

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

MHL CUSTOM, INC.,

Plaintiff,

v.

WAYDOO USA, INC. and SHENZHEN
WAYDOO INTELLIGENCE TECHNOLOGY
CO., LTD,

Defendants.

C.A. No. 21-0091-RGA

JURY TRIAL DEMANDED

EXPERT REPORT OF CHRISTOPHER BARRY

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I. INTRODUCTION

1. My name is Christopher Barry. I have been retained by MHL Custom, Inc. (hereinafter “MHL”) to provide my opinions regarding infringement of MHL’s U.S. Patent Nos. 9,359,044 (the ‘044 Patent) and 9,586,659 (the ‘659 Patent) or collectively (“the Asserted Patents”) (attached as **Exhibits 3 and 4**) by Waydoo USA, Inc. and Shenzhen Waydoo Intelligence Technology Co., Ltd., and other information contained herein.

2. Based on my analysis and investigation, I have reached certain conclusions and opinions on the issues that I discuss in this report. This report is based on information currently available to me, and I expect to testify at the trial in this matter. I reserve the right to continue my investigation and study, which may include a review of documents and information that recently may have been produced, as well as deposition testimony for which transcripts are not yet available or that may yet be taken in this case.

3. I also reserve the right to expand or modify my opinions as my investigation and study continues, and to supplement my opinions in response to any additional information that becomes available to me, any matters raised by Defendants and/or opinions provided by their expert(s), or in light of any relevant Orders from the Court. Therefore, I reserve the right to prepare a supplemental expert report based on, for example, additional deposition testimony and/or additional information that becomes available after this report is issued.

4. I also understand I may be asked to elaborate further on my positions in this report and to provide opinions on other issues. I reserve the right to form and report such additional opinions and the bases for any such opinions. I also reserve the right to use animations, demonstratives, demonstrations, enlargements of real exhibits, and other devices to illustrate my opinions at trial.

II. QUALIFICATIONS AND EXPERIENCE

5. The following is a brief summary of my background and qualifications. My background and qualifications are more fully set out in my curriculum vitae (CV), attached as **Exhibit 1**.

6. I have at least forty-seven years' experience with naval architecture. I am currently a naval architect engaged in a variety of projects as a self-employed part time consultant (and have occupied this role since at least 2006), primarily engaged in various forensic investigations of marine accidents and damage including high speed craft collisions, and high-speed craft dynamic stability and propulsion as well as other topics involved in accidents and damage to boats and ships. I am also employed as a senior naval architect, GS-0871 / 14, at the United States Coast Guard Surface Force Logistics Center, where my responsibilities include hydrodynamics of high speed craft, hydrodynamics of propellers, hydrodynamics of appendages such as rudders and stabilization fins, hydrodynamics of ship motions, hydrostatic stability of boats and ships, structures of boats and various aspects of typical marine engineering systems, including propulsion machinery, auxiliary machinery, and deck machinery. I have held this position since 1992.

7. Prior to my current positions, I was the chief engineer at Munson Manufacturing (Edmonds WA) from 1991 to 1992, where my responsibilities included all aspects of engineering for a builder of aluminum high speed boats except electrical systems. Prior to that, I was a senior naval architect at Elliott Bay Design Group (Seattle WA) mainly involved in structure, stability, propulsion and numeric lofting / hull surface definition from 1990 to 1991. Prior to that, I was a senior engineering analyst at Ground Systems Division, FMC Corp., from 1987 to 1990, engaged mainly in the hydrodynamic design and analysis of a high-speed armored hybrid hydrofoil

amphibious assault vehicle for the U.S. Marine Corps. I also performed other miscellaneous tasks including software development, analysis of crew air systems, infrared signature analysis, and hydrostatic stability and flotation analysis of low speed armored amphibious or “swimming” vehicles. Other positions prior to that included engineering analysis of high-speed propulsion systems, chief engineer at a small shipyard, vice president of engineering at a general naval architecture engineering consultancy, senior naval architect at an engineering consultancy engaged in offshore oil systems support, and as a naval architect in another general naval architecture engineering consultancy.

8. I obtained a Bachelor of Science in Engineering from the University of California, Berkeley in 1974.

9. As shown in my CV, I have authored or coauthored, in the previous 10 years, 7 technical papers, 9 other presentations, and three short courses.

10. I am a member of industry and professional organizations, including the Society of Naval Architects and Marine Engineers (SNAME), the American Boat and Yacht Council (ABYC), and the Association for Materials Protection and Performance (AMPP, formerly NACE International). I also regularly attend and teach or present at industry and educational conferences concerning naval architecture and boat and ship design, and specifically technology involving hydrofoils including the International BoatBuilder’s Exhibition (IBEX, a trade event for boat building and related industries) and the Multi-Agency Craft Conference (MACC, an event concerning high speed watercraft mainly from the military and first responder communities).

11. I have received several awards and recognitions for my work concerning naval architecture, including being named a Fellow of SNAME, the SNAME Hann Award in ship

production technology, and an Innovation Award from FMC Corporation, Ground Systems Division (a prime weapons system corporation, mainly a manufacturer of land and amphibious armored, other military vehicles, and related artillery systems) for invention of the Hybrid Hydrofoil Armored Vehicle.

12. I am an inventor on two (2) US patents related to hydrofoil and watercraft design and a third relating to the hydrodynamics of wave energy conversion devices.

13. For the past 16 years, I have worked as an expert witness. I have testified as an expert in the following cases during the previous four years:

- Deposition testimony: Fish v. The Cincinnati Insurance Co., United States District Court For The District Of Maryland, Case No.: Rdb-19-03355.
- Deposition testimony: Lanzi v. Yamaha Motor Company et al., U.S. District Court, Middle District of Florida, Tampa Division, Case 8:17CV2020-CEH-AEP.
- Deposition and trial testimony: Thabet v. Yamaha Motor Company et al., Superior Court of the State of California for the County of Los Angeles, Case BC635250 September 23, 2016.
- Deposition testimony: Brown v. Reinauer Transportation, U.S. District Court, Eastern District of New York, Case 1:16-CV-03998 LDH-PK.
- Deposition and trial testimony: Nagapetyan et al. v. Honda of North Hollywood et al., Superior Court of the State of California, Stanley Mosk Courthouse, Central District, Los Angeles, Case BC544531.
- Deposition testimony: International Yachting Charters v. Christopher A. Upham, Spencer Rybovitch, et al., Circuit Court of the Fifteenth Judicial Circuit in and for Palm Beach County, Florida, Case No.: 2003 CA 004410 AN.

14. I am being compensated for my time at \$200 for each hour of service that I provide in connection with this case. This compensation is not contingent upon my performance, my opinions, the outcome of this case, or any issues involved in, or related to, this lawsuit.

III. INFORMATION CONSIDERED

15. Attached as **Exhibit 2** is a list of the information I reviewed and considered in preparing my opinions contained in this report.

$C_{n\beta}$ may be called weathercock stiffness and C_{lp} may be called roll damping. Trimmable, stable motion at zero sideslip is achieved by ensuring that the following conditions are true:

$$C_{l0}=0$$

$$C_{n0}=0$$

$$C_{l\beta} < 0$$

$$C_{n\beta} > 0$$

$$C_{lp} < 0$$

‘044 Patent. Col. 6, ln. 35-62; ‘659 Patent Col. 6, ln. 47 – col 7, ln. 5.

VII. MHL’S COMMERCIAL EMBODIMENT

70. Patent owner MHL makes, offers for sale, and sells commercial embodiments of the Asserted Patent. The commercial embodiments include the LIFT1, LIFT2, LIFT3, and LIFT3F (collectively referred to as the Commercial Embodiments).

71. I reviewed several materials and documents concerning the Commercial Embodiments, including engineering drawing, the eFoil User Manual, LiftFoil website, and numerous videos on Lift Foil’s YouTube channel.

72. The Commercial Embodiments of the Asserted Patents are personal hydrofoil watercraft. Relevant features of the Commercial Embodiments include:

- a flotation device or board that has a length measurement that is greater than the lateral width of the board;
- the flotation device or board being capable of receiving a user laying stomach down, in a kneeling position, or standing;
- the flotation device is controlled by weight shifting of the user;
- a strut with an upper end interconnected with the flotation device or board and a lower end that connects with a hydrofoil;

- a hydrofoil interconnected with the lower end of the strut;
- the hydrofoil lacking any movable surfaces and providing passive stability controlled solely by weight shift of the user;
- a propulsion system connected to the hydrofoil; and
- the watercraft having no movable steering system.

73. The Commercial Embodiments use the technology claimed in the Asserted Patent.

Exhibit 5 is a claim chart describing how the LIFT1 Commercial Embodiment practices every element of the independent claims of the Asserted Patents (claim 1 of the '044 Patent and claims 1 and 16 of the '659 Patent). The relevant features of the Commercial Embodiments that practice the elements of the claims of the Asserted Patent are the same between each of the Commercial Embodiments.

74. The Commercial Embodiments provide the advantages of the invention claimed in the Asserted Patents. For example, the Commercial Embodiments provide mechanically simple personal watercraft with improved control and performance while providing a “surfing feel.”

VIII. THE ACCUSED PRODUCTS

75. It is my understanding that the Defendants make, use, offer for sale, and/or sell the Flyer One and Flyer One Plus within the United States. It is also my understanding that the Defendants sold the Flyer within the United States but have ceased selling this model.

76. I am familiar with the Flyer, Flyer One, and Flyer One Plus. I have reviewed materials and documents concerning the Flyer, Flyer One, and Flyer One Plus’s functionality and use, including: engineering drawings, photographs, manuals, videos, and the testimony of Waydoo’s employees and distributors. My opinions herein are based on the foregoing.

XII. SUPPLEMENTATION

227. I reserve the right to supplement this report based on additional information that becomes available to me and/or in response to any reports submitted on behalf of Waydoo USA and/or Shenzhen Waydoo.

XIII. TRIAL EXHIBITS

228. At trial, I may use visual aids and demonstratives to demonstrate the bases for my opinions, such as claim charts, drawings, excerpts from the documents and materials I considered in this action, discovery responses, deposition transcripts, diagrams, videos, and animations. I have not yet prepared any exhibits for use at trial as a summary or support for the opinions cited in this report, but I expect to do so.

I declare under penalty of perjury that all statements made herein are of my own knowledge and are true and correct.

Dated: August 8, 2022



Christopher Barry

EXHIBIT 1

Christopher D. Barry, P.E. (WA, CA, MD)

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Education: B.S. (Mechanical Engineering/Naval Architecture), University of California, Berkeley 1974

Licenses: P.E. Mechanical Engineering, California, No. M 18536, 1978
P.E. Naval Architecture/Marine Engineering, Mechanical Engineering, Washington State, No. 27127, 1990
Professional Engineer, Maryland No. 41778, 2012 (MD does not register by separate disciplines)

Technical Societies: Fellow, Society of Naval Architects and Marine Engineers (SNAME);
Chair: Small Craft Technical and Research (T&R) Committee, Member: Marine Forensics Committee, T&R Panels EC-15, Blue Economy, O-51, Ferry and Marine Highway; SD-3, Stability; Professional Licensure Committee
American Boat and Yacht Council
The Association for Materials Protection and Performance, (formerly NACE International, The Corrosion Society)

Training: Contracting Officer's Technical Representative Certification: Defense Acquisition University

Partial list Proposal Evaluation, Source Selection: George Washington University
Specification Development: Fisher Maritime
Proposal Preparation: Beveridge Assoc.
Shipboard Corrosion Assessment Training (S-CAT) and certification: NACE International
Federal Procedures and Ethics Courses
Post Graduate Course in Finite Element Analysis: University of CA, Berkeley Extension
ISO 9001 Implementation
Human Factors Engineering: Coast Guard
Standards Technician: ABYC
Vocational Welding Technology (two years, evenings): Laney CC, 900 Fallon St Oakland CA 94607
Software applications courses in FEA structural analysis (MAESTRO, ALGOR, ANSYS) and MathCAD
Admiralty Law for Marine Professionals: University of Washington Extension
Level 1 Boating Accident Investigation: NASBLA

Software: Microsoft Office Applications, AutoCAD 2020, Rhino3D, GHS, ShipConstructor, SHCP, FORTRAN, HANSEL, SMP, PowerSea, AVL

EXPERIENCE, KNOWLEDGE, SKILLS AND ABILITIES:

- **Extensive experience in maintenance, overhaul, acquisition, design and construction of commercial and military ships and boats, offshore oil platforms and other floating equipment:** Expert engineering knowledge of ships, boats, and marine systems and long-term capital marine asset management; planning, budgeting, acquisition, contracting, contract management, environmental impact and production of boats, ships, and marine equipment. Experience in a broad range of positions and specific tasks involving every type of surface marine vehicle or platform, analysis, types of systems and roles; (shipyard, design consultant, equipment vendor, and government fleet owner). Experienced in business aspects of commercial marine systems, in formal source selection processes and regulations for government marine operations, and in sustainable/green ship design. Expert experience and knowledge in marine regulations, including regulation development.
- **Extensive experience in shipyard liaison and support:** Ship tests and inspections, working with shipyard management and trades to develop design solutions, and performing and witnessing dockside and underway trials.
- **Hydrostatic, structural, hydrodynamic and mechanical engineering analyses** of resistance, motion RAOs in waves, mooring systems, maneuvering, propulsors, stability, strength, and mechanical systems of cutters and boats including high speed planing craft, semi-displacement craft and displacement vessels. Modeling hull forms and structures in CAD/CAM systems, using CAE tools for analysis and design optimization, including extensive experience in structural analysis and design by both hand methods and Finite Element Analysis.
- **System asset planning, budgeting and development:** Experience in managing planning for optimizing overall system solutions including overall fleet systems as well as individual ship systems, developing and validating requirements, fleet vessel mix, managing and executing support contracts for specific consultant support from high level computer simulation to routine ship condition surveys and minor design tasks. Projects included innovative new concepts for high-speed craft and propulsion systems, five major new acquisition programs for vessel fleets, major rehabilitation and modernization programs, and directing multiple long-term hydrodynamic research programs for fleet improvement.
- **Corrosion:** Extensive knowledge of corrosion processes and prevention including aluminum stress corrosion cracking, and other processes specific to aluminum. Extensive knowledge of corrosion in steel and aluminum including coating and preparation technology and coating assessment (including NACE Shipboard Coating Assessment Training Certification – S-CAT).
- **Welding:** Trained in vocational welding in aluminum, steel and stainless steel, welding metallurgy, weld inspection, strength and fatigue assessment, AWS, ABS and Navy welding standards, experienced in developing welding procedures, processes and productivity improvements including benchmarking and automation techniques.

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- **Rapid Field Response:** Routinely responded with short-term repair processes, plans, and decisions, “scrap or fix” decisions and “safe to sail” decisions for damaged Coast Guard cutters. Supported parts acquisition and QA inspectors for acceptance and rejection of non-conforming spare parts with technical interpretations of drawings and specifications and rework recommendations.
- **New vessel capital acquisition planning and execution** from beginning to end, including needs analysis, business case analysis, requirements development, cost estimates, concept, contract and detail design, acquisition strategy development, specification and RFP development, proposal evaluation, source selection, best and final offer negotiations, protest rebuttal, change proposal management, deliverable reviews, costing and negotiations and support for post contract cost adjustments.
- **Manage contractors:** Formulated, budgeted and managed numerous subcontractors for design tasks, equipment upgrades, safety systems developments, hydrodynamic research and specialized analysis support, managed long term and rapid response contracts for fleet support requirements.
- **Developed policy recommendations:** Developed Coast Guard acquisition plans and technical standards including joint Coast Guard / ABS cutter certification plan. Member of public/industry organization developing fishing vessel safety regulations, advisory committee developing international standards for ship and small vessel stability, advised committee on environmental regulations for Canadian High Arctic pollution control. Developed ISO 9001 documents and Naval Engineering Manual policy documents.
- **CAD/CAM:** Expert in application of information technology to fleet, implemented numerous productivity improvements in application of Computer Aided Design to all aspects of new shipbuilding and management of existing fleet assets.
- **Presentations and outreach:** Presentations and short courses to technical audiences, public interest groups, government and military officials, and the boating business community; numerous peer-reviewed technical articles, trade journal articles, and articles for the consumer press. Teaching in science / engineering for industry, university, community and elementary school programs.

EMPLOYMENT HISTORY:

5/1992 – Present U. S. Coast Guard Surface Forces Logistics Center, 2401 Hawkins Pt Rd., Balt. MD 21226 (410) 762-6704

Senior Naval Architect (GS-0871/14-10) - SFLC-ESD-NAME-NAV ARCH: Performed design, analysis, contract and technical management tasks in support of aluminum and steel boats and cutters involving hydrodynamics, hydrostatics, NAVSEA mooring systems, structure and mechanical engineering. Cutter weight and stability control, salvage and damage control software databases, and stability tests. Developed Computer Aided Lofting/Numeric Controlled Cutting system for Coast Guard YARD and trained YARD staff. Member of ISO 9001 Implementation Team. Developed Owner’s Requirements Documents, specifications, technical evaluations, cost negotiations, Engineering Change Proposal negotiations and claim rebuttals for major boat and cutter acquisition programs. Member of several acquisition Technical Evaluation Teams, and acquisition Subject Matter Expert on others. Provided engineering support to acquisition Project Resident Offices, reviewed drawings, calculations and conducted tests and trials. Developed statements of work, evaluated proposals and provided engineering and design support for fleet support Engineering Changes (ShipAlts, BoatAlts, TCTOs) including vessel configuration management. Investigated accidents. Managed and participated in hydrodynamic model tests and research; projects included ship motions simulation software validation, RAO development, and hydrodynamic efficiency improvements. Boat Engineering Branch (ELC-024) Technical Team Lead / Acting Branch Chief, supervising, mentoring and providing technical guidance and workflow management for seven civilian engineers and technicians, and three senior enlisted military.

4/1991 – 5/1992 Munson Manufacturing Co., 150 Dayton, Edmonds, WA 98020

Chief Naval Architect: In charge of all design and engineering tasks for a builder of aluminum high-speed commercial and military boats including fast ferries, oil spill recovery vessels, and Navy and Coast Guard patrol boats. Responsible for all engineering tasks, supervised design and engineering staff. Developed and implemented Computer Aided Lofting/Numeric Controlled Cutting hull manufacturing system and trained staff in its use. This system increased profits by 300%. Developed more than 16 complete boat designs in one year, including CNC code.

4/1990 – 4/1991 Elliott Bay Design Group, 5305 Shilshole, NW, Seattle, WA 98107 (206) 782-3082

Senior Naval Architect: Engineering support of various projects in support of ferry, tug, merchant ship, fishing vessel and yacht newbuilding and modification. Projects included ferry design, upgrade, and stability studies, proposal preparation, supertanker structural modification, design and stability analysis tasks for fishing vessels, tug, freighter, and excursion passenger vessels, contract designs and proposals for research vessels and patrol craft, lines fairing and numeric lofting for steel, aluminum and Fiber Reinforced Plastic (FRP) ships, super yachts and working and recreational boats.

3/1987 – 4/1990 Ground Systems Division, FMC Corp., P.O. Box 1201, San Jose, Calif. 95108

Principal Engineer/Naval Architect - Responsible for all naval architecture and hydrodynamics for amphibian and swimming armored vehicles (Bradley M2/M3, AAV7A1, LAV-AD, M113A1, AFAS) including development of High Water Speed Test Bed/AAAV for U.S. Marine Corps. Tasks included concept and detailed design development, vendor interface, proposal preparation, hydrodynamic model and full-scale testing, fluid flow analysis; and hydrostatic, hydrodynamic, and infrared signature simulation software development.

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7/1986 – 3/1987 Arneson Marine Inc., 15 Koch Road, Corte Madera, Calif. 94925

Applications Engineer - Responsible for marketing, analytic and design tasks in support of application of innovative surface piercing high-speed marine drive systems to high-speed ferries, military, and recreational vessels. Tasks included certification liaison with ABS, DnV & Lloyds Register, development of hydrodynamic computer programs.

5/1984 – 7/1986 Harborside Marine, 2101 Wilson Ave., National City, Calif. 91950 (Harborside purchased Lee 8/85)
Lee Engineering Corp., 100 Old County Road, Brisbane, Calif. 94005

Chief Engineer (Harborside) - Responsible for all engineering and design tasks in support of newbuilding in FRP and repair/renovations in FRP, steel, aluminum and wood to vessels up to LCM-8 class for U.S. Navy, U.S. Coast Guard, and various fishing/utility work vessels and fiberglass recreational boats including tooling design. Responsible for design and installation of floating marina and dock structures in Mexico and the U.S. Responsible for Coast Guard recreational boat safety test program.

Vice President of Engineering (Lee) - Responsible for all engineering for marine projects in ship design firm. Projects included: Coast Guard recreational boat safety certification (33 CFR 183) survey program; preliminary design and initial drawing package for Navy 42PRMK4 aluminum aircraft rescue boat; design of a 65' catamaran passenger vessel; renovations of debris boats and tug for Army Corps of Engineers; design of various modifications to Matson containership *Lurline*; sail and motor recreational vessel designs; and Navy Ship Selected Records maintenance support. Supervised 13 engineers and technicians.

11/1979 – 5/1984 John Brown/Earl & Wright Ltd., 20 Eastbourne Terrace, London W2 6LE, UK, (Joint venture, '82-'84)
Earl & Wright, Consulting Engineers, Inc., 1 Market Plaza, San Francisco, Calif. 94105

Senior Naval Architect (John Brown / Earl & Wright) - Project responsibility for analysis of hydrostatics, stability, seakeeping and various hydrodynamic analyses in support of North Sea offshore oil projects. Tasks included: survey of UK DoEn research for regulations; owner liaison support, weight control and float-out for *SEDCO 713*; upending and transport motion RAOs of *North Alwyn B* jacket and modules; mating sealoads for *Beryl B*, *Thomeliten* and *Norske Hydro Waterflood* jackets and subsea templates; proposal support, CONOCO TLP; and development of various hydrodynamic simulation computer programs.

Naval Architect (Earl & Wright): Project responsibility for hydrodynamic, hydrostatic, upending and stability, seakeeping, offshore mooring, ice force, structural and fatigue analyses and software development in support of domestic, international and Arctic offshore oil projects. *Alexander Kielland*, forensic analysis of accident; *North Rankin* platform, installation design tasks for platform, flare tower; *SEDCO 711* class, hydrostatics, motions; *Claymore North Sea FPP*; hydrostatics, motions, API RP multi-point mooring system analysis; *SEDCO Stafflo*, improvements to semisubmersible seakeeping; *SEDCO J class* semisubmersible rigs; fleet support for fatigue, motions, hydrostatics; *Kulluck* arctic drill barge, project naval architect for ice-breaking, designed API RP multi-point mooring system for ten foot ice ridges, open water motions prediction, ice breaking model tests, intact and damaged stability. Other: computer simulation of offshore construction projects including hydrostatics, strip theory motion analysis and CFD motion analysis, Supervised three engineers.

4/1974 – 11/1979 Morris Guralnick Associates, 620 Folsom Street, San Francisco, Calif. 94107

Naval Architect/Marine Engineer: Performed various design and analysis tasks in naval and maritime ship newbuilding, modification and renovation included hydrodynamics, deepwater mooring, stability, inclining tests, heat balance, piping design, structure design and analysis and hydrodynamics. Projects included tasks on floating energy production platform *OTEC EOTP IMWe*, research vessels, commercial tankers, Navy combatants, Navy fleet combat support ships, cable layers, cryogenic liquid carriers, dry dock certifications, tugs, motor yachts and sailing yachts.

OTHER EXPERIENCE: Consulting, Teaching, Volunteering, Mentoring

Guest lectures and mentoring to Naval Academy naval architecture major cadets in Capstone team ship design projects

Davis Marine Consulting Associates, Tesuque NM: Marine survey and naval architecture consulting firm.

E-Marine Training Brooklin, ME: Instructor/Developer, on-line propeller matching course.

GLG Council New York NY: Due diligence technology consultants and advisors for investment firms

Olympic Boat Co. Monroe WA: CAD hull design, optimization and lofting for *Northwest 24* FRP production boat

Sunset Engineering Assoc. San Francisco CA: Principal/Owner of firm providing forensic analysis, government proposal preparation, and small craft engineering studies.

KTI Inc. Oakland CA: Consultant for software algorithm development to hardware/software development firm

Bay Area Marine Institute Pier 66 San Francisco CA: Volunteer instructor in lofting, structure, and naval architecture

AWARDS, PATENTS

U.S. Coast Guard Meritorious Team Commendations, Flag Commendation Letters, Spot Cash Awards, Quality Step Increases

US Patents No. 4,974,539 "*Integrated Propulsion ... System*"; 5,134,954 "*Asymmetric Hydrofoil...*"; 10,184,445 "*Linear Array of Wave Energy Conversion Devices*"

FMC Technical Innovation Award

Society of Naval Architects and Marine Engineers 1997 *Elmer Hann Award* (Ship Production)

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PAPERS AND PRESENTATIONS: (Partial list)

- "CNC Enabled Wood/Metal Composite Construction of (Relatively) High Performance Sailing Yachts", *24th Chesapeake Sailing Yacht Symposium*, SNAME, Annapolis, Maryland, June 2022 (To be presented)
- "Biological Ocean Carbon Sequestration", *ALBC 2022*, Washington DC, March 17, 2022
- "ISO 11812: Direct Calculation of Drain Times", "ISO 12217-1 Annex F Level Flotation Test", "The Air Inclining Experiment", *IBEX / SNAME ISO 1217-1 Power Boat Stability Super Session*, Tampa FL, Sept. 2021 (segments of a short course)
- "Beyond Matching: Notes on Small Craft Propulsion Applications", *1st IBEX Symposium 2019*, SNAME, Sept. 2019
- "On the Design and Construction of Military and First Responder Aluminum Boats", *MACC 2018*, Baltimore MD, July 2018
- "Opportunities for Marine Sequestration of Carbon Dioxide", *IMAREST / SNAME New York Section Meeting*, March 20 2018, SNAME Chesapeake Section Meeting, December, 2018
- "Matching Small Craft Propellers: A Short Workshop", *IBEX / SNAME Super Session*, Tampa FL, Oct. 2, 2016
- "Some Notes on Aluminum ... Design and Construction", *5th Chesapeake Power Boat Symposium*, Annapolis MD, June 2016
- "Forensic Engineering ... PWC Off-Throttle Steering Accidents", *NAFE Winter Meeting*, Tampa FL, Jan 2016 (co-author)
- "Adsorbed Natural Gas; What Is It ...", *NTRB 96th Annual Meeting*, Jan 2016
- "An Overview of Wave Energy Conversion", *WMTC*, Providence R.I., SNAME, Nov. 2015 (co-author)
- "Naval Ship Structure Service Life Considerations", *Fleet Maintenance and Modernization Symposium*, Virginia Beach VA, 2015; *Naval Engineer's Journal*, Sept 2015, ASNE, (co-author)
- "Designing and Testing for Stability: ... Powerboat Designs", *IBEX / SNAME Super Session*, Tampa FL, Sept 29, 2014
- "Comparison of Stability Standards for Military, Paramilitary and Other First Responder Small Craft" (co-author); Short Course: "Propeller Matching for Small Craft", *4th Chesapeake Power Boat Symposium*, Annapolis MD June 2014
- "Adsorbed Natural Gas: ... Marine Industry", *Global GreenShip 2013*, Washington DC, Sept 2013
- "The San Francisco 'Monterey Clipper' Fishing Boat: A Small Appreciation", SNAME Annual Meeting, Providence RI, 2012
- "Evaluation of High-Speed Craft Designs for Operations in Survival Conditions", (co-author), "Composite Techniques ... Yacht Construction...", *3rd Chesapeake Power Boat Symposium*, Annapolis MD June 2012
- "Carbon Sequestration Facilities", *Offshore Alternatives 2012*, Washington, DC
- "Stability Standards ... Military ... Small Craft", *Multi Agency Craft Conference*, Little Creek, VA, June 2011 (co-author)
- "On the Stability of Powerboats", *2nd Chesapeake Power Boat Symposium*, Annapolis MD Mar 2010
- "An Overview of Ocean Renewable Energy", *SNAME Website Featured Paper*, June 2010 (co-author)
- "Developments in Offshore Energy Alternatives", *Green Ships / SNAME Chesapeake Section*, Washington DC, Sept 2009
- "Better Mousetraps: ... Challenges in Alternative Energy", *E² Alternative Energy Workshop*, *Stevens Inst.*, June 2009
- "U.S. Flag Group Owned SuperYachts ...", *1st Chesapeake Power Boat Symposium*, Annapolis MD, Mar 2008 (co-author)
- "Shipbuilding Opportunities in Renewable Ocean Energy", *Intelligent Shipbuilding*, *MarineLog*, 6 Dec 2007, Washington DC
- "Alternative Energy from the Sea; a New Paradigm, a Call to Action", *2006 MTC*, Ft Lauderdale, Oct 2006
- "Urban Passenger-Only Ferry Systems: Issues ... Technologies", *2006 MTC*, SNAME, Ft Lauderdale, Oct 2006 (co-author)
- "... Large Yacht Construction ... Product Data Models", *HPYD 2006*, Auckland, New Zealand, (co-author)
- "Linking the Supply Chain into the Product Model", *SHIPYARD USA*, Washington DC, June 2004, (co-author)
- "Global Issues, Speed Costs: How Fast do you REALLY want to go?", *San Francisco Ferry Schmooze*, Oct 21 2003
- "Predicting Shock...Planing ... Simulation", *Multi-Agency Craft Conference*, Little Creek, VA, June 2003 (co-author)
- "Stern Flap Technology: ...", *Multi-Agency Craft Conference*, Little Creek, VA, June 2003 (co-author)
- "Ferries for the Chesapeake ...", *Chesapeake Section, SNAME*, Washington DC, Dec 2003 (co-author)
- "Integrating Manufacturing ...Information ... Product Model", *2003 WMTC*, SNAME, San Francisco, CA, Oct 2003 (co-author)
- "Group Technology Through 'People Modules': A Case History", *SPS 2002*, SNAME, Boston MA, *JSP 2003* (co-author)
- "Implementation ... Zarnick Strip Theory Analysis ...", *HPYD 2002*, Auckland, New Zealand, Dec 2002 (co-author)
- "Ferries ... New Paradigms from New Technologies", *IMT Pacific, SNAME*, Asilomar, May 2002, CA (co-author)
- "Stern Flap Performance on 110 ft Patrol Boat WPB 1345 *STATEN ISLAND*", *David Taylor Model Basin, Carderock Division, Naval Surface Warfare Center*, NSWCCD-50-TR—2002/004, Jan 2002 (co-author)
- "Block Construction of Small Ships ... Developable Panels", *SPS 2001, SNAME*, Ypsilanti, MI, *JSP 2002* (co-author)
- "Hydrodynamic Efficiency Improvements ... Island Class Patrol Boats", *Transactions, SNAME*, 2001 (co-author)
- "CAD/CAM in Shipbuilding", *Harvard University Graduate School of Design*, Oct 2000
- "Implementing CAD/CAM in Shipyards", *Newbuild 2000*, RINA, London, October 1995 (co-author)
- "The Stepped Hull Hybrid Hydrofoil Ferry", *FAST '99*, SNAME, Aug. 1999, Seattle, WA (co-author)
- "Keys to CAD/CAM in Small Shipyards", *1998 Annual Meeting*, SNAME, San Diego, (co-author)
- "Implementation ... CAD/CAM ...", *SPS 1997*, SNAME, New Orleans, *Journal of Ship Production (JSP)* 1998 (co-author)
- "The Stepped Hull Hybrid Hydrofoil" - *Small Boats Symposium '93*, ASNE, May 1993, Norfolk, VA (co-author)

EXHIBIT 2

Materials Considered

- U.S. Patent No. 9,359,044
- U.S. Patent No. 9,586,659
- The Court's claim construction order
- Documents produced by Waydoo, including the following bates numbers:
 - WD000011 (Flyer One Manual)
 - WD000032
 - WD000037
 - WD000038
 - WD000046 (Flyer Manual)
 - WD013890
 - WD014106
- Deposition Testimony of 30(b)(6) (Zhao Tao), Kevin Wade, and Jacob Langelaan and the corresponding exhibits to each.
- Documents produced by MHL include the following bates numbers:
 - MHL_0102250
- The following websites and product manuals:
 - <https://liftfoils.com/>
 - <https://waydootech.com/>
 - <https://waydoousa.com/>
 - <https://waydootech.com/products/flyer-one-plus-efoil?variant=42769856528603>
 - https://cdn.shopify.com/s/files/1/0495/8443/9452/files/Waydoo_Flyer_ON_E_Plus_Manual.pdf?v=1657260813
 - Lift eFoil User Manual, <https://liftfoils.com/manuals>
- Lift Foils YouTube Channel - <https://www.youtube.com/c/LiftFoils>
- Waydoo YouTube Channel - <https://www.youtube.com/c/Waydoo>
- Be Terrific, "Surf Above the Waves! The Waydoo Flyer Electric Hydrofoil at CES 2020!", published March. 13, 2020, <https://www.youtube.com/watch?v=IdB1WJqi5mM>
- Conversation with Nick Leason

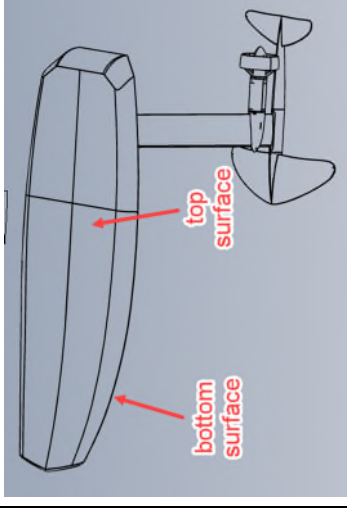
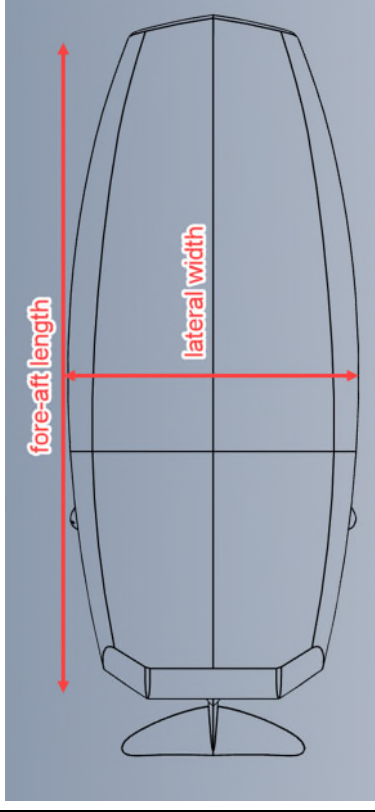
EXHIBIT 5

MHL Commercial Embodiment – Lift1

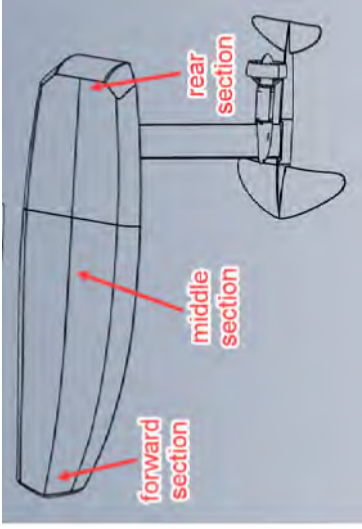
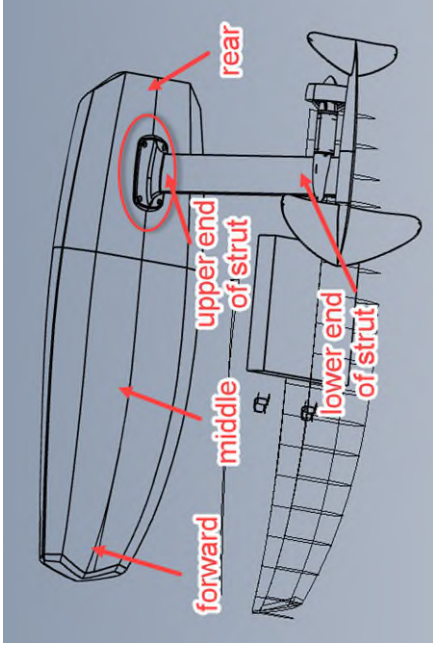
U.S Patent No. 9,359,044

Claim No.	Claim Element	MHL Commercial Embodiment
<i>1</i>	A passively stable, weight-shift controlled personal hydrofoil watercraft, comprising:	Although I understand this portion of the claim is not limiting, the watercraft is passively stable and controlled by weight-shift as set forth in the body of the claim.

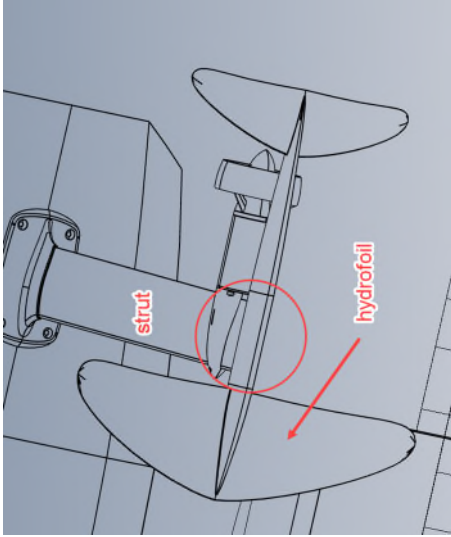
a flotation device that has a fore-aft length greater than a lateral width, the flotation device having a top surface and a bottom surface, wherein a user can be disposed on the top surface of the flotation device in a prone, kneeling, or standing position,



MHL_0102250 (annotation added). As is visible simply by looking at the flotation device, the fore-aft length is great than the lateral width. The flotation device further includes a top surface and a bottom surface, the top surface of the board is substantially flat allowing for a user to be on the flotation device in a prone position, in a kneeling position, or in a standing position.

	the flotation device having a forward section, a middle section, and a rear section, and the flotation device being controlled via weight shift of the user;	 MHL_0102250 (annotations added). As is illustrated in the annotated image above, the board includes a forward, middle, and rear section. Further, the flotation device is controlled via user weight shift.
a strut having an upper end and a lower end, the upper end fixedly interconnected with the flotation device between the middle section and the rear section of the flotation device;		 MHL_0102250 (annotation added). As is clear from the annotated image presented herein, the strut is fixedly interconnected (circled area) to the flotation device between the middle and rear sections.

a hydrofoil fixedly interconnected with the lower end of the strut, the hydrofoil having no movable surface and designed to provide passive static stability controlled solely by weight shift of the user;

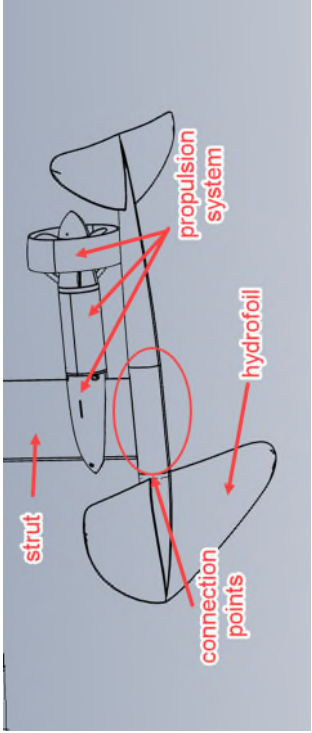


MHL_0102250 (annotation added). As is clear from the annotated image presented herein, the hydrofoil fixedly interconnected with the lower end of the strut (as circled). As is also visible, the hydrofoil lacks any moveable surface.

A formal analysis was conducted using the standard Athena Vortex Lattice (AVL) code for analyzing aircraft and similar bodies operating in fluid to determine stability derivatives. These stability derivatives indicate stability.

	Stable Craft	MHL Lift 1
pitch stability derivative (C_{ma})	negative value	-4.726671
directional stability derivative ($C_{n\beta}$);	positive value	0.258473
roll stability derivate ($C_{l\beta}$)	negative value	-0.031101

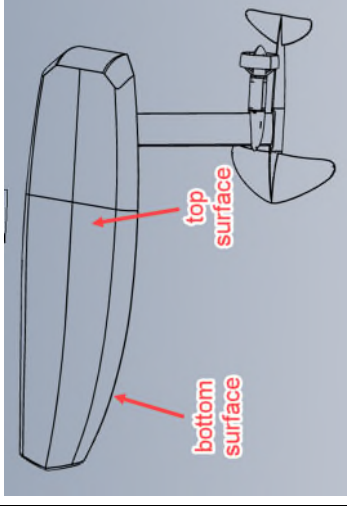
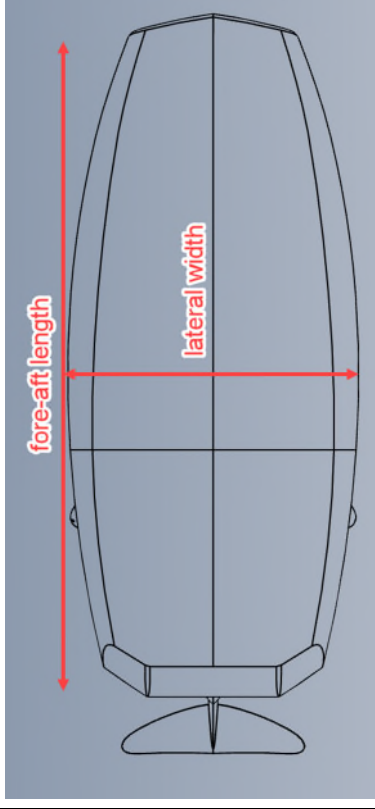
See also Appendix A for full Stability Derivatives

a propulsion system for propelling the watercraft in a body of water, wherein the propulsion system is connected to the hydrofoil; and	 MHL_0102250 (annotations added). As is clear from the annotated image presented herein, the propulsion system is connected to the hydrofoil. When in use, this portion of the watercraft is submerged into the water, to allow the propulsion system to propel the watercraft in the water.
the watercraft having no movable steering system.	There are no movable steering mechanisms.

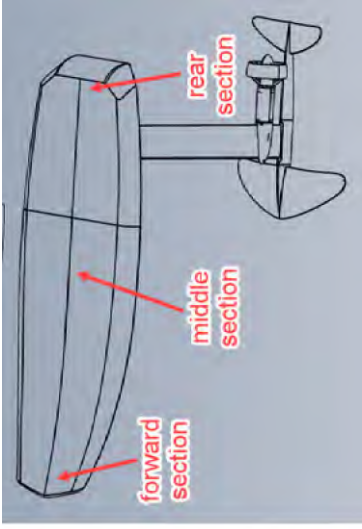
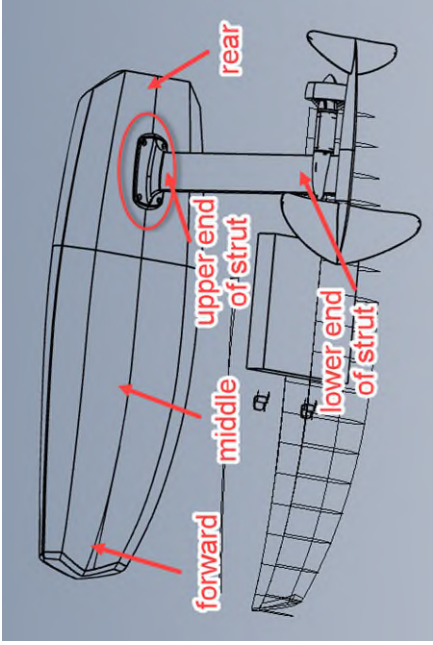
U.S. Patent No. 9,586,659

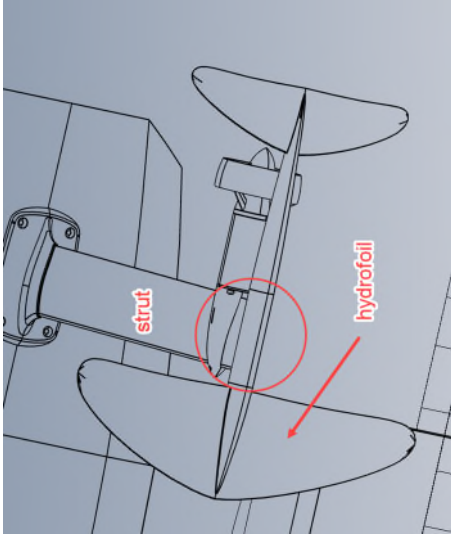
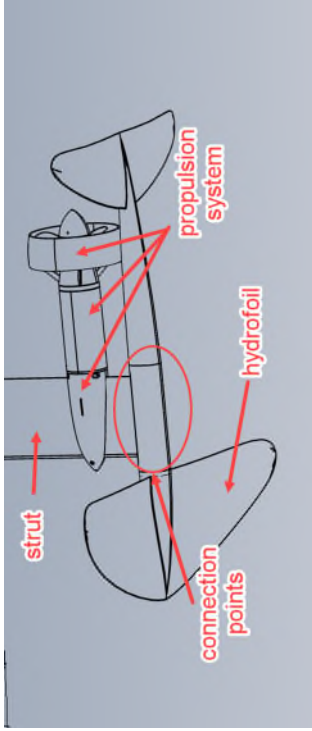
Claim No.	Claim Element	Where Each Element is Found in the Waydoo Flyer (including both the “Explorer” and “Patroller” Packages/Wings)												
1	A passively stable, weight-shift controlled personal hydrofoil watercraft, comprising:	A formal analysis was conducted using the standard Athena Vortex Lattice (AVL) code for analyzing aircraft and similar bodies operating in fluid to determine stability derivatives. These stability derivatives indicate stability. <table><tr><th></th><th>Stable Craft</th><th>MHL Lift 1</th></tr><tr><td>pitch stability derivative (C_{ma})</td><td>negative value</td><td>-4.726671</td></tr><tr><td>directional stability derivative ($C_{n\beta}$);</td><td>positive value</td><td>0.258473</td></tr><tr><td>roll stability derivate ($C_{l\beta}$)</td><td>negative value</td><td>-0.031101</td></tr></table> It should be noted that dynamic stability was also analyzed based on eigenvalues studied with the same code. For the Lift1 the values of omega were negative, meaning they are non-divergent. This means they are dynamically stable.		Stable Craft	MHL Lift 1	pitch stability derivative (C_{ma})	negative value	-4.726671	directional stability derivative ($C_{n\beta}$);	positive value	0.258473	roll stability derivate ($C_{l\beta}$)	negative value	-0.031101
	Stable Craft	MHL Lift 1												
pitch stability derivative (C_{ma})	negative value	-4.726671												
directional stability derivative ($C_{n\beta}$);	positive value	0.258473												
roll stability derivate ($C_{l\beta}$)	negative value	-0.031101												

a flotation device that has a fore-aft length greater than a lateral width, the flotation device having a top surface and a bottom surface, wherein a user can be disposed on the top surface of the flotation device in a prone, kneeling, or standing position,

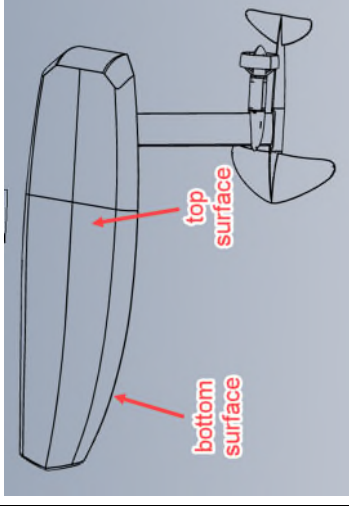
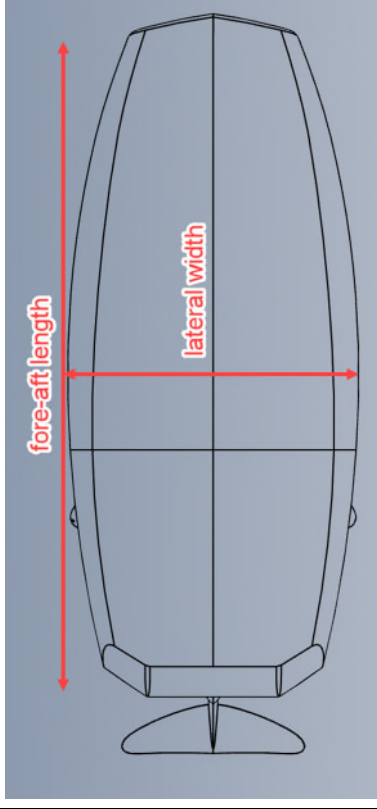


MHL_0102250 (annotation added). As is visible simply by looking at the flotation device, the fore-aft length is great than the lateral width. The flotation device further includes a top surface and a bottom surface, the top surface of the board is substantially flat allowing for a user to be on the flotation device in a prone position, in a kneeling position, or in a standing position.

the flotation device having a forward section, a middle section, and a rear section;	A perspective view of a flotation device, which is a long, narrow, slightly curved structure. It is divided into three distinct sections by two vertical lines. Red arrows point to each section, with labels: 'forward section' for the front part, 'middle section' for the central part, and 'rear section' for the back part. The rear section appears to have a small, rounded protrusion at its end. MHL_0102250 (annotations added). As is illustrated in the annotated image above, the board includes a forward, middle, and rear section.
a strut having a upper end and a lower end, the upper end fixedly interconnected with the flotation device between the middle section and the rear section of the flotation device;	A perspective view of the same flotation device, showing a vertical strut attached to its top surface. The strut connects the middle section to the rear section. Red arrows and labels identify the 'forward', 'middle', and 'rear' sections of the device. The strut is labeled with 'upper end of strut' at its connection to the middle section and 'lower end of strut' at its connection to the rear section. A red circle highlights the upper end of the strut where it connects to the middle section. MHL_0102250 (annotation added). As is clear from the annotated image presented herein, the strut is fixedly interconnected (circled area) to the flotation device between the middle and rear sections.

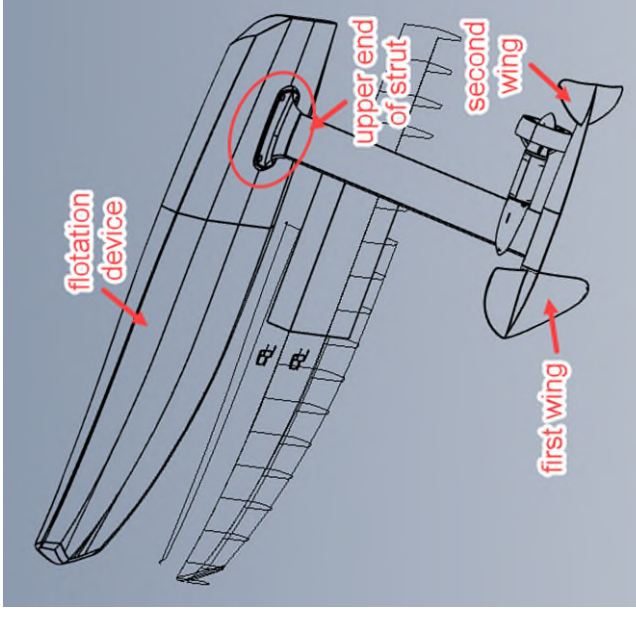
	a hydrofoil fixedly interconnected with the lower end of the strut, the hydrofoil having no movable surface;	 MHL_0102250 (annotation added). As is clear from the annotated image presented herein, the hydrofoil fixedly interconnected with the lower end of the strut (as circled). As is also visible, the hydrofoil lacks any moveable surface.
	a propulsion system for propelling the watercraft in a body of water, wherein the propulsion system is connected to the hydrofoil; and	 MHL_0102250 (annotations added). As is clear from the annotated image presented herein, the propulsion system is connected to the hydrofoil. When in use, this portion of the watercraft is submerged into the water, to allow the propulsion system to propel the watercraft in the water.
	the watercraft having no movable steering system.	There are no movable steering mechanisms.
16	A personal hydrofoil watercraft, comprising:	

a surfboard-shaped flotation device that has a fore-aft length greater than a lateral width, the flotation device having a top surface and a bottom surface, wherein the top surface has a substantially horizontal supporting surface configured to support a user in a prone, kneeling, or standing position, the flotation device having a forward section, a middle section, and a rear section;



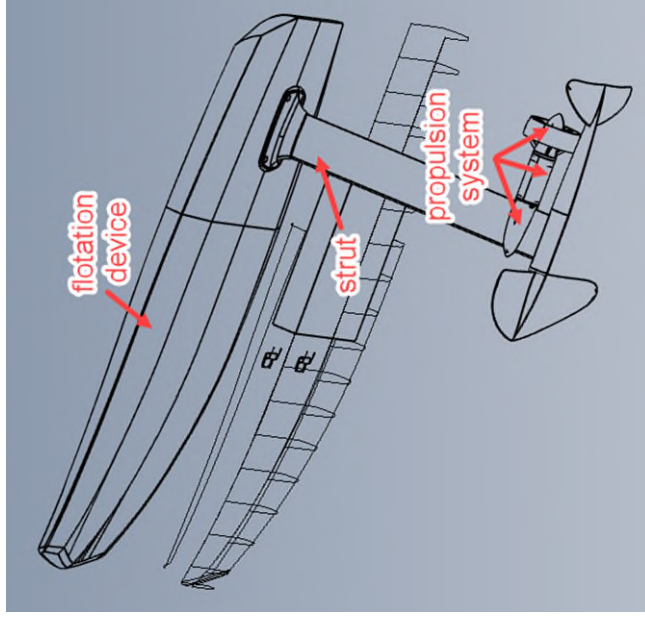
MHL_0102250 (annotation added). As is visible simply by looking at the surfboard-shaped flotation device, the fore-aft length is great than the lateral width. The surfboard-shaped flotation device further includes a top surface that is substantially horizontal and allows a user to be on the flotation device in a prone position, in a kneeling position, or in a standing position.

a hydrofoil interconnected with the surfboard-shaped flotation device, the hydrofoil having a strut and a first hydrofoil wing, an upper end of the strut being fixedly interconnected with the surfboard-shaped flotation device;



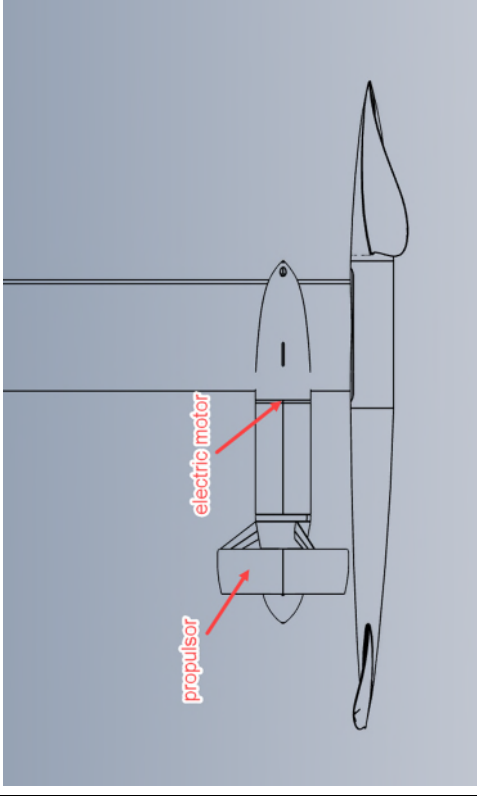
MHL_0102250 (annotations added). As illustrated above, the hydrofoil is interconnected with the surfboard-shaped flotation device by way of the strut. The hydrofoil includes a first wing and a second wing. The strut connecting the hydrofoil to the flotation device includes a first end, that fixedly connects to the surfboard-shaped flotation device (see circled area).

a propulsion system attached to the surfboard-shaped flotation device for propelling the watercraft in a body of water,



MHL_0102250 (annotations added). As is clear from the annotated image presented herein, the propulsion system is attached to the flotation device via the strut. When in use, the highlighted area of the propulsion system of the watercraft is submerged into the water, to allow the propulsion system to propel the watercraft in the water.

the propulsion system comprising a battery, an electric motor, a motor speed controller, and a propulsor, wherein the propulsor is selected from a propeller, a ducted propeller, or a pump-jet,



MHL_0102250 (annotations added). The battery and motor speed controller are contained within a compartment in the flotation device. The electric motor and propulsor (which is a ducted propeller) are illustrated above.



- ⑥ eBox
- ⑦ Back Wing
- ⑧ Battery
- ⑨ Motor
- ⑩ Front Wing

2. HATCH COMPARTMENT

The hatch compartment is found on the top of your board and can be accessed by opening its two latches found on the deck pad.

The components of the hatch compartment include:

- eBox
- Battery
- Battery Lock
- Bluetooth Antenna
- Data Cables

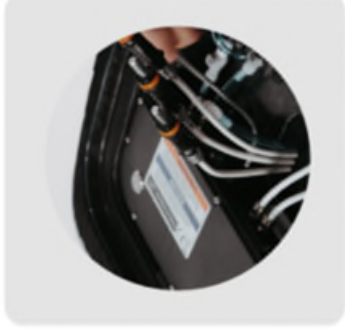


⚠ DO NOT open your hatch compartment over 90 degrees.

3. eBox

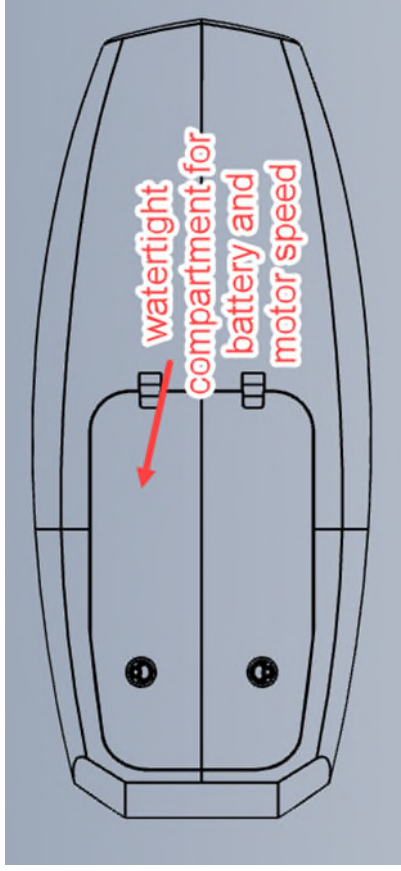
The eBox comes installed in the hatch compartment of your board. The eBox components you need to be familiar with are:

- Power button
- Two blue water tubes (input and output)
- Three phase connector ports, each with a colored dot (one red, one yellow, and one green)
- Pairing/firmware relay switch



The image above from the Liftfoil User Manual illustrates the battery within a compartment in the flotation device. Liftfoils User Manuals, <https://liftfoils.com/manuals>, p. 9. The manual also describes the “hatch compartment” as including the battery and eBox. *Id.* at 19. The eBox contains the motor speed controller.

and the battery and motor speed controller are contained in a watertight compartment integrated into the flotation device;



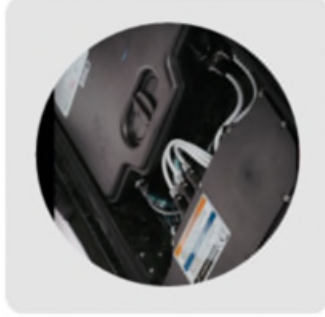
MHL_0102250 (annotations added). The battery and motor speed controller are contained within the watertight compartment illustrated above.

2. HATCH COMPARTMENT

The hatch compartment is found on the top of your board and can be accessed by opening its two latches found on the deck pad.

The components of the hatch compartment include:

- eBox
- Battery
- Battery Lock
- Bluetooth Antenna
- Data Cables



⚠ DO NOT open your hatch compartment over 90 degrees.

	3. eBox The eBox comes installed in the hatch compartment of your board. The eBox components you need to be familiar with are: • Power button • Two blue water tubes (input and output) • Three phase connector ports, each with a colored dot (one red, one yellow, and one green) • Pairing/firmware relay switch 	The image above from the Liftfoil User Manual illustrates the battery within a compartment in the flotation device. Liftfoils User Manuals, https://liftfoils.com/manuals, p. 9. The manual also describes the “hatch compartment” as including the battery and eBox. <i>Id.</i> at 19. The eBox contains the motor speed controller.	
the watercraft having no movable steering system;	There are no movable steering mechanisms.		

a handheld controller having a throttle; and a throttle interface, wherein the throttle is adapted to send electronic signals to the throttle interface that cause an output of the propulsion system to change.

9. HAND CONTROLLER

The hand controller comes with two replaceable AA batteries that will last for 40+ hours of ride time. Use a 2mm hex key to remove the remote's end cap for battery replacement.

NOTE: Always use brand new batteries when replacing the batteries of your hand controller.

Power Button

The power button is above the screen. Click to turn the controller **ON** and **OFF**.

Home Screen

This is the hand controller's display.



PAIRING HAND CONTROLLER VIA BLUETOOTH

If the screen on the hand controller is indicating "no signal," the hand controller is not paired with the board or the board is turned off. To pair the hand controller:

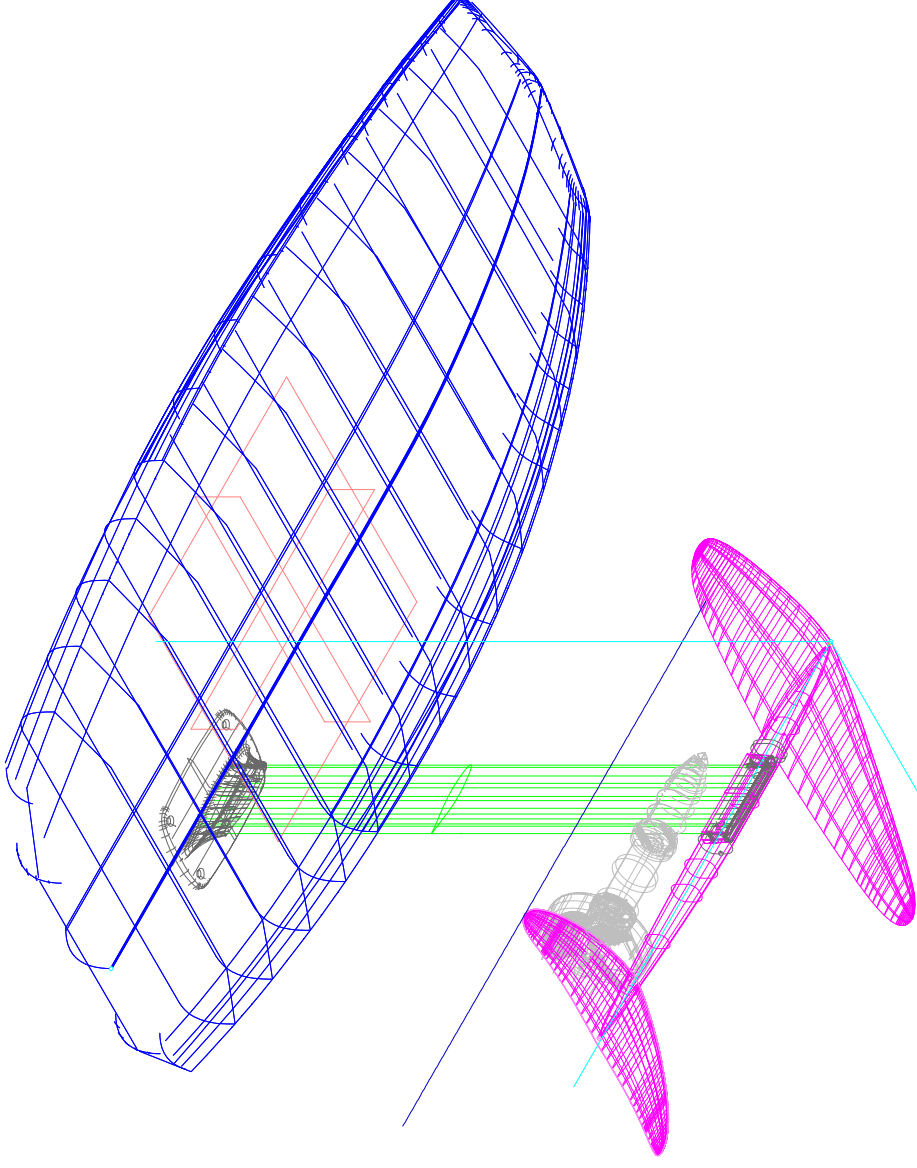
1. Confirm the eBox is turned on.
2. Confirm the hand controller is turned off.
3. Press and hold the (-) and (+) buttons, and then press the power button on the hand controller.
4. The hand controller screen will show a Bluetooth logo, indicating that it is in pairing mode. If this screen does not appear, turn off the hand controller and repeat the above process to enter pairing mode.
5. After the controller is in pairing mode, press and hold the black relay button on the eBox (located near the blue water tubing) for up to 5 seconds. The blue startup button will flash and the hand controller will display a check mark, indicating the hand controller is now paired to the eBox.



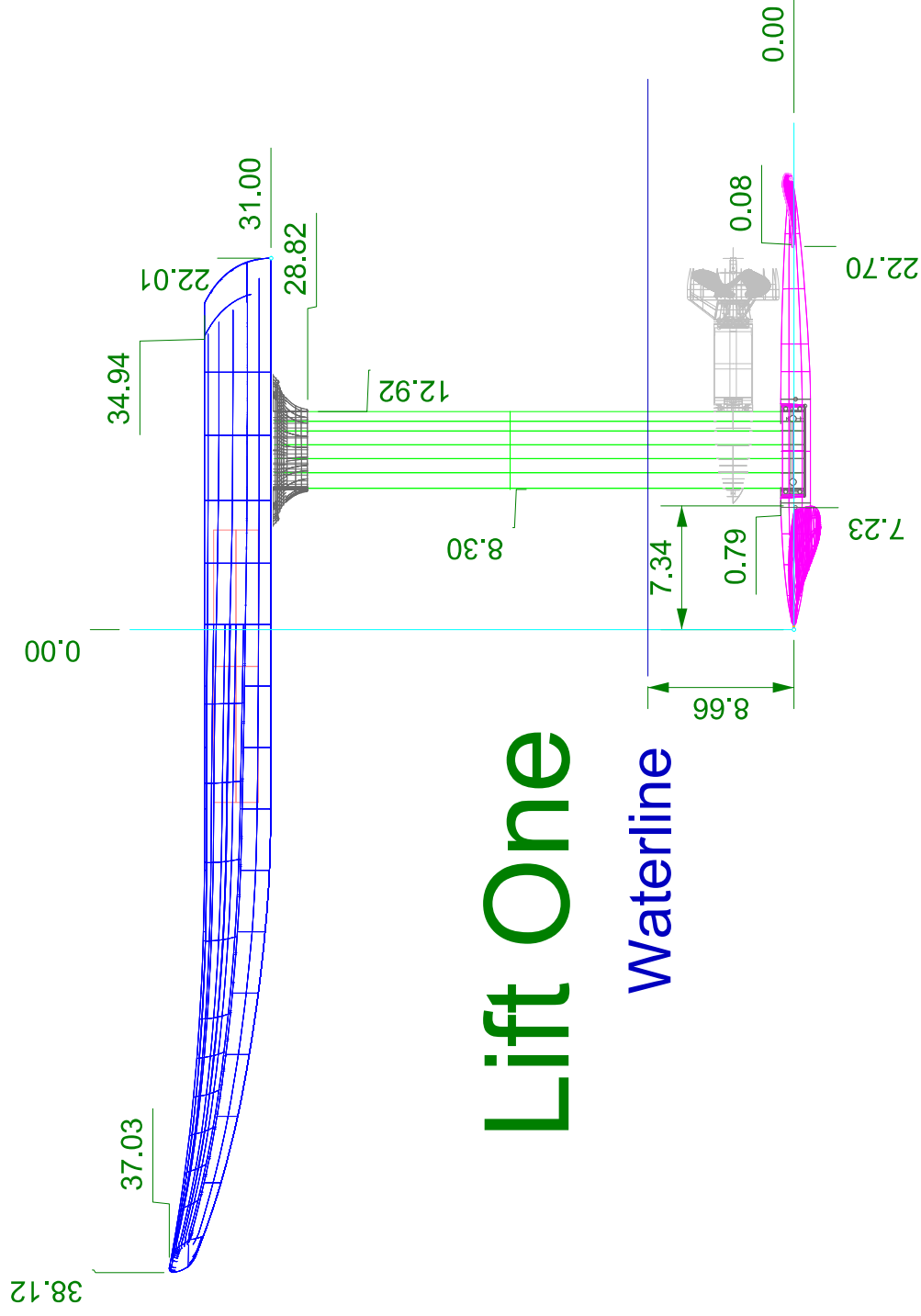
Liftoffs User Manuals, <https://liftoffs.com/manuals>, p. 24 and 38. As is illustrated above, the watercraft includes a handheld controller with a throttle and a throttle interface, where the throttle can send signals to the throttle interface to change the output of the propulsion system.

Exhibit 5 – Appendix A

Stability Derivatives



Lift One



C_L = 0.00 - Zero Lift Condition - Origin at Leading Edge, Wing

Vortex Lattice Output -- Total Forces

Configuration: Lift One Configuration

- # Surfaces = 5
- # Strips = 101
- # Vortices = 798

Sref = 0.84000E-01 Cref = 0.17600 Bref = 0.63500
Xref = 0.0000 Yref = 0.0000 Zref = 0.0000

Standard axis orientation, X fwd, Z down

Run case: -unnamed-

Alpha = -2.42985 pb/2V = -0.00000 p'b/2V = -0.00000
Beta = 0.00000 qc/2V = 0.00000
Mach = 0.000 rb/2V = -0.00000 r'b/2V = -0.00000

CXtot = -0.00380 Cltot = 0.00000 Cl'tot = 0.00000
CYtot = 0.00000 Cmtot = 0.41449
CZtot = 0.00016 Cntot = -0.00000 Cn'tot = -0.00000

CLtot = 0.00000
CDtot = 0.00380
CDvis = 0.00000 CDind = 0.0037991
CLff = 0.00000 CDff = 0.0031047 | Trefftz
CYff = -0.00000 e = 0.0000 | Plane

Stability-axis derivatives...

		alpha		beta	
z' force	CL	CLa = 4.808583	CLb = 0.000000		
y force	CY	CYa = -0.000000	CYb = -0.744013		
x' mom.	Cl'	CLa = -0.000000	CLb = -0.031101		
y mom.	Cm	Cma = -4.726671	Cmb = -0.000000		
z' mom.	Cn'	Cna = 0.000000	Cnb = 0.258473		
		roll rate	p'	pitch rate	q'
				yaw rate	r'

z' force	CL		CLp	=	-0.000000	CLq	=	17.320883	CLr	=	-0.000000
y force	CY		CYp	=	-0.058829	CYq	=	-0.000003	CYr	=	0.646551
x' mom.	CL	'	CLp	=	-0.403904	CLq	=	-0.000000	CLr	=	0.079410
y mom.	Cm		Cmp	=	0.000000	Cmq	=	-40.082592	Cmr	=	0.000000
z' mom.	Cn	'	Cnp	=	0.070397	Cnq	=	0.000003	Cnr	=	-0.235671

Neutral point Xnp = 0.173002

Clb Cnr / Clr Cnb = 0.357102 (> 1 if spirally stable)

C_L = 0.18 - Top Speed Condition - Origin at Leading Edge, Wing

Vortex Lattice Output -- Total Forces

Configuration: Lift One Configuration
Surfaces = 5
Strips = 101
Vortices = 798

Sref = 0.84000E-01 Cref = 0.17600 Bref = 0.63500
Xref = 0.0000 Yref = 0.0000 Zref = 0.0000

Standard axis orientation, X fwd, Z down

Run case: -unnamed-

Alpha = -0.28242 pb/2V = -0.00000 p'b/2V = -0.00000
Beta = 0.00000 qc/2V = 0.00000
Mach = 0.000 rb/2V = -0.00000 r'b/2V = -0.00000

CXtot = -0.00635 Cltot = -0.00000 Cl'tot = 0.00000
CYtot = 0.00000 Cmtot = 0.23683
CZtot = -0.17997 Cntot = -0.00000 Cn'tot = -0.00000

CLtot = 0.18000
CDtot = 0.00546
CDvis = 0.00000 CDind = 0.0054635
CLff = 0.18077 CDff = 0.0044891 | Trefftz
CYff = 0.00000 e = 0.4827 | Plane

Stability-axis derivatives...

			alpha		beta	
			-----		-----	
z' force	CL		CLa =	4.793292	CLb =	0.000000
y force	CY		CYa =	-0.000000	CYb =	-0.747285
x' mom.	Cl'		CLa =	-0.000000	CLb =	-0.045695
y mom.	Cm		Cma =	-4.749142	Cmb =	-0.000000
z' mom.	Cn'		Cna =	0.000000	Cnb =	0.267015
			roll rate p'		pitch rate q'	
			-----		-----	
			yaw rate r'			
			-----		-----	

z' force CL	CLp =	-0.000000	CLq =	17.305935	CLr =	-0.000000
y force CY	CYp =	0.014196	CYq =	-0.000002	CYr =	0.644269
x' mom. Cl'	Clp =	-0.397233	Clq =	-0.000000	Clr =	0.118011
y mom. Cm	Cmp =	0.000000	Cmq =	-40.148056	Cmr =	0.000000
z' mom. Cn'	Cnp =	0.041238	Cnq =	0.000002	Cnr =	-0.244719

Neutral point Xnp = 0.174379

Clb Cnr / Clr Cnb = 0.354875 (> 1 if spirally stable)

C_L = 0.18 - Low Speed Condition - Origin at Leading Edge, Wing

Vortex Lattice Output -- Total Forces

Configuration: Lift One Configuration

- # Surfaces = 5
- # Strips = 101
- # Vortices = 798

Sref = 0.84000E-01 Cref = 0.17600 Bref = 0.63500
Xref = 0.0000 Yref = 0.0000 Zref = 0.0000

Standard axis orientation, X fwd, Z down

Run case: -unnamed-

Alpha = 4.42173 pb/2V = -0.00000 p'b/2V = -0.00000
Beta = 0.00000 qc/2V = 0.00000
Mach = 0.000 rb/2V = -0.00000 r'b/2V = -0.00000

CXtot = 0.02003 Cltot = 0.00000 Cl'tot = 0.00000
CYtot = 0.00000 Cmtot = -0.15216
CZtot = -0.57015 Cntot = 0.00000 Cn'tot = 0.00000

CLtot = 0.57000
CDtot = 0.02399
CDvis = 0.00000 CDind = 0.0239898
CLff = 0.57551 CDff = 0.0233925 | Trefftz
CYff = 0.00000 e = 0.9389 | Plane

Stability-axis derivatives...

			alpha		beta	
			-----		-----	
z' force	CL		CLa =	4.691582	CLb =	0.000000
y force	CY		CYa =	0.000000	CYb =	-0.750781
x' mom.	Cl'		CLa =	-0.000000	CLb =	-0.075177
y mom.	Cm		Cma =	-4.705195	Cmb =	-0.000000
z' mom.	Cn'		Cna =	-0.000000	Cnb =	0.289388
			roll rate p'		pitch rate q'	
			-----		-----	
			yaw rate r'			
			-----		-----	

z' force	CL		CLp	=	-0.000000	CLq	=	17.252455	CLr	=	0.000000
y force	CY		CYp	=	0.172284	CYq	=	0.000000	CYr	=	0.620243
x' mom.	Cl'		Clp	=	-0.380055	Clq	=	-0.000000	Clr	=	0.199249
y mom.	Cm		Cmp	=	0.000000	Cmq	=	-40.094379	Cmr	=	0.000000
z' mom.	Cn'		Cnp	=	-0.025450	Cnq	=	0.000000	Cnr	=	-0.263951

Neutral point Xnp = 0.176511

Clb Cnr / Clr Cnb = 0.344138 (> 1 if spirally stable)

Lift One Configuration

