
Shore Western
Brilliant Minds, Creative Solutions

Shore Western Manufacturing



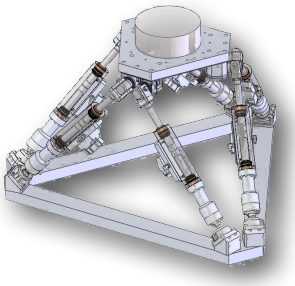
Shore Western is a forward-thinking global high technology company that takes pride in its ability to attract and retain a staff of Engineers and Technicians who innovate solutions to tough problems.

Shore Western specializes in servo-hydraulic test equipment, including turn-key test systems, controllers, actuators, servo valves, manifolds, hydraulic power supplies and hydraulic distribution. Our skill is in taking these core technologies, and applying them to meet your unique test specifications.

Shore Western will not force you into a standard product. We will listen to your specific needs, and craft a solution to meet your requirements.

No project is too small, no problem is too challenging. We will always arrive at the optimal solution.

The company, based in the beautiful city of Monrovia, California, has been in operation since 1971. Located in a single large facility, Shore Western maintains complete control of processes by housing its development, design and build operations in one building, which comprises:



- Advanced software and hardware product development lab
  - Mechanical design area with high-powered CAD and engineering analysis workstations
  - Large, fully equipped CNC machine shop
  - Electronics assembly area
  - Fabrication and paint shop
- Hydraulic assembly and testing area with a high-bay annex



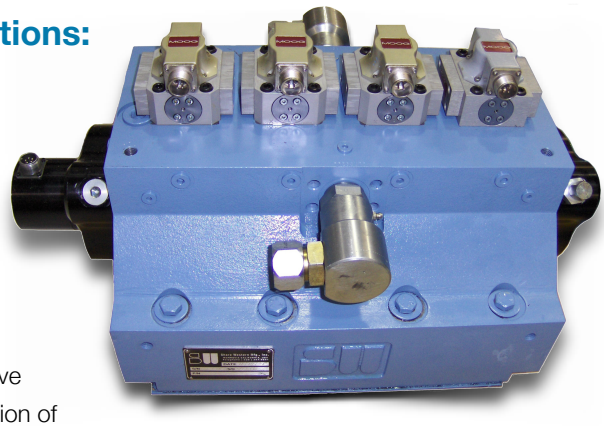
By being based in the greater Los Angeles metropolitan area, we also have access to a vast network of aerospace vendors, who are practiced in high-precision low volume processes.

Shore Western Manufacturing, Inc. 225 W. Duarte Rd. Monrovia, CA 91016 **Telephone** +1 626-357-3251 www.shorewestern.com

Creative Technology

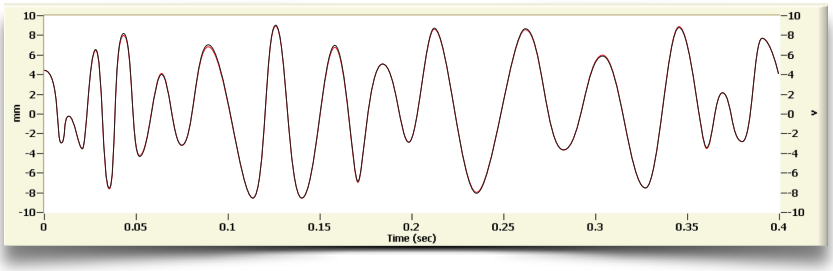
Through our experience with building technically challenging systems, and our “out-of-the-box” thinking, we have shocked our competitors by developing components and software that provide solutions to longstanding challenges.

Here are just a few examples of our innovations:

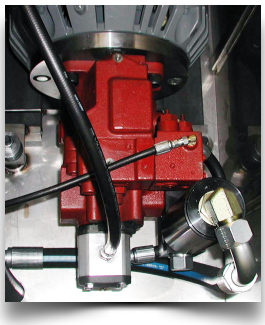


We have developed a **new manufacturing process for three stage servo valves** that provides unprecedented control and accuracy. This improves signal reproduction through the critical region where hydraulic flow is switched from one direction to the other, which is especially important for tests that control to an acceleration response.

Our **Real Time Active Control (RTAC)** is the only non-linear adaptive control algorithm in the industry that provides push-button reproduction of target signals, obviating the need for time consuming, complicated, and expensive Fourier-based techniques.



Our **Whisperpak pumps use a submerged motor to provide quiet operation**. Others have found that this configuration can lead to overheating oil when the flow demands are low. To solve this problem, we have developed a unique and very reliable solution. By installing a through-drive on the pump, we are able to run a second small pump in series, which is dedicated to circulating oil through a cooling and filtering circuit. This ensures that **the oil maintains a stable temperature regardless of demand**, and the oil is kept cleaner by filtering through a kidney-loop. This is more reliable than the bypassing approach taken by others.





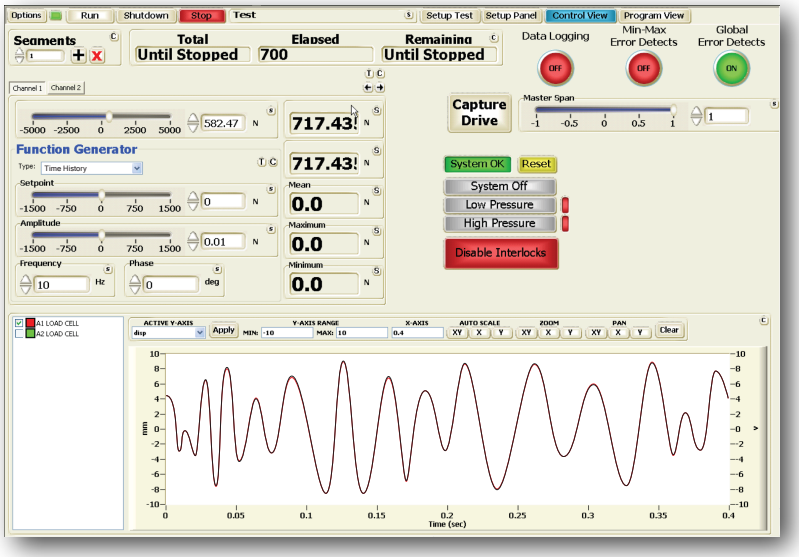
Hydrostatic bearings offer a lot of advantages over traditional designs but they are a challenge to build. They are close to being the “perfect” bearing, with zero backlash and near zero friction. **Shore Western has developed hydrostatic bearings for the most challenging systems**, with load capacities up to 1,200kN (270kip) on a 260mm (10.5in) ball, with working pressures to 34.5Mpa (5000psi).

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Controls

Shore Western's proprietary Real Time Active Control can effortlessly replicate your events with the push of a button

RTAC is a point-by-point reproduction that ensures an entire waveform is reproduced, whether it is a periodic sinewave, or a time history. Phase and amplitude across channels are preserved, making a **multi-channel real-time simulation** possible. What makes RTAC particularly powerful, is the fact that it can run in a "**mixed mode**." This means that you can run the digital optimization with a different transducer than the analog control loop. As an example, you can run the PID loop in **displacement control, while commanding, optimizing, and reproducing acceleration, load or strain**.

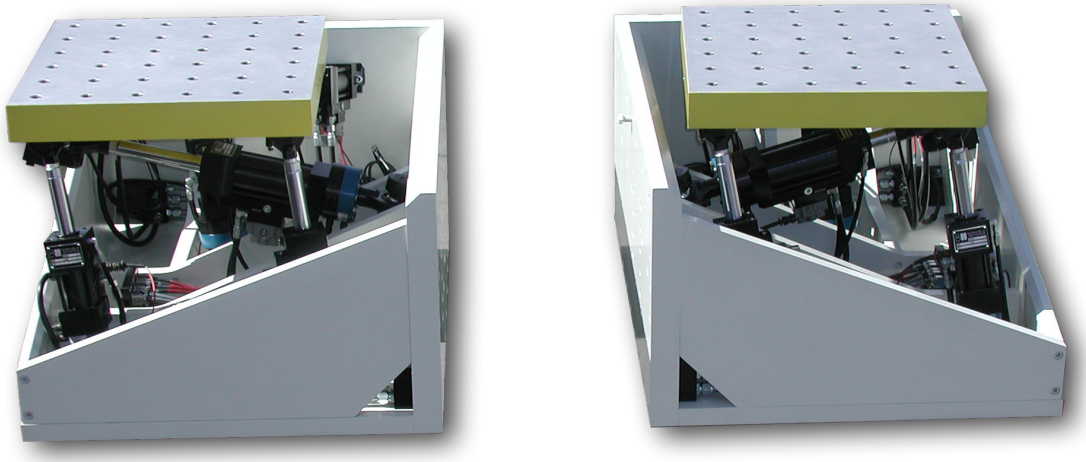


Set up of RTAC is relatively straightforward. A step-by-step process is followed, which leads to a **full simulation in minutes**. Drive files (the files that are used to reproduce the target response) can be stored for use later. When RTAC has finished converging, its adaptation can continue as the specimen properties change (e.g. stiffness), or it can be frozen.

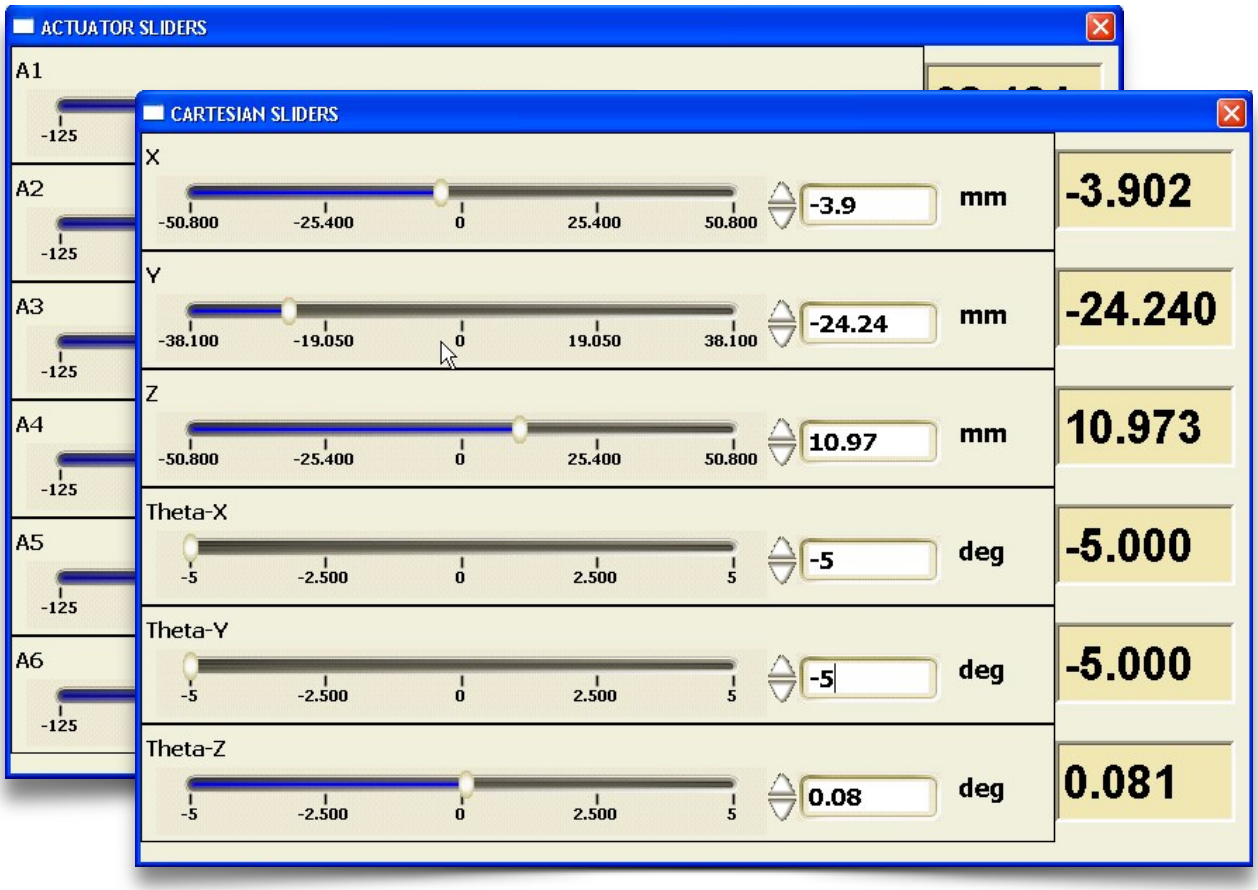
To perform this same task, our competitors use an arcane frequency domain based modeling technique that was invented in the 1970s. Since then, little has changed in the basic technique, which requires a difficult and time intensive set up, and takes highly experienced personnel. Also, compensation is not possible once the test has started, it is effectively open loop. **RTAC is another industry first**. It significantly reduces the required setup time, removing many of the difficulties of a time history simulation, while **improving accuracy throughout the entire course of the test**.

The Multi Axis Function Generator panel is preconfigured with the controls you need, but it can be completely **customized with your own buttons, lights, meters, sliders, and pop-up controls**. It also has Block Programming capability, so that you can define the events before and after the test, along with what happens if there is an emergency stop, controlled stop, or immediate stop. The entire panel can also be embedded in a For-Loop block to create a long-term fatigue test.

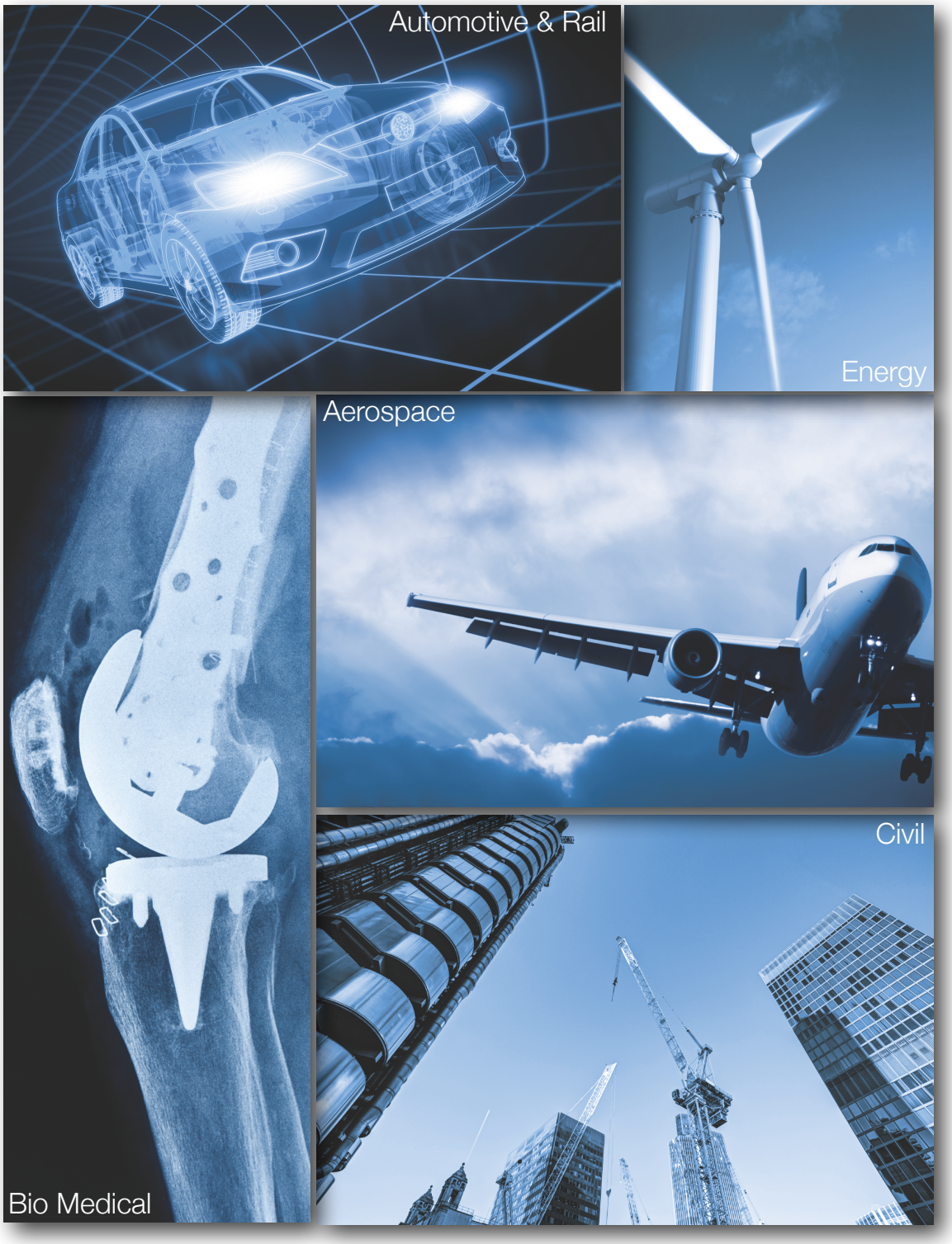
The Shore Western Control System (SWCS) incorporates a sophisticated Degree of Freedom control that allows the user to move the center of origin to any point in space.



We are even able to control **multiple tables as a single plane.** The user can freely switch between actuator commands and cartesian commands, depending on their preference for the given task.

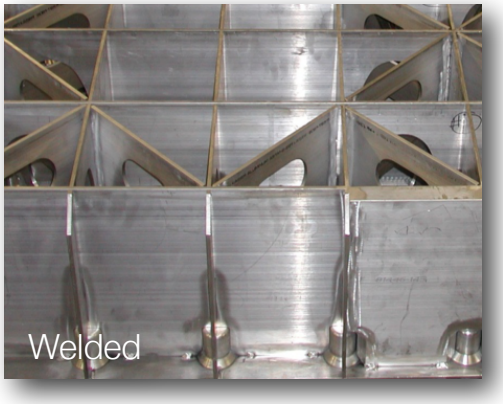


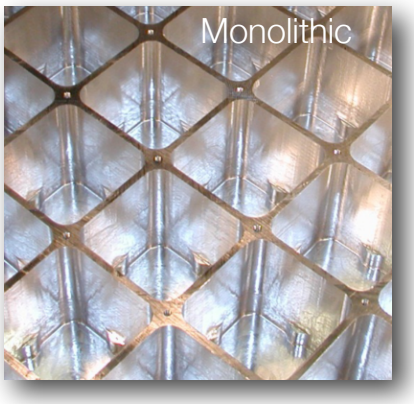
Markets Served



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Shock and Vibration Systems

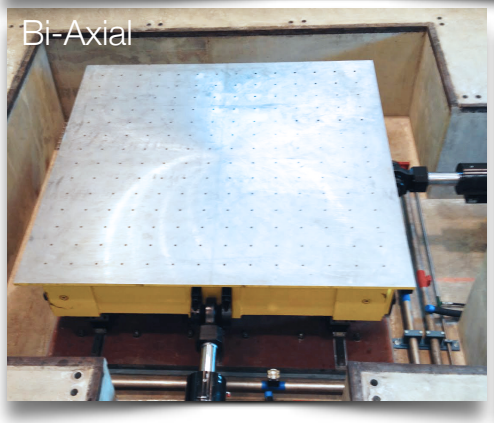


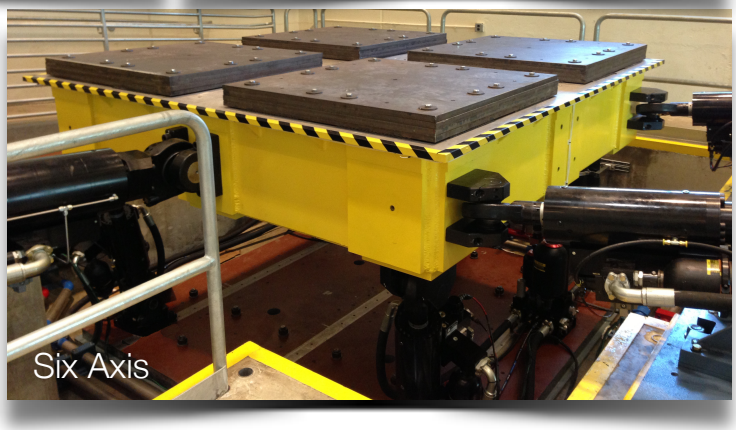


Vibration tables are used to characterize the performance of components, assemblies and structures for the automotive, aerospace and civil markets.







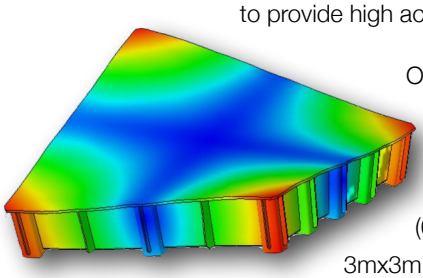


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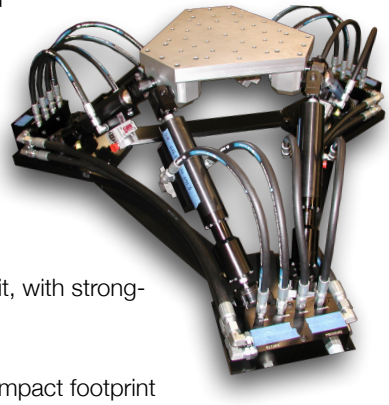
Shore Western builds any configuration of vibration table, from one-axis to six-axis, and in a wide range of table sizes.

Specimens whose failure is a direct result of vibration are usually tested on vibration tables. Rough roads, earthquakes, shaped random, shock or sine sweep signals are used to replicate the service environment. Because the specimen reacts the loads inertially, there are fewer concerns with boundary conditions. As long as the specimen is well fixtured, and the vibration is accurately simulated, the laboratory test is very representative of the operating environment.

Our **Real Time Active Control (RTAC)** technology is used in combination with our well engineered light and stiff tables to provide high accuracy simulation in any number of degrees of freedom.

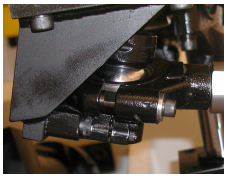


Our engineers use design analysis tools to **maximize stiffness and minimize weight**. The material and manufacturing methods are selected based on the table size and the number of degrees of freedom. We build monolithic aluminum tables up to 1.5mx1.5m (60”x60”), and welded aluminum tables up to 3mx3m (120”x120”). Larger tables are manufactured from welded steel, and in special cases, we have even built tables from magnesium. Constructed as a hollow webbed design, the **3mx3m table structures have high first-mode natural frequencies in excess of 160Hz**.

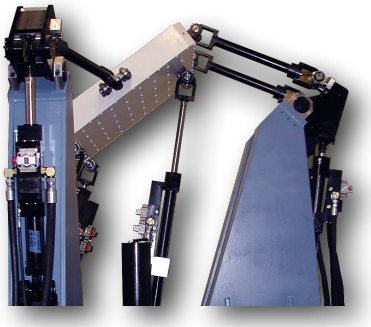


Six degrees of freedom tables can be configured for installations in an enclosed pit, with strong-back reaction, or with bell cranks.

For higher frequency operation, hexapod tables provide a solution with a small compact footprint and shorter struts. **Shore Western builds hexapod tables in a range of sizes.**



Shore Western is the only company that can provide **many swivel options**. Standard swivels are the least expensive, and are used in the majority of our tables. They are castings with pre-loadable bearings. These types of bearings are very common, and are used for most applications.



For very high angle requirements, Shore Western can create **double cardan joints that can articulate up to 90 degrees**.

For applications that require a swivel with equal angle in all directions, Shore Western uses a ball swivel. These can utilize standard teflon bearings, or when friction is an issue or for very high loads, we can build **hydrostatic bearings**.



The actuator sizes and servo valve combinations are selected so that the performance envelope of your table can be tailored to meet your specific and unique needs.

If you want to use your table to perform **random vibration, sine sweep classic shock or SRS** tests, we partner with reputable companies who can provide this capability so that you get a complete, turn-key solution to your needs.

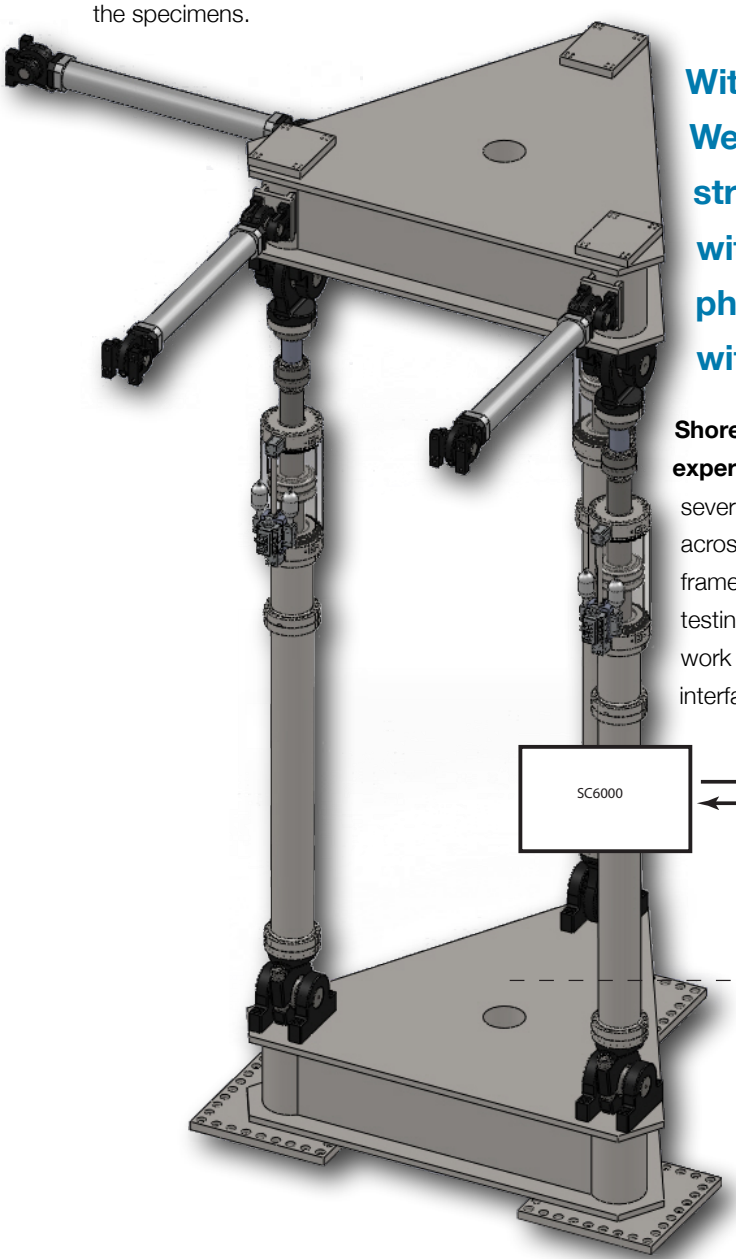
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Structural Test Tables

Multi degrees of freedom tables can be used to statically load structural components. Shore Western has built systems that **mount to strong walls and floors**, to allow civil engineers to evaluate the **performance of structures under various static, or slowly varying dynamic load** conditions.

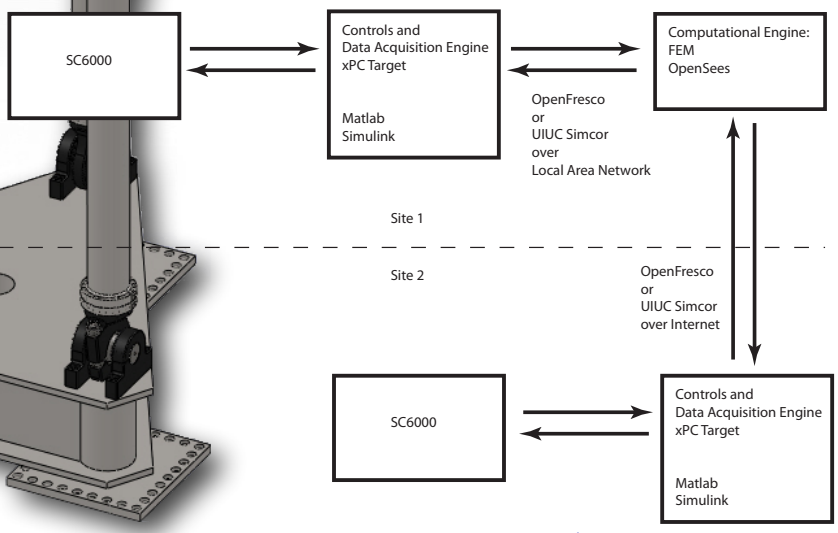


The specimen, typically a beam or column, is fixed to the table at one end, and to a strong wall or strong floor at the other. The loading tables, which are typically six degrees of freedom, are then programmed to apply forces to the specimens.



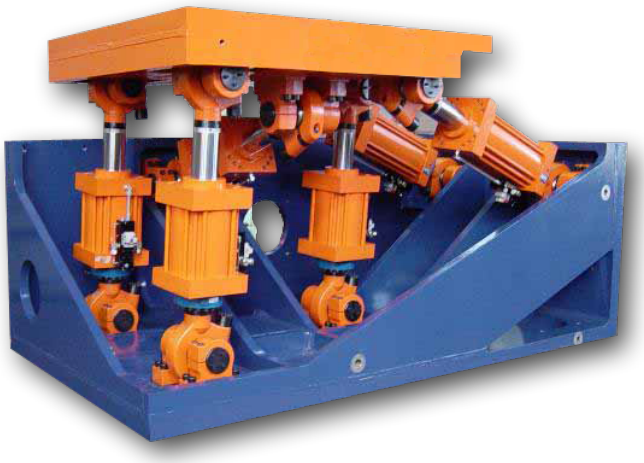
With the open architecture of the Shore Western Control System, it is straightforward to interface the system with analytic models, allowing the physical structures to be tested from within a virtual environment.

Shore Western was directly involved in the pioneering experiments for NEESGrid in 2002-2006. Using this network, several components can be tested together in various labs across the country, to simulate a large integrated structure. Two frameworks have been developed for this “Pseudo Dynamic” testing: SIMCOR and OpenFresco. Shore Western is able to work with both. For full Real Time Hybrid Simulation (RTHS), we interface with an xPC running Simulink.



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Load Boundary Condition Box (LBCB)



Shore Western, in association with University of Illinois Urbana Champaign, has developed **a family of 6 degree of freedom motion bases** to simulate loading boundary conditions. Using a boxed frame, the system provides a **very stiff reaction to ground,** which is essential for precise measurements of component deflections.

The boxes provide a modular solution to the need for a unitized loading platform that can be mounted to strong-walls in any orientation, from one of three sides.



For example, columns can be mounted to the strong floor, with the LBCB on the top, grounded to one of the walls. **Multiple units can be tied together and programmed in one unified plane** using our highly configurable Multi-Degree-of-Freedom (MDoF) control algorithm.

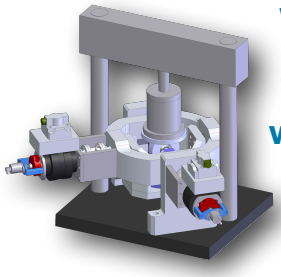
The Load Boundary Condition Box (LBCB) **ranges in size from full scale testing of large civil engineering structural elements to 1:5 scale models.** The scale models are used for instructional purposes and to develop test protocols and control strategies in preparation for full scale testing. The closed loop controls, sensors and hydraulic subsystem are basically the same, the only difference is the size of the servo mechanical subsystem. **User experience is identical on the scale model systems.** Other form factor units are available for standalone applications.

The LBCB may operate in displacement, or mixed mode load control. With mixed mode, the control loop itself is in displacement control, but we wrap a digital load loop around it, giving the best of both worlds: tight displacement control, while commanding load.

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Load Frames

Shore Western Load Frames are highly versatile systems that can be used for a **wide variety of component and material characterization tests** in the aerospace, civil, automotive, rail, bio-medical, and power generation markets.



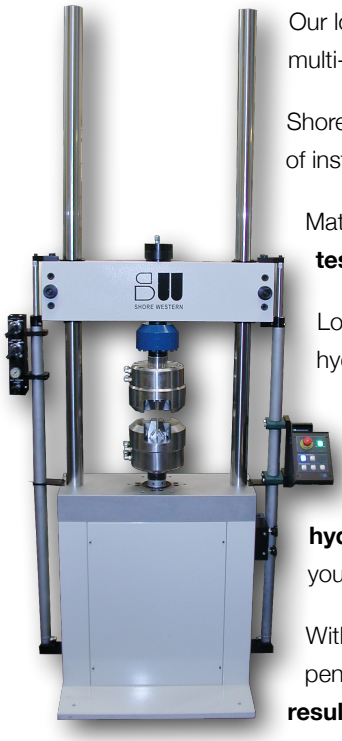
While we offer a broad spectrum of standard configurations, both axial, and axial-torsion, we are also able to custom build frames to perform specialized tests, such as complex multi-axis bearing tests.





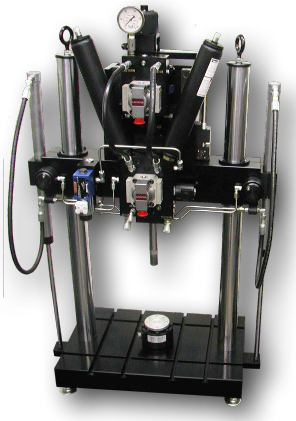
Load frames come in the following configurations:

- 2 column or 4 column
- Crosshead or base actuator mount
- Tabletop or freestanding
- Axial or axial-torsion



Our load frames can also be customized to meet specific multi-axial needs.

Shore Western load frames have proven themselves to be **stiff, reliable and versatile** in hundreds of installations worldwide.



Material characterization applications range **from simple monotonic tests to bi-axial Thermo-Mechanical Fatigue (TMF)**.

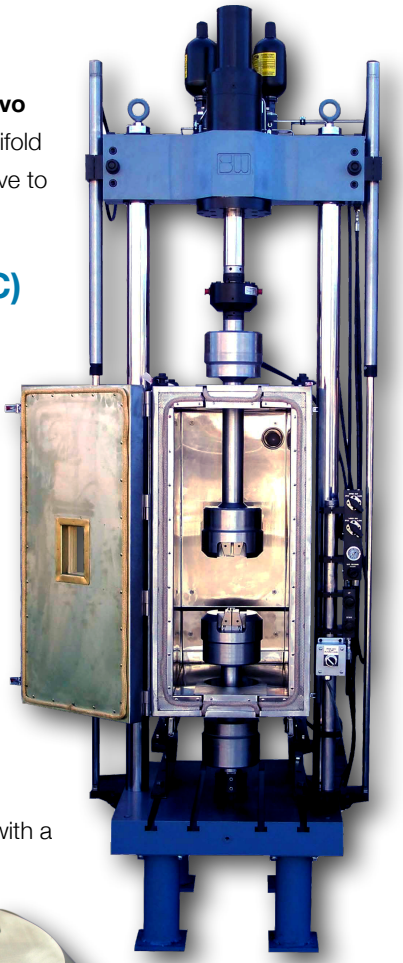
Load frames are packaged with our industry leading controllers, hydraulic actuators, integrated manifolds, servo valves, and Whisperpak® pumps to create highly accurate and durable test instruments.

All Shore Western load frames feature **chrome plated columns**, **hydraulic crosshead controls**, and **accurate alignment** to ensure your specimens are loaded only in the intended axis.

With software block programming, dynamic mode switching and the convenience of remote pendant operation, it is possible to quickly develop a set of **ASTM or custom test panels, resulting in button-press simplicity for test operators**.

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For high-rate tests, systems can be configured with **bump-less switchable servo valves**, without compromising low rate testing needs. Our unique switching manifold and control electronics allow you to switch from a high-rate three stage servo valve to a low-rate two stage servo valve (and vice-versa) on the fly.



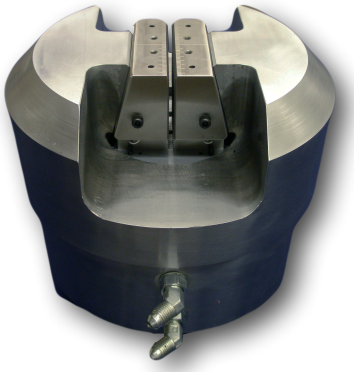


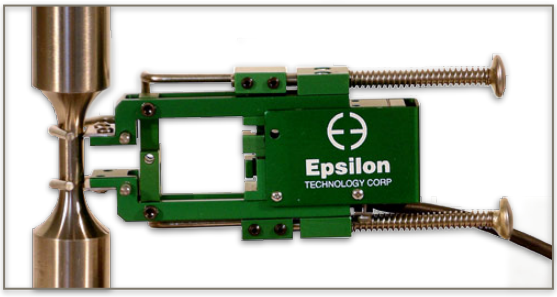
Our unique Real Time Active Control (RTAC) allows the most challenging tests to be performed with unparalleled speed and accuracy.

With its mixed-mode control capability, **the servo loop can be controlled in load or displacement control, while the test itself is programmed and optimized in strain control**. This results in a highly stable and accurate control loop that is unmatched by any of our competitors.

Shore Western load frames can also be integrated with a broad array of accessories:

- Grips and fixtures
- Extensometers
- Furnaces
- Environmental chambers
- Remote pendants





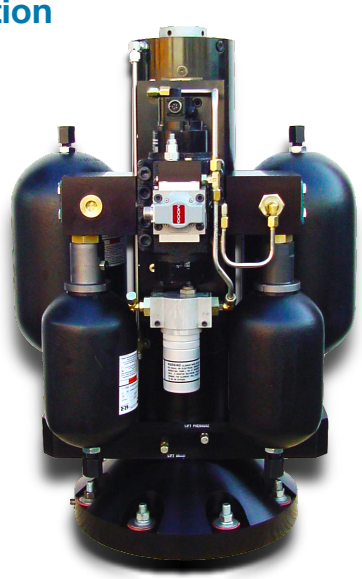
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Road Simulators



Couple our **94 Series actuators** and **high precision three stage servo valves** with **Real Time Active Control (RTAC)** and you have the perfect ingredients for a **reliable, easy to use and accurate Four Post Road Simulator**. Push button reproduction of spindle acceleration means that **novice operators can recreate road profiles easily**, without long-winded training or specialized personnel.

Four Post Road Simulators are the workhorse for ground vehicle development, from lawn tractors to large off-road construction equipment.



They are used for many different test applications:

- Structural durability
- Squeak and Rattle assessment
- End-of-line quality control
- Ride Comfort evaluation

Series 94 actuators utilize hydrostatic bearings with polymer backup bearings to protect the actuator in the event of main bearing failure. Wheel pans and restraints keep the vehicle safe, while minimizing extraneous side loads through the tires.

Shore Western can help you with your **facility design** too. Simulators can be placed **below floor level to provide drive-on-drive-off convenience.** They may include an **inspection pit**, and they may be housed in a **full environmental chamber** to reproduce temperature and sun load extremes.

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Bio Medical

Shore Western Manufacturing provides test equipment to labs who are helping with the advancement of modern bionics that bring mobility back to individuals who have lost limbs, or have impeded use of their joints. **Biomedical systems are able to replicate the kinematics and kinetics of human joints and limbs** for testing synthetic replacements.





Using the direction of medical device manufacturers and orthopedic academics, our systems were developed to closely simulate the complexities of the human anatomy.

Shore Western Manufacturing builds **systems to test hips, knees, feet, and the complex multiple degrees of freedom spine**.

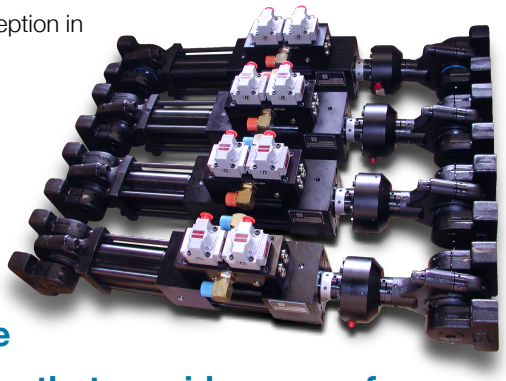


Our Real Time Active Control (RTAC) algorithm is adept at **reproducing highly non-linear forces.** For example, the force in a walking foot is controlled and adjusted in real time via the angle of the lower platen and the vertical actuator position. A capability not shared by our competitors.

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Test Pro Components

Shore Western has been manufacturing hydraulic components since its inception in 1971. You can take advantage of our experience by purchasing these components to build your own test systems.





Over the years, we have perfected the bearing, coating, machining and grinding practices to produce durable, low maintenance, fatigue rated hydromechanical assemblies that provide years of trouble-free operation.

Our innovative designs such as easily **replacement actuator seals and bearings** provide solutions with low operating costs and high uptime.

Our industry-leading multi-station controller with RTAC compensation can be customized to meet your unique testing requirements. **The user interface can be created for simple push-button operation of standard test protocols, then locked to prevent unwanted changes**.

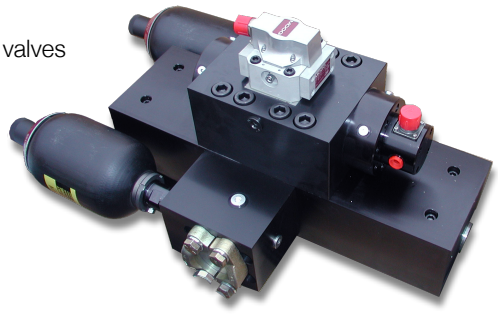


Our Hydraulic Service Manifolds can be built for any flow requirement, and they include **smooth pressure ramping, filtration, accumulation and pilot circuits**.

The Shore Western Whisper-Pack Hydraulic Power Supply is built to the highest standards, with **noise levels below 70dBA under full compensation.** All our pumps use **kidney-loop cooling and filtration for stable temperatures and clean oil under all flow conditions**.

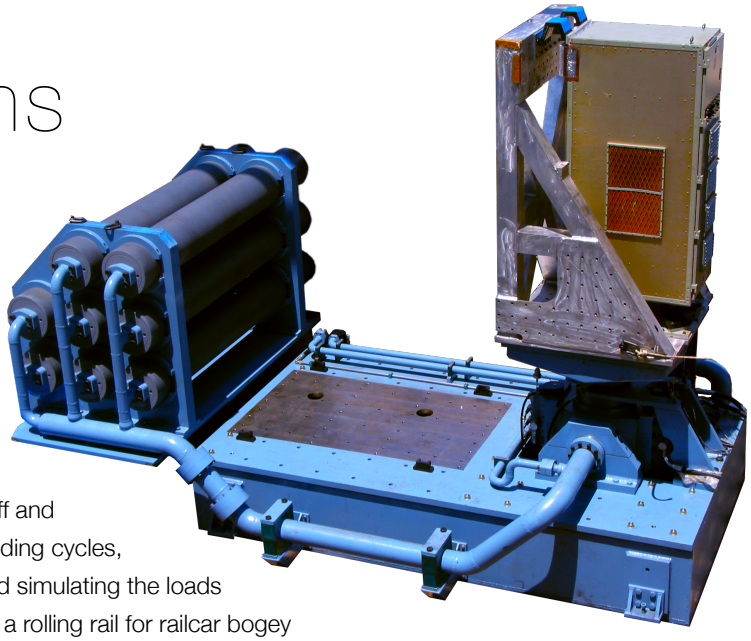


The Shore Western three stage servo valves are manufactured using a **proprietary technique that results in extremely high accuracy** through the critical switching region.



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Custom Systems



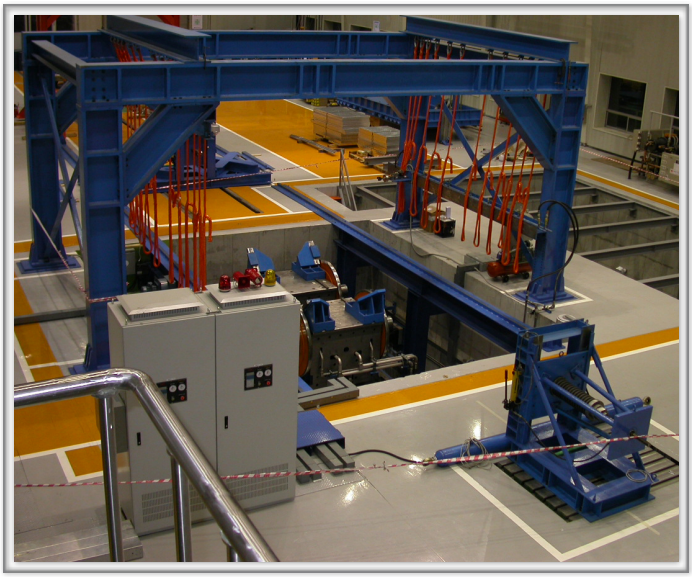
The innovation at Shore Western becomes most evident in our engineered custom solutions.

Pictured are some examples of more complex Shore Western systems: replicating bomb-blasts on shipboard electronics cabinets, testing the hub and shaft of a heavy-lift seven bladed helicopter during take-off and landing cycles, and simulating the loads on a rolling rail for railcar bogey development. **Each system presented unique technical challenges we were forced to tackle.**



The transient blast of a subsea charge creates a very high velocity event. For this system, we developed a special servo valve, and high flow hydraulic swivels to allow the actuator to pivot for both horizontal and vertical orientations.

The helicopter hub and shaft system demanded very high loads in a compact space. For this we designed 260mm hydrostatic balls capable of reacting 1200kN of force, and software that was able to stage a complex start-up and shutdown procedure, while controlling the load and angle state in hub coordinates.



Time and again, high profile companies choose Shore Western Manufacturing because they recognize our ability to solve their problems with innovative solutions.

We are ready to provide you with solutions to meet your specific needs. Whether they are as simple as a single actuator, or as complex as a multiple degree of freedom system, our team will value you as a customer and ensure that your unique needs are met.

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