

ARC, the Best Kept Secret in Efficiency!





Auto Research Center

ARC, the Best Kept Secret in Efficiency!

The Auto Research Center has the facilities to provide **advanced technical solutions** for all types of vehicles and is committed to excellence, leading edge technology, and rapid project turnaround. This philosophy has made us a leader in automotive research and development projects and facilities.

Services and areas of expertise include:

- Customer Test Rig Design, Manufacture and Commissioning
- Aerodynamic Wind Tunnel Testing and Analysis
- CFD Transient and Steady State Simulation with Design of Experiment methods
- CFD ELEMENTS Software Developer
- Vehicle Dynamic 7-Post Testing and Vehicle Simulation
- Drivetrain Test Rig
- Engineering Design Consultancy
- Vehicle Development
- Commercial Fleet Efficiency
- Reverse Engineering
- Rapid Prototyping
- Model Making/Custom Fabrication





Broad Industry Experience

ARC, the Best Kept Secret in Efficiency!

ARC's **vast experience** reaches all areas of the automotive industry including passenger cars and trucks, commercial and delivery vehicles, and semi-trucks and trailers.

Our assets have been **used to improve** and enhance many of the cars and trucks you see on the road today including:

- US OEM road cars (sedans, SUVs etc)
- High performance road-going sportscars
- Semi-truck and trailers
- Medium-duty trucks and delivery vehicles
- Recreational vehicles (RV)
- National fleets and parcel carriers
- Formula 1, NASCAR, IRL, NHRA, ALMS and landspeed records

ARC is also a proactive member of the heavy vehicle industry, and works with the American Trucking Associations (ATA) to educate its members on fuel economy and aerodynamics.

By **testing at ARC**, our customers gain access to the same technology and advanced solutions that ARC has pioneered for the leaders of the automotive and racing industries.

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Confidential Vehicle Development

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ARC expertise was formulated in the highly successful open wheel racing industry. ARC's expertise was sought out by and expanded to the growing NASCAR industry, where we now work for a number of production OEMs and commercial trucking manufactures as their **Tier 1 partner** in aerodynamic development.

Such is the strength of these relationships, that the manufacturers now locate their own staff in **secure workshops** within the ARC facility, with compliment to a permanent team of ARC engineers and model makers who work specifically with that OEM. From race cars, supercars, OEM production cars to commercial trucks where new designs may be years away from production or undergoing late stage tweaks.

ARC is the place to develop your vehicle in **absolute secrecy**.Divided in to self contained workshops, each with electronic security, personal access, bathrooms and design offices, a team or OEM can be confident that the development of their future vehicles occurs safely behind closed doors.



Facility Design & Commissioning

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Real-world experience enables ARC to understand the stringent requirements of a testing facility. This experience coupled with our innovative engineering staff allows us to design, manufacture, and commission almost any test and simulation system to meet the research and development needs of our customers.

ARC has built numerous scale model moving ground wind tunnels in **Europe and the USA**, including two Formula One Teams. The worldwide ARC network of staff is the most experienced team for this specialized facility in the world. The specifications are constantly improving based on research and the knowledge gained from daily operations.

With test facilities in operation spanning

aerodynamics, vehicle dynamics, and drivetrain, ARC can ensure that your facility comes equipped with the necessary support services and maintenance structure, rapid prototyping, scanning, workshops and offices.







Engineering Consultancy

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Our team of **highly qualified engineers** span all disciplines of CAD, mechanical, fluid flow, and electrical. They are available to work on projects for our customers either as a stand alone team capable of completing the entire project, or as a supplementary team to their existing resources. ARC currently uses Creo Pro/Engineer CAD software, however we are able to collaborate and work with any CAD that our customers employ.

ARC specializes in vehicle design consultancy. Having the experience with playing team roles in full vehicle design cycles, we have the understanding and personality to provide a supporting or lead role in large scale design programs. **Maintaining flexibility**, ARC also likes to maintain smaller consultancy projects in several different vehicle attribute areas.

ARC's record of confidentiality, it is no surprise we have become an important "go to" team member for multiple OEMs. As a **tier one supplier**, we are fully integrateable into your company's specific processes and requirements.





Beyond the Transportation Industry

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The same tools and knowledge that ARC uses to benefit its transportation customers can be used to help you find **efficiencies in your product**.

ARC's motorsports heritage serves it well, the work ethic to get the **job done correctly on time** to quickly **adapting to new situations**.

In-house **Computational Fluid Dynamics (CFD)** services offers the biggest benefit for any industry that has anything that interacts with heat, air or water. ARC is also a reseller of HELYX[®] a general purpose CFD software developed by ENGYS Ltd.

The 7-post shaker rig allows for products to be **durability vibration** tested, by using custom vibration inputs to using generic wave input from a catalog.

ARC's rolling road **wind tunnel** is one of the more unique tools, with air speeds able to reach 50 meters per second (112 mph), testing products directly in a controlled environment that allows for optimization and real world learning.

Having a team of experts in-house, ranging from engineering, research and development to styling designers allows for a **comprehensive consulting packages** to improve product life cycles.

Every wind tunnel scale model is custom built and is highly detailed and must work first time out. Thus, ARC has a team of **custom fabricators** who work with metal, carbon fiber and rapid prototyping/3d printing.

Reverse Engineering services at ARC allow physical parts to be scanned and turned into digital 3D stl and CAD models. Combined with the **Rapid Prototyping/3D Printing** lab, at ARC we can produce prototype parts for your needs.



ARC Wind Tunnel Specifications

Max Wind Speed 50 m/s Max Road Speed 50 m/s Nozzle Size 2.3 m wide x 2.1 m high Contraction Ratio 4.8 : 1.0 Moving Ground Plane Size 3.4 m x 1.7 m Average Air Temperature 74°F +/- 0.5°F Road Temperature 74°F +/- 0.5°F Cooling Coil 5.25 fins per inch Boundary Layer 99% free stream @ 1mm Primary BL Motor Power 80 kW Secondary BL Motor Power 19 kW Belt Suction Motor Power 19 kW Rolling Road Motor Power 120 kW Main Fan Motor Power 320 kW



Moving Ground Wind Tunnel

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The ARC moving ground wind tunnel is a 50% scale, open jet, rolling road design. All the components, from fan blades to its complex nozzle, have been researched and developed to give the **accurate correlation** between wind tunnel results and on-road/track performance.

In addition to the **technical support** of the finest aerodynamicists, ARC offers a variety of support services: model rental, test program consultation, model setup, and model part construction.

Our "state-of-the-art" **model motion system** allows for testing using up to 14 force components and 5 axis of motion (automated heave, pitch, roll, yaw and steer). Our data collection system and repeatability is second to none.

The ARC Wind Tunnel is **available for rent** on a daily basis, and has become a second home to the design and engineering departments from many automotive and commercial vehicle OEMs.

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CFD Services & ELEMENTS

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To offer an **advanced aerodynamic CFD toolset**, ARC develops its own CFD software, Elements, through a joint venture with ENGYS Ltd. ELEMENTS, has been validated on over 100+ models using physical data from the ARC wind tunnel and other full scale testing.

ELEMENTS can run with transient and steady state analysis, with the transient code having been highly developed to **reduce it's run time while increasing the accuracy**. ELEMENTS also offers a moving mesh for wheel spoke flow.

ELEMENTS also utilizes **design of experiment** to allows for a range of shapes to be morphed & automatically tested via multiple input parameters.

ARC maintains its own **in-house High Performance Computing** (HPC) data center for maximum customer privacy. Current cluster computing power includes more than 10 teraFLOPS and 600+ cores. More than 1,000 additional processors are also accessible remotely outside of the headquarters.



317-291-8600



Adjoint Optimization

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Adjoint Optimization is a **complex CFD solver** that allows for a more efficient way to optimize designs. **Topology optimization** with Adjoint delivers optimized internal flows for scenarios such as intake ports, HVAC ducts, exhaust manifolds, water jackets, etc. The user supplies a package volume and target parameters and **adjoint automatically shows the direction to morph for aerodynamic targets.**

Adjoint sensitivity takes the exterior of a car, for example and shows whether you should **push or pull on the surface to improve** several parameters (drag, downforce, efficiency, balance, etc.).

Streamline Solutions, a joint venture between ARC and ENGYS Ltd, **ELEMENTS Adjoint** solver uses industry leading **quasi-trasient accuracy** to deliver the best predictions available for improvements.

The Adjoint Optimization solver delivers in a single run what would take many numerous CFD runs to deliver using traditional parametric techniques.





Thermal Management

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Heat rejection and cooling of parts is critical to achieving **optimum efficiency**. ARC thermal management services can solve thermal problems.

Streamline Solutions, a joint venture between ARC and ENGYS Inc, **CFD ELEMENTS package** is used in tandem with a 1D code to evaluate and optimize the air side performance of a cooling system, including heat-exchangers, fans and HVAC modules. Exceptional computing scalability (minimal HPC licenses) permits quick iterative cycles.

All thermal simulations are done at ARC using its **in-house High Performance Computing** (HPC) data center for maximum customer privacy. Current cluster computing power includes more than 10 teraFLOPS and 600+ cores. More than 1,000 additional processors are also accessible remotely outside of the headquarters.



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Aerodynamic Bike Testing Facility

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The ARC Aerodynamic Bike Testing Facility (ABT) provides competitive cyclists, triathletes, manufacturer of gear, clothing and bikes the advantage of increasing their speed and efficiency and most accurate available bicycle testing facility. The facility allows a range of testing with or without the rider, with six component balance resolution as accurate as 0.25 Watts.

Facility Specifications:

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- Yaw capability +/- 30° during a run
- Capacity to test with bike rolled left at 5°
- Normal test speed 30mph max 40mph
- Real Time Data Output
- ANT+ compatible bike data recording
- Wheelbases of 950mm to 1050mm
- Bike can be tested with or without rider
- Rider pedaling or legs stationary
- Wheels driven independently with torque measurement of rotational wheel drag
- Rider driven against cadence resistance measurement

Call 317-291-8600, email biketest@arcindy.com or visit arcindy.com/biketest to request a test booking at America's Premier Bicycle Testing Facility.

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Vehicle Dynamics 7-Post

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ARC's 7-Post Vehicle Dynamics Rig offers our customers the ability to **optimize suspension performance** in a repeatable environment at a cost that is considerably lower than road testing.

Our expert vehicle dynamics engineers can provide assistance with test plan design, data interpretation, and results analysis. Test inputs from swept-sine waves to **reproducing road conditions** using data gathered at the race track or vehicle proving ground.

Using system ID techniques, variables such as damping curves and effective spring rates can be quantified and correlated to the road/track. Innovations such as **temperature controlled dampers and tires** improve accuracy, which gives a better understanding of the real-world effects of these variables.

The 7-Post test rig is also used by many commerical OEMs for **duability testing**.

The ARC Vehicle Dynamics Rig is located in Indianapolis, and is **available to rent** on a daily basis.



7-Post Specifications

Wheel Pan Actuator Type Servotest Rated Force Capacity +/- 25.0 kN @ 210 Bar Maximum Velocity 1,000 mm/second Aerodynamic Loading Actuator Type Servotest Rated Force Capacity +/- 20.0 kN Total Sensor Input Channels 44 Wheel Pan Accelerometers 4 PCB Piezotronics Wheel Pan Load Cell 4 Servotest Aeroloader Displacement 3 RDP Electrosense Aeroloader Velocity 3 Trans-tek Aeroloader Load Cell 3 Servotest Wheel/Body Accelerometers 7 PCB Piezotronics

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Durability Testing

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Durability testing helps to ensure the success of your product. Using the **shaker rig** at ARC, a wide variety of parts can be tested, from seats, commercial trailer skirts to frame assemblies. ARC has the **in-house capability** to take digital models or reverse engineer them, create the mounting structure, complete the install, run the test and produce a full report.

Using **accelerated test methods** one hour of shake inputs results in a simulation of 1440 miles. Thus, **one week of testing** is equivalent to **100,000 miles**. At any point during the testing, the rig can be paused and a design check completed, from bolt torque to crack checking. This allows for a rapid improvement cycle.

ARC can apply various vibration profiles:

- **Sinusoidal inputs**; used for checking of resonance problems
- Actual road data; actual accelerations collected by data logger on actual truck
- ASTM D4728 Assure Level I; white noise random inputs that are shaped to be representative of a real road. This input is the most often used.

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Hybrid Drivetrain Test Rig

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Driveline failures, whether mechanical or hydraulic, happen frequently towards the start and finish of a vehicle's service life. By **testing your drive train components** on an ARC Drive Train Test Rig before production, errors and hence development costs can be reduced.

On the ARC Drive Train Test Rig, the performance of a gearbox, rear-end and driveline can be independently and **accurately measured** and optimized. The ARC Rig also allows for hybrid drive units to be tested. Our customers are therefore able to ensure the correct balance of performance and durability, while selecting the most suitable materials, design, and component configuration.

Fatigue life can be established with confidence under new operating conditions such as cooling airflow availability, improving total-life reliability.

The ARC Vehicle Dynamics Rig is located in Indianapoils, IN and is **available to rent** on a daily basis.



Drivetain Test Rig Specifications

Input Power > 600 HP Max Input Speed > 9,000 RPM Output Simulated Road Speed ~ 190 MPH Max Gearbox Inclination = 60° (~1.75g) Maximum rig tilt angle = 10° Horsepower accuracy = 0.1% (calculated) Torque accuracy = 0.01% RPM accuracy = 0.05% Gearbox Installation Time ~ 15 minutes

Data Acquisition System

Speeds: Input, Output (Gearbox, LH & RH) Torque: Input, Output (Gearbox, LH & RH) Gearbox Oil Pressures Gearbox Temperature

Control Commands from PC: Input Speed Gearbox Oil Temperature

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Reverse Engineering

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ARC's reverse engineering capabilities begin with our fully integrated seven-axis, contact / non-contact **FARO laser scanning system**. The portability of the equipment allows us to provide this service at a location convenient to our customers.

This **cutting edge technology** allows us to collect a dense cloud of points from the surface of any shape, from a small component to a complete semi truck tractor-trailer. The system's accuracy of 0.0005", is ideal for point-to-point contact mapping, which can be used for a variety of purposes.

Using the latest Geomagic software, our **Surfacing CAD Department** can translate this point cloud data into accurate, high quality NURBS surfaces for CAD and CAM applications including digital models for:

- Visualization & Analysis
- Rapid Prototyping & 3-D Modeling
- Manufacturing
- Inspection



SCANNED DATA OF PHYSICAL PART "A"

SCANNED DATA OF PHYSICAL PART "B"

Reverse Engineering 3D Comparsion

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3D Comparison inspection using the ARC Reverse Engineering Services is a great way to inspect **dimensional deviation** between **complex parts**.

Parts can be **compared** against a **scanned physical part or CAD model**. 3D Comparison could be used for a wide range of inspection reasons. From **checking for consistency** between molded parts or first article **drawing comparison** to CAD data, the inspection results can save a lot of time, while giving very detailed comparative data.

Using Geomagic Studio, an innovative software package, two CAD datasets can be brought into the package and a detailed comparison done. The files used for comparison are accuratey aligned using a wide range of tools.

Specs / Features:

- Deviation to 0.0001 inch
- Non destructive inspection
- Accurate alignment of models
- Customer driven output, from deviation map to units

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3D COMPARISON

SCAN DATASETS

BETWEEN THE



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Rapid Prototyping

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Using advanced rapid prototyping techniques such as **Stereo Lithography** (SLA) and **Fused Deposition Modeling** (FDM), we can produce individual components in a variety of materials directly from CAD files. The quick turnaround, durability, and materials used make these components ideal for:

- Tooling for low-temperature composite parts
- Wind Tunnel Model test components
- Presentation models
- Prototype parts

ARC specializes in making the parts for your custom projects, however big or small they may be. ARC is happy to provide a no-obligation quote along with guidance on build orientation and technique. An STL file is the recommended format, but all common cad export formats can be used or ARC can create the cad model for you using their consulting services.

Various **post-finishing services**, such as sanding, smoothing and painting can also be included. If the parts are larger than 18"x18"x24" it is possible to build parts in several sections and bond them together to create parts that are larger than the build envelope of the machines.

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Pneumatic Tires

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Using pneumatic tires for wind tunnel testing, allows a replication of **real world tire deformation** and its effect on aerodynamic forces. Pneumatic tires allow for a realistic contact patch and sidewall shape when moving through camber curves.

For NASCAR testing the wheel used is the AERO 15x9.5 and includes dummy wheel nuts and studs. Each **tire is corner specific**, with different widths and with conicity for maximum shape accuracy. Each tire used is selected from stock, based upon the desired loaded radius.

Dynamic tire profiles can be varied by customer requirements by changing:

- Tires of a different diameter
- Inflation pressure
- Corner weight
- Tire insert profiles
- Static camber & Camber curves

Currently, ARC is only offering the pneumatic tires for lease at the ARC Indianapolis facility. ContactARC for other vehicle tire applications.



Fleet Efficiency Analysis

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ARC specialists review tractor/trailer fleet combinations for **aerodynamic fuel economy** improvements and **attainable savings** estimates per **your fleets' configurations**.

To use ARC's Fleet Efficiency Services, call (317)-291-8600 or email save@arcindy.com

Consultancy Analysis:

Why fleets need ARC specialists to review their tractor/trailer combinations?

• Assess your current fleet configurations, duty cycles, fuel spend, and existing technologies

• **Identify** aerodynamic **fuel economy improvements** per your fleet configurations

• **Determine attainable savings** estimates per your fleets duty cycles a nd fuel prices

• **Resource** for fuel **savings approaches** through Aerodynamics and other technologies

Product Evaluation Analysis:

Why test tractor/trailer combos with ARC's catalog of Aftermarket Aero devices?

• Calculates your fleet's current tractor/trailer combination for baseline fuel economy

• **Determines** fuel economy gains using fleets' **best setup** to evaluate **Aftermarket Aero devices**

• **Test** tractor/Trailer configurations to identify **optimized aero devices setup**

• **Report** giving fleet decision makers a guide for **optimal selection** of tractors, trailers, and the right aftermarket Aerodynamic devices that provide the greatest fuel savings

Vehicle Efficiency Development:

Why would fleets seek fuel economy savings through design development?

• ARC can produce even **greater fuel savings from untapped areas** by utilizing design know-how,scale model wind tunnel testing, and computational fluid dynamics (CFD)

• **Develop** fleet **specific designs** for optimization of engine bay, wheel well, underbody, etc

• Double digit fleet **fuel efficiency gains realized** by globally recognized company View details at:

http://www.arcindy.com/arc-casestudies-and-testimonials.html





AUTO RESEARCH CENTER LLC

4012 Championship Drive Indianapolis, Indiana 46268

EPA SmartWay Wind Tunnel Test Report for

Verifying the Performance of Tractor-trailer

Aerodynamic Devices

Date of test:

Test run:

Conducted for:

Device tested:

Date of report:

Version 2.1

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EPA Smartway Verification

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EPA SmartWay has released the protocol for wind tunnel Verification Testing. ARC is an **approved test facility** for EPA Smartway Verification

The EPA Technology Assessment Center (TAC) provides **EPA verification of the potential fuel savings** for devices and combinations of devices that reduce the aerodynamic drag of 53 foot box trailers intended for long-haul use.

Trailer aerodynamic devices are eligible for EPA Smartway verification on 53 foot van dry and refrigerated trailers. EPA verifies devices such as front fairings, side fairings, rear fairings, under trays and others.

ARC can assist with all phases of the nine step EPA verification process. From writing of applications and creation of test plans to testing and final reporting.

To start the EPA Smartway Verification approval process, call ARC at 317-291-8600 or email sales@arcindy.com





Electric Vehicle Range Improvement

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The specialized testing capabilities at ARC allow for several areas of further development to increase the range of your electric vehicle.

Consultancy

ARC has a team of expert aerodynamicists and vehicle designers on staff that can provide a third party independent review of designs.

Aerodynamic Drag Reduction - Lowering the overall drag means less power is needed to propel the vehicle.

Rolling Road Wind Tunnel - Put your styling clay model in the ARC scale wind tunnel or have ARC build a scale model for you to find improvements throughout the design cycle.

Computational Fluid Dynamics - Using ELEMENTS, a CFD program custom coded for the automotive industry.

Adjoint CFD - A specialized CFD solver that is like 1000 CFD runs in 1. It morphs the car surface to show which way to morph the body for aerodynamic improvements. Adjoint has helped OEM's find additional drag reductions even after intensive traditional aerodynamic development.

Sculpted Underfloor - ARC is a world leader in understanding how to make a 3d aerodynamic underfloor, while still retaining correct cooling, exhaust and safety requirements.

Thermal Testing - Increase the efficiency of electric components and batteries by getting cool airflow to them.

Thermal CFD Testing - Using the thermal solvers in ELEMENTS, CFD software coded specially for automotive purposes, get valuable flow visualization information and temperatures. Then, optimize the flow to the components and ensure hot air is kept away. **Development Ductwork** - Adjoint CFD solver can take a duct and automatically morph it into the most efficienct shape in one CFD run.

Rolling Resistance - Decreasing the rolling resistance of your drivetrain

Hybrid Drivetrain Test Rig - The ARC drivetrain test rig, capable of 600 hp and shaft speeds of 9000 rpm can do hybrid drivetrain testing by switching the wheel side of the dyno from absorption to driving thus replicating realistic drive cycles.

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Fuel Economy and Sculpted Underfloor

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Fuel consumption is now one of the key purchasing drivers as vehicle buyers look for lower ownership costs, and increasingly environmental friendly transportation. When traveling at approximately 60 mph, the majority of fuel consumed is used to overcome losses due to aerodynamic drag.

ARC is uniquely placed to provide automotive and **commercial vehicle OEMs** with advanced aerodynamic testing solutions that can directly and significantly reduce vehicle drag in areas that cannot be found using traditional fixed floor wind tunnel techniques.

In an ARC wind tunnel, as the wheels rotate and the car moves relative to the ground, a true representation of vehicle drag can be accurately measured. Engineers can therefore find additional **drag savings** in both the upperbody and underbody regions.

ARC has developed a system to create optimized **sculpted underfloor** for production cars that offers significant Fuel Economy Efficiency Improvement. It also allows for vehicle styling to cover more of the vehicle. ARC offers two development packages.

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Wind Tunnel **Model Motion**

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Designed in house by ARC, the model motion system is a state of the art scale model force measurement system. Accurate & repeatable aerodynamic numbers are produced by mounting the system inside of the scale model and utilizing an Aerotech 6-axis force measurement balance. The system also features an internal gear system to minimize backlash and provides high level accuracy of model movement.

The Model Motion system **provides a range** of yaw motion of $+/-14^{\circ}$, roll motion of $+/-5^{\circ}$, and pitch motion of $+/-4^{\circ}$. The use of stepper motors driving through a gear reduction system to multiply torque allows the range of motion to be repeated time after time.

For increased aerodynamic simulation, the system also provides an air circuit to allow the use of a compressed air feed, routed down the sting, so as to allow the option of blown model exhausts.



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Detailed Model Making

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The ARC model makers rank amongst the finest in the industry. A broad range of shop skills such as metal fabrication, machining, woodworking, and composite techniques compliment our model building talents.

Our model makers are dedicated craftsmen with exacting standards that routinely work to demanding schedules. This elite group is capable of producing a prototype part or complete model from a verbal description, or from an engineering drawing that is accurate to the last detail.

The ARC model shop staff's ability to react quickly and efficiently to engineering decisions ensures that our clients get maximum results from their scale model testing in the wind tunnel.

The talents and services from this detail-oriented group are highly sought after by race teams, production OEMs and commercial manufacturers alike.













Case Study Frito Lay

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As part of their effort to become the most fuel efficent fleet in the country, Frito Lay used ARC's aerodynamic development tools and knowledge to help them find a **14% fuel economy savings**. Frito Lay worked with ARC in conjunction with Utilimaster and Morgan Olson, using both scale model **wind tunnel testing** and **computational fluid dynamics** (CFD).

ARC developed an **upgrade kit package**, that included side skirts, fairings, engine bay modifications to find the fuel economy savings.

Through the results of the program and with a letter of recommendation, Frito Lay won the **SmartWay Excellence Award**. This award recognizes manufacture effort to reduce emissions and further the development of an efficient freight supply chain.



Case Study HTT Supercar

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When HTT Automobile from Quebec Canada was looking to **improve the aerodynamic** characteristics of their HTT Pléthore LC-750 supercar, they turned to ARC to assist with development. They put forth the goals of significantly reducing drag, making the aerodynamic balance more drivable and increasing thermal cooling without harming the aesthetic character of the car.

By utilizing both the ARC scale model **wind tunnel** and **ELEMENTS CFD** software, ARC developed a **multiple stage program**, starting with CFD analysis first and then combining wind tunnel testing. In addition the correlation between CFD and wind tunnel results were very good and well received by HTT.

Working directly with HTT, ARC produced manufacturable aerodynamic gains. The **drag was reduced by 21%**, at 200mph, this meant 100 less hp was needed to overcome drag resistance, while keeping downforce levels the same. **Thermal cooling was improved by 65%**, solving overheating issues and finally the aero balance was improved to create a **safer ride for the driver**.









Case Study Bikesports Sportscar 2014 Championship

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The **British 750 Motor Club, Bikesports Championship** features sports cars powered by motorcycle engines. The championship is highly competitive and features some of the fastest lap times in club motorsports.

In 2014 Adrian Reynard decided to race in the Class A division for the first time using the Radical SR3 sportscar. Any aerodynamic improvements would greatly increase the chances of winning first time out.

Knowing the challenges, Adrian used **ARC's CFD and aerodynamic consulting**. ARC's aerodynamicist found a **number of key areas for impovement**, ranging from diveplane placement to wing development. Changes resulted in a more stable well balanced car, allowing for consistent lap times throughout the season.

Using ARC's consulting services paid off, for Adrian. As he **won the 2014 Bikesports Class A Championship**, with 6 race wins, 2 pole positions and 2 race fastest laps.

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Case Study Bonneville Streamliner

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The Bonneville Salt Flats are about record breaking speed and speed at Bonneville is found by reducing aerodynamic drag and an efficient engine. The body shape of a streamliner race car must be very smooth and avoid any shapes that can cause drag turbulence. With top speed held for the entire run at Bonneville, even the slightest bit of turbulence will have an impact on top speed.

The **Brine Shrimp Streamliner team needed a flow visualization study** to help them understand their body design. Outdoor straight line aerodynamic testing had been done, but the weather was often unpredictable and didn't match the conditions found at Bonneville. Therefore, the Brine Shrimp team **turned to ARC to test in stable repeatable conditions** using the ARC wind tunnel.

Using wool tufting technique, the team was able to gather full car flow visualization. Testing showed the **design was near an optimum shape and pinpointed a single area that development was needed**. With test results, the Brine Shrimp team set out to increase efficiency of the design in the quest for more **speed**.

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Case Study SCCA F2000

In the SCCA F2000 racing class, **a tenth of a second** is the **difference between pole and starting several rows back**. Finding that edge is difficult and OSQ Hoosier Racing knows this well.

One area to find time is through **tuning of shocks and springs**, along with understanding of how the tweaks affects the vehicle dynamics and the driver's feedback to the changes at the track. Thus, OSQ Hoosier Racing turned to the ARC 7-Post rig to gain the advantage. With **ARC's expert engineering advice**, OSQ Hooiser Racing left with a vastly increased understanding and **optimized setup**.

Selecting the **inputs for the test runs** was achieved by using OSQ Hoosier Racing's **ontrack data** and **ARC's library of track and sine waves.**

Using the data collected from the testing and with advice from the ARC Engineering staff, **OSQ Hoosier Racing recorded their best starting position and finish of the season** at the first race following the test.

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