FORCE DYNAMICS QUICK INFO SHEET - OCTOBER 2014

FORCE DYNAMICS
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ABOUT FORCE DYNAMICS

Force Dynamics is a family-owned business located in the Finger Lakes region of upstate New York, a few minutes from Watkins Glen (where it's gorgeous in the summer, which makes us want to go racing, and freezing in the winter, which makes us want to go racing). We were founded in 2005, and we've shipped more than 100 motion systems to customers in 20 countries and every continent except Antarctica.

Why did we get into this business? Back in the dark ages of the late 1990s, not long after Michael and Neil were racing in GT1 in the SCCA, David became ensnared by Dave Kaemmer's masterful simulation Grand Prix Legends. The unprecedented fidelity of GPL's physics and the family's familiarity with motorsport, business, and high-performance automation design led us to look for a solution to the last missing puzzle piece of simulation: The ability to feel the car.

Between 2000 and 2003 David and Michael researched motion simulation and chewed over designs; by 2004 a prototype was working, and in 2005 Force Dynamics officially launched the 301.

Our customers include Microsoft's Turn10 Studios, Lockheed Martin, Boeing, Ford Motor Company, and Gulf Racing, and in addition to racing simulators we've built flight simulators, tank simulators, camera test rigs, and more.

We Are

David Wiernicki - President

David's mainly responsible for product direction and marketing, but is known to write code (for motion systems and web sites) when duty calls. In his off hours, he writes downtempo & trance music, and wonders why so many people in China are searching for it.

Michael Wiernicki - Director of Engineering

Michael (David's father) is the guy who has to figure out how to build the things David wants to make. He leveraged x-treme engineering synergy to do the base design for the 301 platform in 30 days, and is personally offended by marketing buzzwords.

Judy Allen - Chief Financial Officer

Judy prevents David from buying too much camera gear, Michael from buying too much test equipment, and Neil from buying too many drill bits. She also makes sure we sell simulators for more than it costs to make them, which is harder than it sounds.

Neil Wiernicki - Director of Manufacturing

Without Neil, we'd have a great design, lots of customers, and a perfect balance sheet, but nothing built. Making sure the hardware gets built — and gets built so we can be proud of everything that leaves our shop - is his job.

INTRODUCTION

Model breakdown and basics

There are four models of the Force Dynamics motion platform.

The **301** is our original design with 3 degrees of freedom: roll, heave (vertical motion), and pitch.

The **401** is similar to the 301 but has 4-DOF: roll, heave, pitch, and yaw. It comes in three versions. The first two have 180 degrees of rotation, with an external control mast located 3 to 4 feet behind the machine.

The **401-AFE** needs to be fixed permanently to the floor, so it can't be transported.

The **401-ATE** has a portable floor allowing it to be moved from place to place.

The **401CR** has continuous yaw (infinite rotation). The computers are on board, eliminating the control mast and external cabling, and with its fold-up floor, it can be transported in one piece, moved to location with a fork lift, and be running in only a few minutes.

The **302** is similar to the 301 in its basic motion capability, but generally uses a different motion style, as it is usually used with a detached display system. It is 7 feet long, and narrow enough to fit through a standard doorway. It is less expensive than the other models, but still has the same high quality construction of the larger machines. The base system comes with Logitech steering and pedals, and Logitech sound. A display is optional and can be either fixed or integrated with the motion.

The **201** is based on the 302 but has only 2 axes: roll and heave. The sheet metal nose is optional to keep the price down. Likewise, the sound system is optional.

Two computers are necessary to run these platforms. Using only one computer to control both game software and machine control software can have negative effects on the quality of the motion. In addition, high performance gaming computers can sometimes be unstable so having a separate computer, built for reliability rather than speed, control the hardware improves stability and makes troubleshooting easier. These platforms support Windows-based software, and many off the shelf games like Live for Speed, rFactor, GTR, iRacing, Dirt, Dirt 2, and Grid. We can also build support for many games on a custom basis.

We do not support Microsoft X-Box or Sony Playstation software at this time.

Both the 301 and the 401 can be modified for use with Microsoft Flight Simulator (2004 and X) and we also offer a model that can convert back and forth from flight to driving mode.

Any of our platforms can be modified or customized.

For further information

For more detailed specifications or for other questions, please feel free to contact us directly:

David Wiernicki, President

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CONSTRUCTION

Struts

Strut tubes are case hardened steel guided by 4140 steel rollers that are fitted with sealed needle bearings. The strut tube is driven by an oversized ball screw whose large pitch and consequent slow rotation gives it a very long life. The servo motors are three-phase brushless permanent magnet motors fitted with a spring actuated brake and differential output incremental encoder. The motor drives the screw with a toothed belt.

Frame

The frame is a weldment fabricated from low-carbon steel and is finished with a textured polyester powder coating. Removable panels are attached with hardened thread forming screws. All aluminum parts are clear anodized or polyester powder coated.

Electrical

Electrical components are mounted in a subframe fabricated from Galvalume (55% Al-Zn coated sheet steel) This steel is corrosion resistant and allows excellent and reliable ground connections. All fan openings are covered with metal screens and the power connection is via a standard filtered and switched power entry module. A 25 ampere single pole thermal circuit breaker protects the circuit in case it is connected to an unfused power source.

MACHINE COMPARISON

General

We produce small, highly-capable motion systems for private and professional use. Pricing can vary significantly depending on the country of purchase, volume, and other factors, but US MSRPs range from the mid 20s for the 201 and 302 to the upper 80s for a fully-optioned 401cr. Due to fluctuations in exchange rates, the effect of import/export duties, shipping, and other factors, we generally prefer to avoid discussing pricing in the press.

301

The 301 is a three axis simulator having roll, pitch, and heave axes. The roll simulates the forces that occur when a car rounds a corner. The pitch motion simulates the forces of braking and acceleration. Heave is up and down motion that simulates bumps. The roll and pitch axis of rotation are located just below the riders chin. This high rotation axis location is very important because by being close to the vestibular system in the ears, it reduces or eliminates (in 95% of the people) motion sickness. Competing motion systems in most cases have a low roll and pitch axis, and as a result can induce motion sickness.

Motion sickness is also induced by time delays between actual motion and the motion portrayed by the graphics system. By using low inertia brushless motors and high power amplifiers we have reduced this delay to less than 10 one-thousand's of a second. While some professional racing drivers will notice this delay, most people cannot.

201/302

The 302 is a three axis simulator having roll, pitch, and heave axis. To make the machine smaller we limited the pitch to +/- 6 degrees and roll to +/- 15 degrees (The 301 provides 30 degrees for in both pitch and roll). Heave is limited to +/- 13 cm compared to +/- 24 cm for the 301 Motors, controller, and other electronics are identical for both the 301 and 302.

401

The 401 adds a yaw table (rotation about a vertical axis) to the 301. The axis position is just forward of the seat. We determined this position as being best by extensive testing with a number of drivers. We use the same motors and servo amplifiers that are used on the 301. This axis adds the feel of the car rounding a corner to the 301 forces. The 401 rotates +/- 90 degrees, and is connected to the computers by a cable loop that attaches to a fixed post. Because a car rounding successive right or left hand bends can easily rotate more than 90 degrees the motion must be scaled and a "washout" factor applied. The washout continually moves the yaw axis towards the home or zero rotation position slowly enough so the rider does not notice the rotation.

401CR

The "CR" refers to continuous rotation rather than being limited to +/-90 degrees as in the 401. To achieve this we located the computers on board the moving part of the machine and supplied power to the machine through slip rings. This has the added advantage of simplifying set up of the machine and making a cleaner overall installation.

The continual rotation means that the actual rotation of the car can be duplicated in the simulator. This has proven to enhance the simulator more than we expected when we began the CR project.

401CR SPECIFICATIONS

Description

The 401CR driving simulator provides four-axis motion, pitch, roll, yaw, and heave. The yaw axis has the capability of continuous rotation and thus can have a 1:1 relationship to the car yaw angle in space. The roll axis is located approximately at shoulder level in the driver's plane of symmetry. The pitch axis is located perpendicular to the rider's plane of symmetry but 10 cm (4 in) forward of the rider's shoulders. The yaw axis is vertical and lies in the rider's symmetry plane approximately 51cm (20 in) forward of the rider's shoulders (with seat in its furthest-back position).

The platform includes the seat, interlocked seat belt, interlocked doors, display screen, and projector. Controls included are force feedback steering, brake, paddle shifters, and throttle.

Electrical

The 401 is equipped with an isolation transformer and may be used with the non-polarized outlets found in many parts of the world.

USA		EU	
Input Voltage	120 VAC	Input Voltage	240 VAC
Input Current, RMS	20 A*	Input Current, RMS	10 A*
Input Current, Peak	80 A	Input Current, Peak	40 A

** A thermal circuit breaker is necessary in the branch circuit supplying the machine because of high peak currents.*

Safety

The 401 is equipped with a safety relay with contacts that are monitored during a cold start. Operation is prevented if either of the redundant power relay contacts is welded. A varistor that is in series with the main contacts is shunted after main contact closure. This reduces startup current surges and reduces the chance of contact welding. It meets ANSI B11.19, EN418, and EN954-1 standards.

A rider accessible emergency stop switch is provided, as well as provision for a remote E-stop switch. In the emergency stop state all power is removed from the motors and spring actuated brakes. The computers, motor controller, and encoders remain powered so that when the E-stop is canceled operation can be resumed without re-homing.

The seat belt and door both have interlocks that place the machine in a pause mode. Pause mode brings the servo motors to a controlled stop, applies the motor brakes, and disables the servo amplifiers. Operation can be resumed by simply removing the condition that caused the pause mode and pressing the green pause button located on the left-hand side of the steering column.

Motion

Roll	+/- 30 degrees
Pitch	+/- 30 degrees
Heave	+/- 20 cm (+/- 8 inches)
Yaw	Continuous rotation possible
Radius for rotation	1.04 m (41 in)
Passenger Weight Full performance	100 kg (220 lbs)
Passenger Weight Maximum	127 kg (280 lbs)

Dynamic Performance

Dynamic performance is specified at maximum passenger weight.

Roll Slew Rate	1 rad /sec (57°/sec)
Pitch Slew Rate	1 rad /sec (57°/sec)
Heave Slew Rate	48 cm/sec (19 inches/sec)
Yaw Slew Rate	1.6 rad/sec (91°/sec)
Pitch Acceleration (peak)	5 rad/sec^2 (286°/sec^2)
Roll Acceleration (peak)	10 rad/sec^2 (573°/sec^2)
Heave Acceleration (peak)	2.0 g
Yaw Acceleration (peak)	6 rad/sec^2 (343°/sec^2)

Working Envelope

The working envelope is for the simulator only. Space is also required for an operator's console if the 401CR is supplied with the optional remote station; while the remote station is wireless, it should be kept in close proximity to the simulator to decrease the likelihood of issues with the wireless video transmitter and keyboard/mouse.

Plan	244 cm x 244 cm (8 ft x 8 ft)
Elevation	274 cm (9 ft)

Dimensions

Width	140 cm (55 in)
Width with 3 LCD display	156 cm (61 in)
Length	224 cm (88 in)
Height at rest	206 cm (81 in)
Height for Transport	184 cm (72.5 in)
Weight	771 kg (1700 lbs) with floor