. Further, by using the kinetic energy in cruise mode, it is also possible to give the vehicle the ability to jump up for vertical obstacle avoidance. Larger craft will have the same maneuverability. FF/AFD are currently working on the commercialization of 20 seat and 80 seat variants.

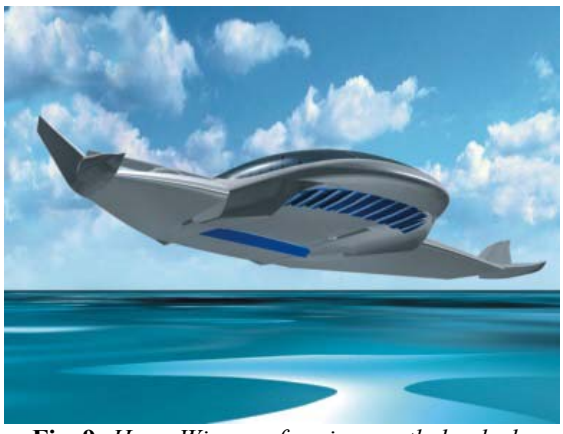

Fig. 9: *HoverWing performing gentle banked turn. Note retracted skirts are visible. **

2.2. Technology Next Steps

Viable commercial WIG vehicles are now within easy reach. All the fundamental problems have been solved. But there remains the task of translating concept and prototype work into an actual marketable product at a vehicle size that is commercially viable. The next step is to take the technology through the iterative process of the 'design spiral' [Ref. 3] to produce an optimal vehicle design which will balance all the technical elements together with the financial, commercial and risk dimensions of the problem. Said simply, the ideal design will be the optimal balance of advancement against risk.

This step cannot be taken without funding, which in turn, cannot be gained without the reasonable expectation of recovering such costs through sales to customers - which leads nicely into the subjects discussed in the next section.

3. COMMERCIAL - GETTING THE BUSINESS TO WORK

3.1. Brave New World

WIG represents a whole new sector of marine transport – maybe even a whole new industry. It is not just the sheer speed of 90 knots plus which differentiates it from the mainstream. As we will see, there are commercial dimensions associated with WIG which give it its own operational and business paradigms also.

To an engineer the benefit of WIG is its power efficiency (e.g. the Karman-Gabrielli diagram). In truth, within the context of total operating costs, the fuel costs for WIG are reduced to the point where they cease to be the main cost-driver, and may be overtaken by capital cost repayment/leasing, or staffing costs, or even insurance costs [Ref. 4,5]. So power efficiency is good, but it is in other areas that WIG has to make improvements.

Another popular myth is that WIG costs one-third that of the equivalent aircraft. This is not completely true. There are still large R&D costs to be faced ('first of class' costs); tank tests, wing tunnel tests, safety assessment, certification procedures, general design costs etc. because there is not yet an established formula. If all these costs were to be

recovered within the price of one craft (as is often the case in traditional ship building) then that vessel would be considerably more expensive than an aircraft. Indeed, a reasonable price for a WIG vessel can only be arrived at if the 'first costs' are amortized across several vehicles on a series production line (as is done in the aircraft and car industries). The precise detail of just how these first costs are spread is a director-level decision and will be based on that company's assessment of its business plan and its view of the market. So through the trickery of accountancy, the price becomes a manipulated figure aimed at being acceptable to both the manufacturer and the operator. Just how that price relates to an aircraft still remains to be seen. Ultimately the attractiveness or otherwise of a price depends on whether the WIG is operating against competition of aircraft, helicopter, boat, or in a whole new market scenario.

The above has a powerful shaping effect on the WIG industry. The significant first-of-class R&D cost represents a high entry barrier to deter potential new players. It also dictates that series/mass production of 'identical' vessels must take place. This in turn necessitates that manufacturers obtain a 'critical-mass' of orders before starting production [Ref. 6]. The high cost of working up a design to accommodate whimsical requirements of individual customers will force the WIG industry away from the custom-built, yet 'commodity' nature of traditional ship/boat-building. Instead, a WIG manufacturer will sell from a standardized product (more like aviation) but will have a seller-market strength, like Henry Ford, who offered cars 'in any color, so long as it's black'.

3.1. Relationships – The First Step

In the formative stage of the WIG industry, the technology, the product, the manufacturing business and the operating business will be at their most interdependent. The success or failure of one determines the state of the other. This means that there must be a strong relationship between each party; perhaps with interlinked business models. (Each party is likely to have to present the relationship to their investors in order to raise money). This can be illustrated by a value-chain type diagram [Fig. 10], in which there is a free flow of communication and information from one end to the other. Such a degree of collaboration and transparency is something that may not be well understood in the adversarial world of mainstream marine business.

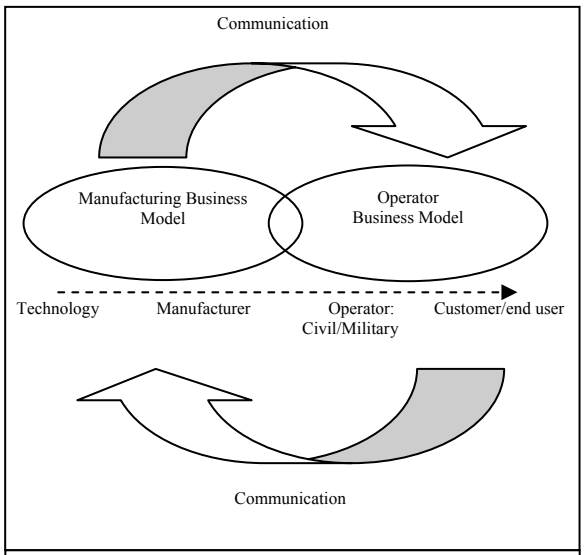

Fig. 10: *Interlinking business models and communication channels for manufacturer and operator*

This close relationship will also be necessary to enable swift operational evolution of WIG vessels, in light of real experience, in real seas, with real customers.

The most important step to take is to find the *right* players with which to build the relationships. This is a point that the author feels cannot be over-emphasized. WIG, like so many innovations, has a tendency to attract the attentions of those seeking a 'fast buck' at the expense of others, yet for WIG realize its true potential it will need dedication and strategic vision that can only come from the most sincere.

4. THE MARKET: CIVIL AND MILITARY

4.1. The Product in a Market Context

What does the product mean to the market? James Dyson [Ref. 7] observed when recounting his experience of selling high speed boats:

> *"... You simply cannot mix your messages when selling something new. A consumer can barely handle one great new idea, let alone two, or even several".*

This is perhaps a problem for WIG, with its multitude of facets. Setting aside price and fuel savings, the tangible benefits offered by WIG are:

Speed (sustained speed of 90 knots plus):

- Turns the business machine faster. This means harder working capital investment, more frequent service, more 'pax' for your bucks.

- Brings new destinations 'closer together'.
- New routes become possible within acceptable journey times

Zero Water Contact:

- No sea motion, or sea sickness
- Low fatigue for occupants or equipment
- No wash, no environmental damage to waterways, no effect on other waterway users
- Immune to sea or river currents, will not hit floating objects such as driftwood, whales, etc.
- Shallow water operation, unaffected by tidal variation/water level
- No visible wake (stealth)

Despite its high speed, the author believes that WIG is most applicable for medium/short-range applications (typically of around one hour duration) such as river and lake, coastal, inter-island, delta/estuary transport, indeed, any part of the world where the sea-state permits. WIG may never become the blue-water craft that some people dream of, but the market opportunities are plentiful. Regions include the Gulf of Mexico, the Caribbean, vast areas of East Asia, part of the Mediterranean, Red Sea and The Gulf, as well as the thousands of miles of major rivers in each continent. There is a world of opportunity out there. Whether the civil market will lead the military, or vice versa, is difficult to tell right now. The authors' guess is that they are of similar value, so they get equal billing.

3.2. The Civil Market

Some Civil applications are suggested below:

- Passenger Ferry/Water Taxi – services between population centers
- Freight/Workboat – e.g. high value/time sensitive freight and mail, servicing oil rigs etc.
- Tour boat – e.g. able to take passengers from cruise liners to remote destinations in short space of time
- Resort boat – ferry passengers from airport to hotel beach
- Dive boat – reach remote reefs, follow reef activity

Successful operation requires local knowledge of the transport opportunities and demands. So the WIG manufacturer can expect to build relationships with numerous potential local operators in order to reach the 'critical mass'. They must also work within the constraints of local cabotage requirements, such as the US "Jones" Act, which may dictate the place of manufacture to serve certain markets. There are also likely to be (local) governmental dimensions to the puzzle regarding support of tourism and trade.

On the other hand, WIG operators will gain unique skills which can be applied to routes in many parts of the world, so there is the opportunity to build a global business with global brand identification, operating on a 'multi-local' basis.

3.3 The Military Market

In the military environment WIGs attributes are:

- Ability to cover a wide area within a short time
- Rapid response capability – rapid closure.
- Genuine capability to intercept almost all other marine vessels.
- Zero wake stealth

Potential paramilitary applications might include:

- Over-horizon and littoral operations
- Drug-running interdiction
- Anti-piracy
- Border patrol
- Fleet patrol/asymmetric threat protection
- Search and rescue
- Medevac
- Pollution / environmental monitoring
- Ship to shore transport
- Covert and special operations

The high interception speed combined with stealth means that persons undertaking illegal activities can be caught red-handed, leading to more effective enforcement, especially beneficial in areas with high incidences of piracy, terrorism or smuggling. Such WIG vehicles could have a great deal of presence, as illustrated by the HoverWing HW20 Mil concept [Fig.11]. In addition these craft may be difficult to detect by mines or sonar, making them suitable for crossing minefields, mine clearance or ASW work. Opportunities certainly exist to substitute WIG vehicles for horrendously expensive and maintenance intensive helicopters.

Sadly the slowness of adoption of new technology is a standing joke in some military services. One wonders who benefits from this or if the culture will ever change. However, military services worldwide are currently going through radical 'transformational' review and re-engineering as they grapple with new emphasis on concepts such as sea-basing, over-horizon operation, rapid response, expeditionary forces and asymmetric warfare. This represents an opportunity for WIG. Perhaps the best way forward

is through construction of a technology demonstrator vessel for military trials (as per Incats' 'Joint Venture HSV-X1' and Austals' 'WestPac Express'). Such a craft can then be used by the armed forces over an extended period to explore first hand what the special qualities of this 100 knot capability could mean to them. This would enable operational evolution and development to be focused on real mission scenarios in field conditions; to explore what works and what doesn't, what breaks and what doesn't, what can be achieved by closing on a target at more than one-and-a-half miles a minute. The result of such a program would be a hardened and competent warfighting vessel.

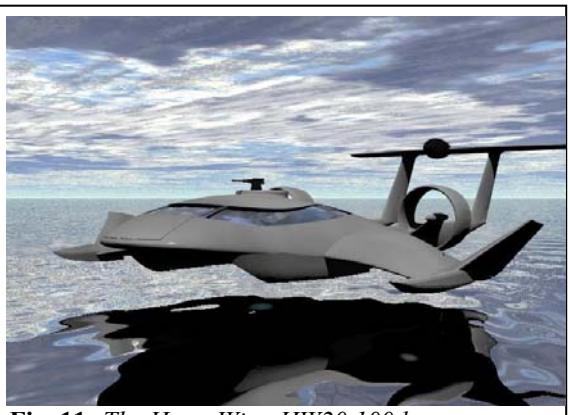

Fig. 11: *The HoverWing HW20 100 knot concept. Accommodates 12 fully armed troops, or two quad bikes and other equipment. Armed with 50 cal chain gun with remote/stabilised gun laying for littoral patrol/special operations.**

CONCLUSIONS: DON'T KEEP THE FUTURE WAITING

The paper has outlined some step which need to be taken to move WIG forward from technology, commercial, civil and military perspectives.

WIG is exactly what some parts of the globe are waiting for: transport is absolutely fundamental for economic development in today's world. Better transport means greater trade. Yet many regions are handicapped by terrain, geography, or simply lack the money for traditional high-speed transport systems. East Asia and the Baltic Sea are two obvious examples of where destinations can be brought closer together through high speed sea routes, but there are many more. Just how higher transport speed can bring destinations 'closer together' is illustrated by FF/AFD time/distance model of the Baltic Sea [Fig. 12] [Ref. 9].

WIG brings the speed and comfort of freeway travel, but without having to build the freeway first, or having to sink vast amounts of money into fixed infrastructure assets like roads, railways or airports [Ref. 8]. It offers a speed of the service that is about twice the legal road speed limit in most countries. And it does this without necessitate the huge environmental destruction inherent in building and operating most transport infrastructure schemes in which the vehicles themselves are often only a fraction of the total cost. Also a WIG service can be introduced or re-deployed at short notice so the service can be evaluated by practice rather than by theoretical projection.

One of the most exciting announcements made recently was Korea's Ministry of Marine Affairs and Fisheries (MOMAF) commitment to support WIG transport and inject 120 billion won (£62 m, $117 m USD) of investment into creating a transport network with 50 large vessels to be built by 2010. MOMAF believe that the benefit of such a transport system will be worth 1.25 billion Won (£645m, 1,220m USD) to the economy of the region. This is projected to bring about major changes in the North-eastern Asian maritime logistics system and the network of WIG transport may set Korea up as the 'logistics hub' of the region [Ref. 10].

The urgent need for effective transport in East Asia cannot be understated. There are huge socio-demographic changes afoot which must be addressed. Over the next 20 years, the urban population in East Asia and the Pacific is projected to increase by 500

Fig. 12. *Time/distance illustration. The short journey time of a 90 knot WIG in the Baltic Sea (left) has the effect of bringing destinations closer together (right).* Courtesy of Fischer Flugmechanik/AFD*

million people, or 60 percent [Ref. 11]. This demands radical action. Several very large transport and trade infrastructure initiatives are currently underway which will interlink East Asian countries (mainly over land) such as the Southern Economic Corridor, from Thailand to Vietnam [Ref. 12]. WIG could certainly help and, in the authors' opinion, the payback from high speed WIG transport to economies of East Asia of will far exceed the cost of investment in vessels.

What is WIG worth? How big could the WIG business be? Some say equal to the helicopter business. There are a lot of parallels: a helicopter is far less self-stable than WIG, it offers similar point-to-point speed, yet it has secured a rich 'niche' business. The world helicopter market is currently worth 4 billion USD, and growing at 3% per year [Ref. 13]. It is dominated by just five big players – perhaps another sign for WIG. (On the other hand, there no 80+ seat helicopters and never will be). If WIG vessels were to cost just one-tenth the price of a helicopter the market would be worth 400 million USD. Surely this is an incentive for potential players, investors, and suppliers to step into the sector.

In the authors view, demand will outstrip supply for at least the first decade, giving WIG manufacturers the opportunity to cherry-pick their customers (operators) and WIG operators a market which is secure against competition from new entrants. Who, in mainstream marine transport business has such luxury?

The most important step is to start. The marine transport industry may be world's second-oldest profession, founded when man first floated down a river on a log. Yet it can be woefully slow at evolving and adopting new ideas. Papers for this conference all concern adoption of new technology and new ideas, so maybe now is a good time for us all to ask ourselves "What are we waiting for?".

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