KEISER POWERED™
EDUCATION | COACHING | TRAINING

ESSENTIALS

KEISER RESISTANCE TRAINING

KEISER ESSENTIALS OUTLINE

KEISER®
BECAUSE... 'GOOD ENOUGH' ISN'T.™

1 INTRODUCTION
- What is Resistance Training?
- The Status Quo
- What Is Keiser's Pneumatic Technology?

2 THE KEISER RESISTANCE TRAINING PLATFORM
- The Three Keiser Resistance Training Platforms
- Dynamic Variable Resistance – Why Is It Important?
- Types of Resistance Curves

3 ANATOMY OF THE MACHINE
- The Heart – Keiser Air Compressor
- The Arteries – Keiser Air Supply System
- The Muscles – Keiser Pneumatic Cylinders
- Keiser Resistance Controls
- The Tendons – Keiser Linkage System
- The Skeleton – Keiser Unit Frame
- The Brain – Keiser Pneumatic Processor
- The Eyes – Keiser Display
- Keiser Chip System and Integrated Technology
- The Keiser System

4 WHY DOES THE TYPE OF RESISTANCE MATTER?
- The Role of Inertia
- A Kilogram Is Not Always a Kilogram
- The Force and Muscle Activation Killer – Momentum
- Collateral Damage to the Human Body

5 KEISER TESTING PROTOCOLS
- Strength Protocol and Procedures
- Power Protocol and Procedures
- Speed Protocol and Procedures

6 THE FIVE TRAINABLE QUALITIES
- The Five Qualities
- Training Themes

7 HUMAN BODY SYSTEMS AND ADAPTATION
- Muscular System
- Nervous System
- Skeletal System
- Energy Systems

8 THE RESEARCH BEHIND KEISER PNEUMATICS
- Acute Adaptation Comparisons
- Chronic Adaptation Comparisons
- Discussion

9 MARKET APPLICATIONS
- Health Clubs
- Sports Performance
- Medical/Rehabilitation
- Older Adult
- Government
- Hospitality

10 SUMMARY OF ADVANTAGES
- Versatility
- Usability
- Safety and Education
- Testing Capabilities

11 COMMONLY ASKED QUESTIONS

INTRODUCTION

What Is Resistance Training?

Consisting of movements that cause muscles to contract against an external resistance, resistance training is a category of exercise designed to promote muscular performance. The benefits of resistance training include increases in muscular force, power, speed, size, and endurance. Changes to these qualities are all dependent on the type of resistance utilized.

The Status Quo

Traditionally, most resistance training protocols have used mass (including barbells, dumbbells, and weight stack machines) as the primary method to create resistance. Mass can be an efficient form of resistance when primarily used to train for improvements in maximum force production (strength) and muscular size (hypertrophy). This is a result of the movement velocity being relatively slow. It is no coincidence that resistance training is often called “strength training”, as speed and power cannot be trained as efficiently. It is the inertia involved with mass-based resistance training that is the enemy of speed. Utilizing mass for speed or power improvements is simply an inefficient medium, and we have the science to prove it.

What Is Keiser’s Pneumatic Technology?

Pneumatics simply deals with the mechanical properties of compressed gases or air. In the case of the Keiser Resistance Training Platform, compressed air is used to create a pure form of resistance. We refer to the resistance created by compressed air as “pure” because Newton’s Laws of Motion do not govern the resistance, as is the case with a mass-based resistance. In simplistic terms, “pure” simply refers to the fact that 10 kilograms of resistance created by pneumatics is always 10 kilograms, regardless of the velocity of movement. In contrast, 10 kilograms of mass-based resistance varies depending on the velocity of movement as acceleration and deceleration of the weight have different effects on actual resistance. Pneumatics can be described as a low mass - low inertia form of resistance, and its impact on power and speed is far greater than mass.

THE KEISER RESISTANCE TRAINING PLATFORM

The Keiser Resistance Training Platform consists of three lines of equipment (Strength Machines, Racks, and The Infinity Series) designed to maximize performance in a safer and more efficient manner for all ages and fitness levels. From professional athletes to older adults and everyone in between, Keiser has a solution for EVERY BODY. In addition to Keiser's Pneumatic Technology, each piece of equipment is specifically designed with Keiser's Dynamic Variable Resistance.

The Three Keiser Resistance Training Platforms

- **Strength Machines**
  The Keiser line of strength machines utilizes both Keiser's Pneumatic Technology and Keiser's Dynamic Variable Resistance Force Curves. The Keiser Platform includes 13 lower body units, 2 core units, and 10 upper body units. The line consists of both compound and isolation exercises that ensure a solution for every application. Examples include the Keiser A300 Squat Machine and the A350 Biaxial Chest Press Machine.

Keiser A300 Squat Machine

Keiser A350 Biaxial Chest Press Machine

- **Infinity Series**
  Train real-world movements at real-world speeds. From professional athletes to the elderly, Keiser's Infinity Series is the most efficient way to develop functional, real-world power — on any plane, and at any speed. Whatever motion you want to train — throwing a ball, swinging a golf club, or just performing the activities of daily living — Keiser's Infinity Series lets you train the neuromuscular system at the speed of life. Infinity Series utilizes a flat resistance curve that provides a consistent resistance throughout the range of motion for all pushing, pulling, and rotational exercises. The Infinity line consists of the Functional Trainer, Triple Trainer, Six Pack, and Performance Trainer.

Functional Trainer

Triple Trainer

Six Pack

Performance Trainer

- **Racks**

Walk into any performance center in the world and usually the first things you see are racks. Racks dominate floor space in performance centers simply because of the number of compound and isolation exercises that can be performed in a small space. Unfortunately, research says that mass is a very poor form of resistance for training power and speed. By using a Keiser Rack with air, you receive the benefits of a traditional rack using iron as well as the ability to maximize your power and speed training using air.

Keiser's Flat Resistance Curve allows you to execute both pulling and pushing movements with Keiser's Pneumatic Technology. You can train at any speed, from controlled to explosive, developing power and stability. No matter what exercise you perform (push/pull/chop/rotation), you will have a reliable, constant, and consistent load. As seen below, Keiser offers 4 models of Racks with air and 3 non-air options. See our catalog for a vast array of accessories and options.

Half Rack Long Base

Rack and a Half

Half Rack Short Base

Power Rack

Rack without Air

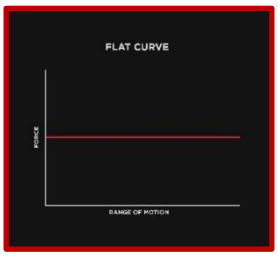
Dynamic Variable Resistance – Why Is It Important?

Dynamic Variable Resistance is the key to safer and more efficient resistance training. It is based on anatomical science in which your ability to produce force varies throughout a range of motion. At certain points throughout a range of motion, you are stronger or weaker due to a mechanical lever advantage or disadvantage. Ideally, you want the neuromuscular system to work at its maximum potential throughout every point in the range of motion. To accomplish this, we apply more resistance where you are mechanically stronger and less resistance where you are mechanically weaker (or where your joints and connective tissue are most vulnerable to injury). Dynamic Variable Resistance has often been used to describe an accommodating resistance such as bands and chains incorporated with mass-based resistances. However, it is only with Keiser's ability to train at any speed that the word dynamic gets to live up to its true meaning. As shown in our Warrior demonstration, variable resistance curves utilizing mass only hold up doing repetitions equal to or slower than 4 seconds. Keiser's Pneumatic Technology and Keiser's Dynamic Variable Resistance aid in the improvement of the following:

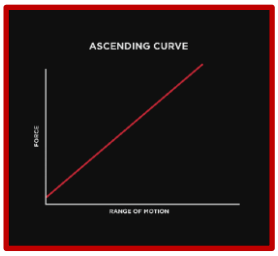
- **Maximum Strength**
- **Maximum Power**
- **Maximum Speed**
- **Muscular Endurance**
- **Muscular Hypertrophy**

Types of Resistance Curves

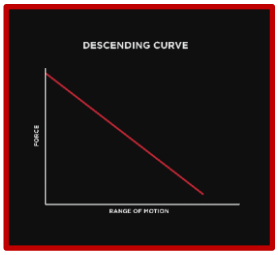
- **Flat Resistance Curve**
  Flat resistance allows for the same resistance throughout the entire range of motion where both pulling and pushing movements are executed. A flat resistance curve on a pneumatic platform provides the same force regardless of velocity. (Examples: Racks, Infinity Series, and the A250 Standing Hip)



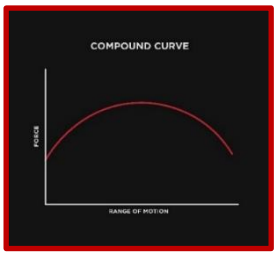
- **Ascending Variable Resistance Curve**
  Ascending variable resistance allows for greater resistance at the end of a pushing movement. During a pushing movement, the mechanical lever advantage increases throughout the concentric range of motion. Executing a pushing movement without an ascending resistance curve disproportionately challenges the neuromuscular system at the beginning of the concentric phase (where you are at your mechanically weakest and most vulnerable position). As the mechanical lever advantage increases, the neuromuscular system is not challenged to same degree that it initially was. The utilization of Keiser's Ascending Force Curve further guarantees that muscle activation can be maximized at all points throughout a range of motion at any speed. (Examples: A350 Biaxial Chest Press, A300 Leg Press, and the A300 Squat)



- **Descending Variable Resistance Curve**
  Descending variable resistance allows for less resistance at the end of a pulling movement. During a pulling movement, the mechanical lever advantage decreases throughout the concentric range of motion. Executing a pulling movement without a descending resistance curve disproportionately challenges the neuromuscular system at the end of the concentric phase (again, where you are at your mechanically weakest position). The utilization of Keiser's Descending Force Curve further guarantees that muscle activation can be maximized throughout the entire range of motion at any speed. (Examples: A350 Biaxial Upper Back and the A250 Lat Pulldown)



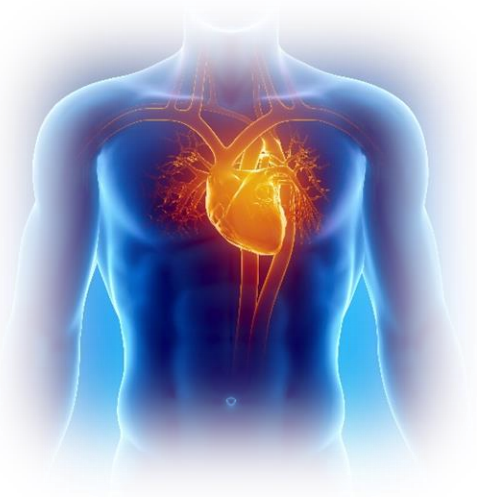
- **Compound Resistance Curve**
  Compound resistance allows for greater resistance in the middle of a movement on uniaxial, single-joint exercises. The curve goes from light to heavy and back to light. In essence, it is a combination of an ascending and descending curve. (Examples: A300 Leg Extension, A300 Leg Curl, and the A250 Arm Curl)



THE ANATOMY OF THE EQUIPMENT

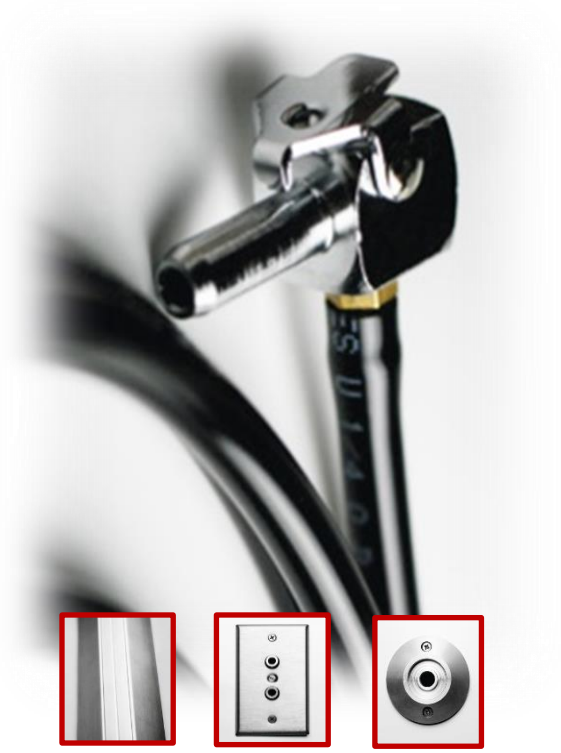
The Heart - Keiser Air Compressor

Effectively the “heart” of the Keiser System, the Keiser Air Compressor works similarly to the air compressor that you may currently have in your garage or workshop. It converts electrical power into potential energy in the form of compressed air stored within a storage tank. When needed, this potential energy (compressed air) can then be utilized to create a resistive force on all Keiser Resistance Equipment. This concept is easily demonstrated by blowing air into a balloon. The balloon represents the storage tank and the act of blowing air into the balloon represents the compressor forcing air into the tank. The Keiser Compressor is specifically designed to be utilized with the Keiser Platform, offering two distinct sizes of compressors to meet your needs.



The Small Compressor is designed for placement in the exercise area without being conspicuous to your customers. It features a dryer unit that supplies clean, dry air for up to as many as 8 Keiser machines.

Designed to work behind the scenes away from the exercise area and engineered for durability, the Large Compressor features a dryer unit that supplies clean, dry air for up to as many as 18 Keiser machines.



The Arteries - Keiser Air Supply System

Very similar to the way your arteries distribute freshly oxygenated blood throughout your body, the Keiser Air Supply System distributes the compressed air that is stored in the compressor tank to the individual pieces of the Keiser Resistance Equipment.

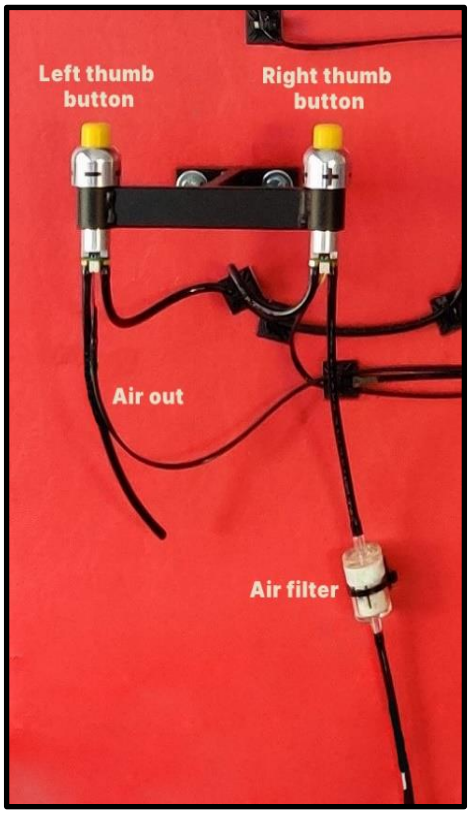
Keiser is a leader in the commercial market and its air system is no different. We design our products to meet the commercial demands of professional sports teams, medical facilities, and military installations. Whether you are a corporate partner, boutique owner, or home user, you can be assured our tubing system will perform the way it was designed to. Chemical resistant, flexible, and durable polyethylene tubing easily attaches to the air system outlets on the Keiser Air Compressor and the Keiser Resistance Machines. The quick attach connectors reduce installation and maintenance time.

At Keiser, we understand it cannot only be about performance, but that aesthetics and safety also play a critical role in facility design and appeal. Additional hardware includes aluminum trim, wall mounts, and sub-floor outlets in order to discreetly and safely hide system tubing. Please contact your Keiser representative for a custom install.

The Muscles - Keiser Pneumatic Cylinders

The Keiser Pneumatic Cylinders are the “muscular system” of the Keiser Platform. Just as muscles contract and lengthen to create work, the Keiser Pneumatic Cylinders utilize the mechanical properties of compressed air to create a pure form of resistance. The resistance created utilizing compressed air minimizes the effect of inertia. Inertia is the enemy of speed, highlighting the big disadvantage of traditional, mass-based resistance where iron cannot be moved at high speeds.

The piston and linkage system are used to transfer the potential energy within compressed air into kinetic energy that provides resistance throughout a range of motion. The increase in air pressure increases the force produced by the cylinder which, when combined with the mechanical linkage in the system, creates the variable resistance force curve exactly as the human body varies its forces. The contractile effort of the muscle changes as it shortens, and the muscular leverage changes as the joint passes through its range of movement. Additionally, the increase in pressure stores the energy that you expend on your positive stroke to deliver it back to you on a negative or eccentric contraction (unlike a hydraulic machine, which cannot produce a negative or eccentric contraction).



In order to control the compressed air in the Keiser Pneumatic Cylinders, an accumulator tank is necessary to maintain the pressure fluctuation created with piston movement. As the piston travels through the cylinder during the concentric phase, air is compressed in the accumulator tank and cylinder. Air diverts to the accumulator tank to control the associated increase in pressure. Likewise, as the piston returns to the bottom of the stroke during the eccentric phase when there is a reduction in air pressure, air diverts back into the cylinder to control the associated decrease in pressure. The accumulator tank is necessary as it allows for an eccentric load, which is the one of the major benefits of pneumatics over hydraulics.

Keiser Resistance Controls

Often referred to as the (+) and (–) thumb controls, the resistance controls regulate airflow into and out of the cylinder and accumulator. The air supply line from the compressor storage tank directly connects to the (+) thumb control valve on the machine. When the (+) thumb button is depressed, air flows from the storage tank to the cylinder and accumulator. Likewise, when the (-) is depressed, air flows from the cylinder and accumulator into the atmosphere. In simplistic terms, depressing the (+) buttons adds resistance and depressing the (-) button reduces resistance.

The Tendons - Keiser Linkage System

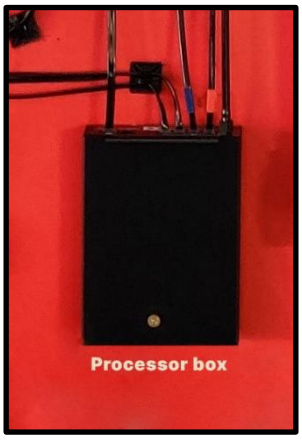
The Keiser Linkage System acts as the tendons of the Keiser Platform. Like the tendons connecting the muscles to bone in the human body, the linkage system connects the piston apparatus, Keiser's "muscular system", to the Keiser Unit Frame. Tendon connections and the Keiser Linkage System play a crucial role in the transfer of work through a lever system. The design and attachment placement of the linkage system cannot only transfer force but are also designed to control resistance curves. Components of the linkage system may include cables and pulleys that connect the Keiser Pneumatic Cylinder and associated piston to the articulating arms on the Keiser Unit Frame.

The Skeleton – Keiser Unit Frame

The Keiser Unit Frame and Articulating Arms are the skeleton of the Keiser Platform. The attachment point of the Articulating Arms to the unit function similar to how joints connect multiple bones. The Articulating Arms, when powered by the user, are essentially levers used to overcome the resistive forces created by compressed air. Along with the Keiser Linkage System, the design and attachment location of the articulating arms determine what type of force curve the machine utilizes. Each machine is designed with a specific force curve that increases efficiency while maximizing muscle activation. The Unit Frame is simply a structural apparatus. There are over 30 different resistance machines in the Keiser Platform.

The Brain - Keiser Pneumatic Processor

The Keiser Processor is the "digital brain" of the Keiser Platform. Just as the brain processes and disseminates information in the human body, the Keiser Processor does all of the "thinking" for the unit. This proprietary hardware has the ability to collect valuable information from the cylinder while instantaneously calculating and distributing all the necessary data points needed to run the machine.



Processor Hard Line Attachments	
Display	• Data is captured, calculated, and sent to the display
Keiser Resistance Controls	• The (+) and (-) button controls are linked via two independent inputs
Linear Potentiometer	• Piston positional information is captured and relayed to the processor
Pressure Gauge	• An air-line from the cylinder feeds directly into the processor box and air pressure is measured

The Eyes - Keiser Display

Considered the eyes of the Keiser Platform, the Keiser Computerized Display is standard on every piece of Keiser resistance equipment. The display passes along valuable information on the go and in real time. The display tracks:

- Resistance
- Sets
- Reps
- Peak Power
- % of Peak Power
- Adjustment Positions

Without Chip Inserted

Keiser Chip System and Integrated Technology

The Keiser Chip can serve as your electronic workout card. The chip stores and displays your previous workout resistance, sets, reps and adjustment positions. It easily inserts into the chip reader at the bottom of the display. With the use of the chip system, Keiser Integrated Technology allows you to download your workout to your phone, tablet, or computer. For a more complete explanation of the Keiser Chip System and Integrated Technology, please contact your Keiser representative.

The Keiser System

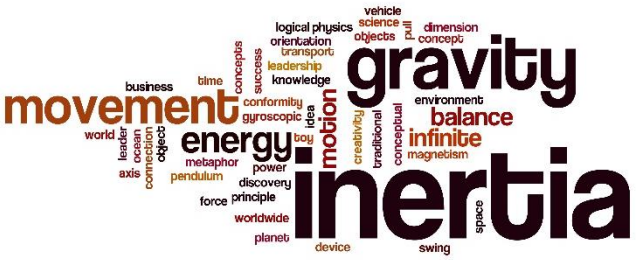
WHY DOES THE TYPE OF RESISTANCE MATTER?

> "All motion is governed by the laws of physics, independent of the exercise being performed or the exercise being used, however the degree to which the governance affects the associated kinetics, kinematics (force, power, velocity, acceleration, etc.) and muscle activity is dependent on the resistance type" — Dr. David Frost

In order to comprehend the mechanical differences between Keiser's Pneumatic Resistance and a mass-based resistance (free weights, weight stacks, the human body, etc.) we have to travel back to elementary science class and investigate some of the basic laws of physics. Each type of resistance has specific inherent qualities based on the mechanical laws of physics and it is these qualities that influence the specific adaptations expected from different types of resistance training.

The Role of Inertia

First, we must understand what inertia is and what challenges it presents to resistance training. Inertia is a property of matter outlined in Newton's First Law of Motion, otherwise known as the Law of Inertia. Inertia is simply the tendency of a body to resist movement unless acted upon by an unbalanced force.



Inertia is different from the gravitational force that pulls an object down to earth. The measure of the force created by gravitational pull on a mass is its weight. When we step on a scale or place an object on a scale, we are measuring the gravitational force created by an object in pounds or kilograms.

The effects of inertia can be observed by witnessing the resistance to movement of a large object suspended in the air. The act of suspending the object overcomes the gravitational force created by the earth's gravitational pull, subsequently reducing the weight of the object to zero. If you walked up to a suspended car and tried to push or pull it, the resistance to movement is attributed to the object's inertia. The more mass an object has, the higher its inertia and, subsequently, the harder it is to move. All mediums used to create force via mass are said to be high inertia and governed by Newton's First Law of Motion.

Keiser Pneumatic Resistance is said to be low inertia because only the piston and linkage system are governed by Newton's First Law. The resistive forces employed by Keiser's Pneumatics are generated by exploiting the potential energy of compressed air. A small 2 ½-inch diameter pneumatic cylinder can produce over 227 kilograms of force, but with less than 1 ½ kilograms of actual moving weight. It is only that 1 ½ kilograms that are subjected to Newton's Laws of Motion. This is the secret to the very pure, very consistent, and very controllable resistance of Keiser's Pneumatic Technology.

Mass-Based Resistances = High Inertia

Pneumatic-Based Resistances = Low Inertia

A Kilogram Is Not Always a Kilogram

Sir Isaac Newton proved that a kilogram is not always a kilogram. When looking at a gravitational resistance (whether in the form of a barbell, dumbbell, or a weight stack) one assumes it represents a particular weight. It does, but only when it is at rest or moving at a constant speed (no acceleration). Once in motion, the changes in speed of movement cause this weight to change. Sir Isaac Newton demonstrated this in his Second Law of Motion, The Law of Acceleration. This law states that the changing force is proportional to the mass or weight one is lifting multiplied by the acceleration (rate of change of speed). The faster you try to accelerate a mass, the more force is required to move the object. Everyone is familiar with this formula for Force:

Force = Mass x Acceleration

It can be much easier to comprehend this concept by utilizing this formula:

Force = Mass x Gravity + Mass x Acceleration

The “mass x gravity” segment represents the force created by the gravitational pull of the object to the earth, while the “mass x acceleration” segment represents the acceleration of the object. Regardless of the movement velocity, the “mass x gravity” stays constant, while any desired increase in acceleration will elicit a greater force that is proportional to the mass or weight lifted.

The Force and Muscle Activation Killer – Momentum

Momentum plays a critical role when discussing a gravitational-based resistance. Momentum is simply the product of mass and velocity.

Momentum = Mass x Velocity

You need to move to have momentum. If two objects are travelling with the same velocity, the object with the larger mass will have greater momentum.

Mass-Based Resistance = Great Momentum

Pneumatic Resistance = Trivial Momentum

When using a massed-based resistance, momentum builds as the object accelerates. A key concept to remember is that an object with momentum is harder to stop and an object with higher mass will be even harder to stop because of greater momentum. This is the reason that trains can take kilometers to come to a full stop. An additional consequence of momentum is its direct correlation to a reduction in force application and muscle activation.

Collateral Damage to the Human Body

Now that we know a kilogram is not always a kilogram, we need to investigate how this phenomenon affects the human body. For this, we go right back to Sir Isaac Newton. Newton’s Third Law of Motion, The Law of Reaction, states that for every action there is an equal and opposite reaction. More specifically, in every interaction, the magnitude of the forces on the first object equals the magnitude of the forces on the second object. Additionally, the direction of the force on the first object is opposite to the direction of the force on the second object. Regardless of the numerical weight associated with a resistance, the shock loads that are placed on the human body are the actual forces generated to overcome the impeding resistance.

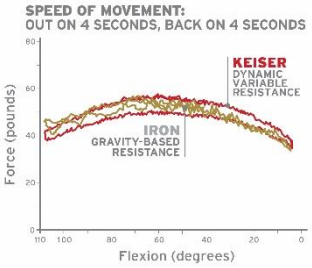
When you initiate a movement using Keiser Pneumatics you are only loaded with the forces associated with the numeric resistance. When you initiate a movement with a mass-based resistance you are shock-loaded with both the numerical forces associated with the object and the additional inertial forces needed to accelerate the load. The initiation of the majority of movements happen during the transition from the eccentric to concentric phases where our joints and soft tissue are most susceptible to injury. This notion is magnified in certain exercises like the back squat, where you have shock forces in addition to shearing forces placed on the knee joint.

Let us now look at an actual demonstration to compare the different inherent qualities of a mass-based and pneumatic-based resistance.

THE FOLLOWING GRAPHS DEPICT DATA FROM AN ACTUAL DEMONSTRATION

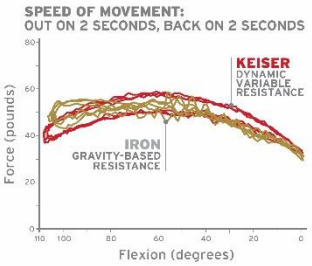
To illustrate the difference between a mass-based resistance and a pneumatic resistance, a special machine was built with two independent exercise arms contacting the user's lower legs. One connected to a weight stack while the other to Keiser's Pneumatics. The machine was designed so that the two systems provide the same variable resistance curve utilizing a four second concentric phase and a four second eccentric phase. Force sensors, attached to each pad in contact with the user's legs, provide data to a computer. The computer then graphs the exact force being applied to the legs by each system as the user extends his or her legs throughout the range of motion.

FIGURE 1



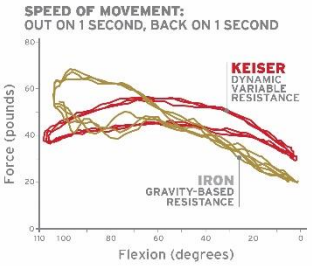
This graph shows a four second concentric phase and four second eccentric phase. The gold line shows the force the weight stack is producing and the red line shows the force the pneumatic cylinder is producing. At this speed, the two resistances are producing almost identical forces due to almost no acceleration. Using the Force = Mass x Gravity and Mass x Acceleration formula for the mass-based resistance, the force curve is very similar due to acceleration being virtually zero at a four second rep. The variable resistance curve also holds true for both systems.

FIGURE 2



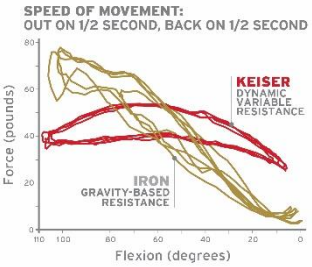
The graph depicts what begins to happen as the training speed is increased to a two second concentric phase and two second eccentric phase. There is a slight increase in force for the weight stack at the beginning to get the weight moving, and a slight drop off towards full extension as the momentum tends to carry the weight. The Keiser forces do not appear to change. The systems seem very similar at this speed. This increase in force at the beginning of the concentric phase is related to the increase in acceleration needed to complete a two second rep. The variable resistance curve holds true for both resistances, although the mass-based resistance is slightly deformed.

FIGURE 3



This graph shows a more dramatic change when the training speeds are increased to a one second concentric phase and one second eccentric phase. Note the 70% increase in resistance with the weight stack during the beginning of the exercise, by just going one second faster. Unfortunately, these high spikes in resistance most often come at a point in the range of motion that can result in the greatest harm to joints and connective tissue. As the reps get faster, more force is needed to accelerate the mass. The variable resistance force curve completely breaks down with a one second repetition.

FIGURE 4



As you can see in this graph, the mass-based resistance significantly spikes when the speed is increased to a half second concentric phase and half second eccentric phase. This velocity results in a near doubling of force at the beginning of the concentric phase and near zero resistance at full extension. This data highlights Newton's Laws of Motion. As the leg begins to extend in the first part of the stroke, more force is required to accelerate the weight stack to the desired speed. Momentum then takes over and in the last half of the positive stroke the resistance drops as the weight stack slows to a stop. As the leg nears the starting position, a greater force must be exerted to slow or decelerate the weight to a stop. The faster the speed of movement, the greater the acceleration and force. Throughout these changes in training speed, you can see the resistance provided by Keiser's Pneumatic Technology remains consistent, opening up an array of training options not possible with traditional, mass-based resistances. In short, Keiser is very hard on muscle and very easy on joints and connective tissue.

KEISER TESTING PROTOCOLS AND PROCEDURES

Testing is an essential part of the evaluation process as it helps establish a physical baseline and allows for analysis of progress (adaptations) under a particular training plan. A physical baseline consists of measurable variables that are collected through a testing process, including speed, power, and force capabilities. This information becomes valuable when prescribing a training plan to meet a participant's goals. Future testing can then be used to evaluate the physical adaptations that occur after completion of a training plan. Special care must be taken to ensure that these testing procedures are reliable and duplicable. A well designed warm up should always be implemented before any physical activity.

In this section, we will discuss simple testing protocols for 3 of the 5 main trainable qualities.

- **Strength**
- **Power**
- **Speed**

Strength Protocols and Procedures

Strength is commonly used to describe many variables associated with human performance. In regards to this section, we will refer to strength as it relates to overcoming the maximum amount of force regardless of velocity (high force-low velocity). Strength protocols should be utilized if the objective is to test a participant's absolute or maximum force capacity. Special care should be taken to ensure proper technique when using these testing protocols. Regardless of the type of resistance used, the testing procedures require no specialized testing equipment. Below is a common protocol for determining a 1RM (one rep max), also referred to as a strength baseline. Once a strength baseline is established, any future increase in 1RM corresponds to increased maximum force capacity.

- **1RM REP TEST**

  The 1RM Rep Test calculates a 1RM by having the participant do as many reps as possible with a load between 85-92.5% of an estimated max. The corresponding load and reps achieved are inputted into a 1RM calculator to establish an estimated 1RM. From a risk-reward standpoint, some performance specialists may choose to utilize the 1RM Rep Test over the 1RM Max Test. This can be beneficial for less experienced participants.

1. Perform Keiser Warm Up.
2. Select a resistance that allows the performance of 3-6 reps (85-92.5% of estimated 1RM).
3. Perform exercise and record resistance used and the # of reps performed until failure.
4. Use formula below to calculate the projected 1RM.

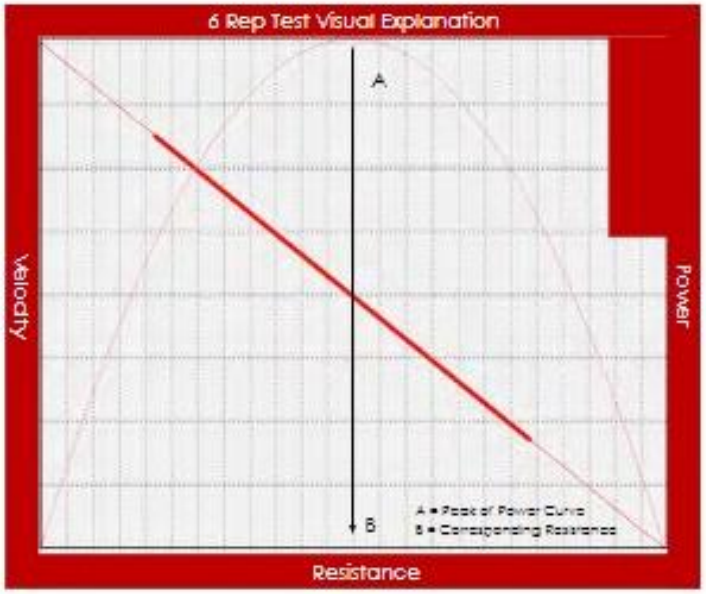
1 RM CALCULATOR
(Resistance) *x (.03) x* ***(# of reps Performed)*** *+* ***(Resistance)*** *=* ***Estimated 1RM***
(Example: 50kg was performed for 5 reps)
(50) *x (.03) x* ***(5) + (50) =*** ***57.5kg***

Power Protocol and Procedures

Power, which is moderate force at moderate velocity, is commonly described as strength at speed. As covered earlier, power, which is measured in watts (W), can be equated as Power = Work / Time or Power = Force x Velocity. Most performance specialists regard power output as the most important measurable variable associated with exceptional human performance as increased anaerobic power capacity is positively correlated to increased athletic performance. Power becomes the most important variable when a participant needs to accelerate at the fastest possible speed, in the shortest possible time. All Keiser platforms (racks, single station strength machines, and cable trainers) have built-in protocols utilizing Keiser software technology to determine the resistance where max power is achieved and how many watts are generated at any resistance along the strength continuum. Once we know where max power occurs, we then need to determine how many watts can be generated on a specific exercise. Once a power baseline is established in watts, any increase in wattage, utilizing the initial Keiser Optimal Power Resistance (KOPR), corresponds to increased power production.

- **KEISER 6 REP TEST**

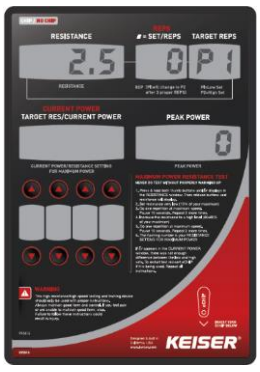
  The Keiser 6 Rep Test is utilized to determine the resistance at which max power is achieved (60% 1RM or 50% of absolute strength) on any given piece of equipment. This resistance is called the Keiser Optimal Power Resistance (KOPR).



1. Press and hold both thumb buttons until ‘6r’ displays in the RESISTANCE window. Then release buttons and resistance will display.

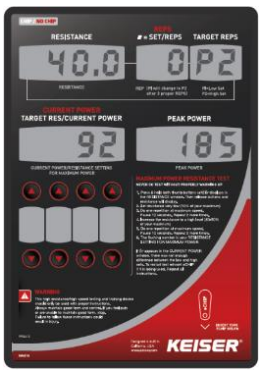
2. Set resistance low level (10% of your maximum).

3. Perform 1 repetition at maximum speed. Pause 10 seconds. Repeat twice.
   (Note: During this phase, ‘P1’ must be displayed in the Target Reps display.)



4. Increase the resistance to a high level (80-90% of your maximum).

5. Perform 1 repetition at maximum speed. Pause 10 seconds. Repeat twice. (Note: During this phase, ‘P2’ must be displayed in the Target Reps display.)



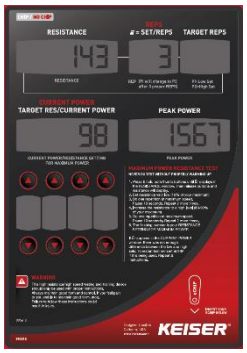
6. The flashing number in the current power window is your KOPR.

- **KEISER MAX POWER TEST (KMPT)**

Once we know the resistance where Max Power occurs, we then need to determine how many watts can be generated. The KMPT utilizes the KOPR to measure the maximum number of watts generated for a given exercise. The number of watts generated creates a max power baseline that can be used to measure power development over time. Simply retake the test at the conclusion of a training regimen utilizing the same resistance and compare the results. Once a baseline is established, any increase in wattage corresponds to an increase in power production. Any increase in power production is contributed to an increase in velocity (Power = Force x Velocity).

1. Perform Keiser Warm Up.
2. Using the participant's KOPR, perform 1 set of 3 to 5 reps and record the highest watts achieved in that set. (Note: If the power output drops below 90% before completion of 5 repetitions, terminate the set and proceed to step #3.)
3. Rest 3 minutes and perform the second set. Record the wattage. (Note: If the power output drops below 90% before completion of 5 repetitions, terminate the set and proceed to step #4.)
4. Rest 3 minutes and perform the last set of 3-5 reps. Record the wattage. (Note: If the power output drops below 90% before completion of 5 repetitions, terminate the set.)
5. The highest amount of watts achieved during the 3 sets is the Keiser Max Power (KMP) for a given exercise and will serve as the Max Power Baseline.

*Test can be performed unilaterally and bilaterally to determine deficiencies



Shows current resistance setting, which can be adjusted up or down with the yellow buttons on the handles.

Shows the current power percentage, based on the peak power/wattage.

Shows the number of reps performed.

Shows your peak power/wattage.

Speed Protocol and Procedures

Speed, as it pertains to resistance training, corresponds to low force production at high velocities. Speed training has been correlated to elastic and reactive capabilities. Speed capacity is also positively correlated to increased limb speed. Speed becomes the most important variable when a participant needs to move in a very quick reactive manner (i.e. movements that are performed by a goalie). Low inertia forms of resistance, such as pneumatics, are the preferred method for training speed. Free weight movements can be used to train speed, although they must be performed in a ballistic manner to accommodate for momentum. When utilizing free weights, external devices and software must be implemented to determine speed output matrices. Additionally, weight stack machines are typically not viewed as a safe or effective modality to train or test speed capacity. In this section, we will cover the Keiser speed testing protocol and procedures.

- **KEISER MAX SPEED TEST (KMST)**

The KMST utilizes 50% of a participant's KOPR (around 30% 1 RM) to measure the maximum number of watts generated for a given exercise. The number of watts generated can be used to measure speed development over time. At the conclusion of a training regimen, simply retake the test utilizing the same resistance and compare the results. Once a baseline is established, any increase in wattage corresponds to an increase in speed production and vice versa.

1. Perform Keiser Warm Up.
2. Using 50% of the participant's KOPR, perform 1 set of 3 to 5 reps and record the highest watts. (Note: If the power output drops below 90% before completion of 5 repetitions, terminate the set and proceed to step #3.)
3. Rest 3 minutes and perform the second set. Record the wattage. (Note: If the power output drops below 90% before completion of 5 repetitions, terminate the set and proceed to step #4.)
4. Rest 3 minutes and perform the last set of 3-5 reps. Record the wattage. (Note: If the power output drops below 90% before completion of 5 repetitions, terminate the set.)
5. The highest amount of watts achieved during the 3 sets will be the Speed Baseline.

TRAINABLE QUALITIES

The Five Qualities

To understand trainable qualities, we must first understand the concept of adaptation. Adaptation refers to the body's ability to respond to an increase or decrease in physical demands, commonly referred to as a stimulus. In the case of resistance training, the implementation of physical activity is considered the stimulus, while the trainable qualities are the specific traits that the program intends to improve. The success of any exercise routine is dependent on targeting the qualities intended for improvement by implementing training themes designed to improve the desired adaptation response. Listed below are 5 major training qualities that are used as the foundation of resistance training:

- **Strength**
  Strength is the ability to produce large forces at relatively low velocities. An improvement in strength would correspond with the ability to generate greater forces to improve a participant's one repetition max.

- **Power**
  Power is the ability to produce force at speed. Power is proportional to the speed at which the force is applied. An improvement in power would correspond with the ability to generate larger wattage outputs and will lead to an improvement in max power for a given exercise. Power is highly regarded as the most important measurable matrix in human performance.

- **Speed**
  Speed is the ability to produce force at relatively high velocities. Speed, in resistance training, is the ability to generate velocity through a given movement. An improvement in speed will correspond with an increase in limb velocity.

- **Muscular Endurance**
  Muscular endurance is the ability to produce work over an extended period. An improvement in endurance will correspond with the ability to increase the number of repetitions that can be performed with a given resistance.

- **Muscular Hypertrophy**
  Hypertrophy is the enlargement of muscle tissue. An increase in muscular hypertrophy will correspond with the enlargement of the cross-sectional area of a muscle or multiple muscle groups.

Training Themes

Now that we have identified the 5 major training qualities, let's look at the training theme guidelines that should be implemented to elicit a positive adaptation to the outlined qualities. One theme is listed for each quality although multiple themes for each quality exist and can be found in the Keiser Resistance Training Foundations Course.

- **Strength (High Force, Low Velocity)**
  Max Strength Development is a theme used to develop high forces at relatively low velocities. An improvement in Max Strength would correspond to an increase in a 1 repetition max.

  - » Reps: 1-5
  - » Working Sets: 4-10
  - » Load: 80-100% 1 RM
  - » Recommended Tempo: Concentric – As fast as possible
    Eccentric – 1 second
  - » Recovery: >3 minutes

- **Power (Moderate Force / Moderate Velocity)**
  Max Power is a theme used to develop power at the resistance that creates the greatest wattage output within a given exercise. It should be noted that any set should be terminated if power output drops below 90% on two consecutive repetitions.

  - » Reps: 3-6
  - » Working Sets: 3-9
  - » Load: Keiser Optimal Power Resistance (KOPR)
  - » Recommended Tempo: Concentric – As fast as possible Eccentric – 1 second
  - » Recovery: >2 minutes

- **Speed (Low Force / High Velocity)**
  Max Speed is a theme designed to increase limb speed at low forces. Incorporating ballistic movements can enhance this theme. Ballistic movements target elastic and reactive capabilities. Any set should be terminated if power output drops below 90% on two consecutive repetitions.

  - » Reps: 5-12
  - » Working Sets: 3-9
  - » Load: 33-66% of the Keiser Optimal Power Resistance (KOPR)
  - » Recommended Tempo: Concentric – As fast as possible Eccentric – 1 second
  - » Recovery: >2 minutes

- **Muscular Endurance**
  General Strength Endurance is a theme designed to enhance general muscular endurance. An increase in muscular endurance would correspond to increased muscular work capacity. This theme is often modified into circuit form.

  - » Reps: 12-20 or 20-40 sec for as many reps as possible (AMRAP)
  - » Working Sets: 2-4
  - » Load: 50-70% of 1 rep max
  - » Recommended Tempo: Concentric – 1 second Eccentric – 2 seconds
  - » Recovery: 45-90 seconds

- **Muscular Hypertrophy**
  Hypertrophy is a theme designed to increase the cross-sectional area of a muscle. It is believed that the cross-sectional area of a muscle can be correlated to force capacities.

  - » Reps: 6-12
  - » Working Sets: 2-6
  - » Load: 60-85% of a 1 RM
  - » Recommended Tempo: Concentric – 1 second Eccentric – 3 seconds (Note: Variations acceptable to increase time under tension)
  - » Recovery: 1-2 minutes

Note: Other themes, such as Eccentric Overload, Strength Speed, Speed Strength, Max Strength Preparation, and Max Strength Complimentary, are covered in the Keiser Resistance Training Foundations Course.

HUMAN BODY SYSTEMS AND ADAPTATION

Resistance training has been identified as a form of training where muscles contract against an opposing resistance. The intended outcome is an improvement in muscular performance. To fully understand the mechanisms related to muscular performance, we must investigate the primary body systems associated with human movement and the specific adaptations that can be elicited with the application of a targeted training regime. Adaptation is simply the physiological changes that occur to our body systems when a stress or stimulus is applied. Chronic adaptation refers to the ability of the body systems to adapt to prolonged (8 weeks or more) resistance training. For the purpose of this section, we will focus on relevant aspects of the Muscular, Nervous, Skeletal, and Energy Systems along with possible chronic adaptations associated with resistance training.

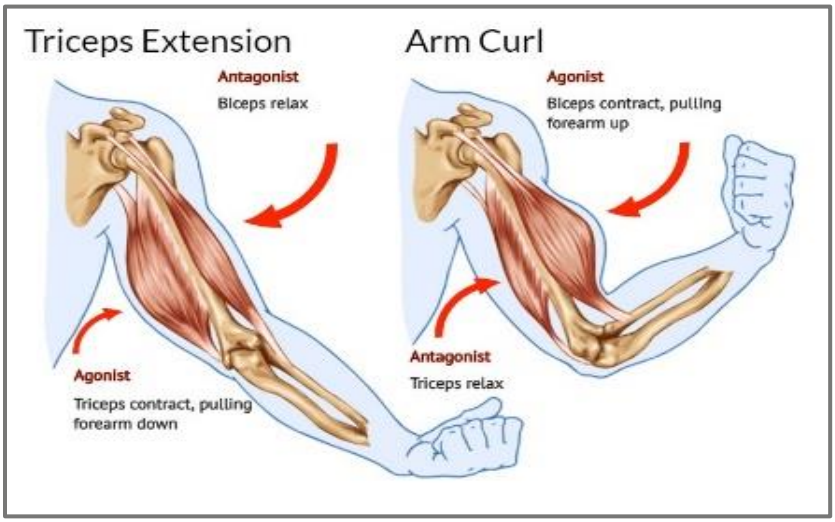
Muscular System

Muscles are essential to our movement, so it is imperative to understand what they are composed of, how they function, and how they adapt. The muscular system is comprised of more than 600 muscles of the human body and its accessory structures. It is further broken up into three types of muscle - skeletal, cardiac, and smooth muscles. For our purposes, we will be concentrating on skeletal muscle.

- **Function**

  One of the main functions of skeletal muscle is to generate movement by the lengthening and shortening of opposing muscles. A muscle that initiates movement (shortening) is referred to as an agonist. A muscle that is being stretched during movement (lengthening) is referred to as the antagonist. Additional functions of the skeletal system include:

  - **Posture**
  - **Stabilization**
  - **Heat production**



- **Types**

  Skeletal muscle fibers are classified as slow twitch or fast twitch depending on their metabolic and contractile characteristics. The proportion of these fiber types in skeletal muscle is largely determined by genetics.

  - **Slow Twitch Fibers**
    - Type I – Slow Twitch Oxidative (STO)
  - **Fast Twitch Fibers**
    - Type IIA – Fast Twitch Oxidative-Glycolytic (FOG)
    - Type IIB – Fast Twitch Glycolytic (FG)

CHARACTERISTICS	TYPE I (STO)	TYPE IIA (FOG)	TYPE IIB (FG)
Fiber Size (Diameter)	Small	Medium	Large
Speed of Contraction	Slow	Fast	Fast
Strength of Contraction	Low	High	High
Aerobic Capacity	High	Medium	Low
Anaerobic Capacity	Low	Medium	High
Resistance to Fatigue	High	Medium	Low
Predominant Energy System	Aerobic	Combination	Anaerobic

Chronic Adaptations

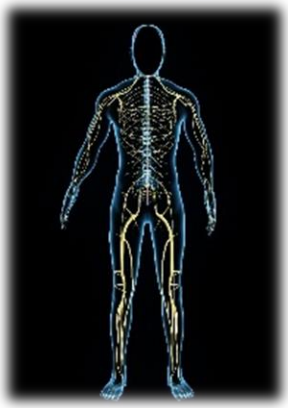
» **Hypertrophy** - The most significant adaptation observed through resistance training is an increase in the cross-sectional area (CSA) of a muscle. This increase in size is referred to as hypertrophy. Most research suggests that type II fast twitch fibers have superior growth potential in comparison to type I slow twitch fibers. These are the muscle fiber types that should be targeted for hypertrophy training.

» **Muscle Growth** - Researchers have identified three primary mechanisms that might stimulate muscle growth.

- Mechanical Tension – Mechanical tension is related to the force that stresses a muscle fiber to change length, width, or thickness. Muscular force is maximized close to or near 1RM.
- Metabolic Stress – Metabolic stress is the accumulation of metabolites (lactate, inorganic phosphates, and H+). It increases when utilizing the glycolytic system with loads under 80% 1RM.
- Muscle Damage – Muscle damage is increased under the following conditions:
  - Increasing volume
  - Increasing loads
  - Utilizing a constant load
  - Eccentric contraction
  - Utilizing larger ranges of motion

Nervous System

The nervous system consists of the brain, spinal cord, and all of the peripheral nerves of the human body. The neuromuscular system is the interaction between the nervous system and muscular function**.** Every movement made by the human body must be initiated by the nervous system. The nervous system can be broken down into two main parts:



- **Central Nervous System (CNS)**
  The central nervous system (CNS) consists of the brain and spinal cord. The major functions of the CNS are to collect, process, interpret, and respond to sensory input between the body and external environment.

- **Peripheral Nervous System (PNS)**
  The peripheral nervous system (PNS) consists of 12 pairs of cranial nerves, 31 pairs of spinal nerves, and includes all of the nerves outside the brain and spinal cord. The PNS has two pathways that function to carry messages from the body periphery and external environment back to the CNS.

Chronic Adaptations

A substantial amount of evidence supports the notion that resistance training leads to a number of neural adaptations, which promote an increased capacity to generate force, power, and velocity. These adaptations affect intramuscular and intermuscular coordination of trained movement patterns. An increase in force during the first 8 weeks of training can be contributed almost entirely to neural adaptations. The 3 most relevant adaptations of the nervous system that specifically target force production regardless of velocity are:

» **Coordination –** Ability of a muscle or group of muscles to synchronize themselves in a more efficient manner. These adaptations occur at loads between 40 and 100% in relation to a 1RM.

» **Motor Unit Recruitment (Activation) –** In order for a muscle to exhibit its maximum force and/or size capability, 100% of the motor units within a given muscle must be activated. In order to maximize motor unit activation, resistance training must occur utilizing high intensities, maximized at loads between 70-100% in relation to a 1RM.

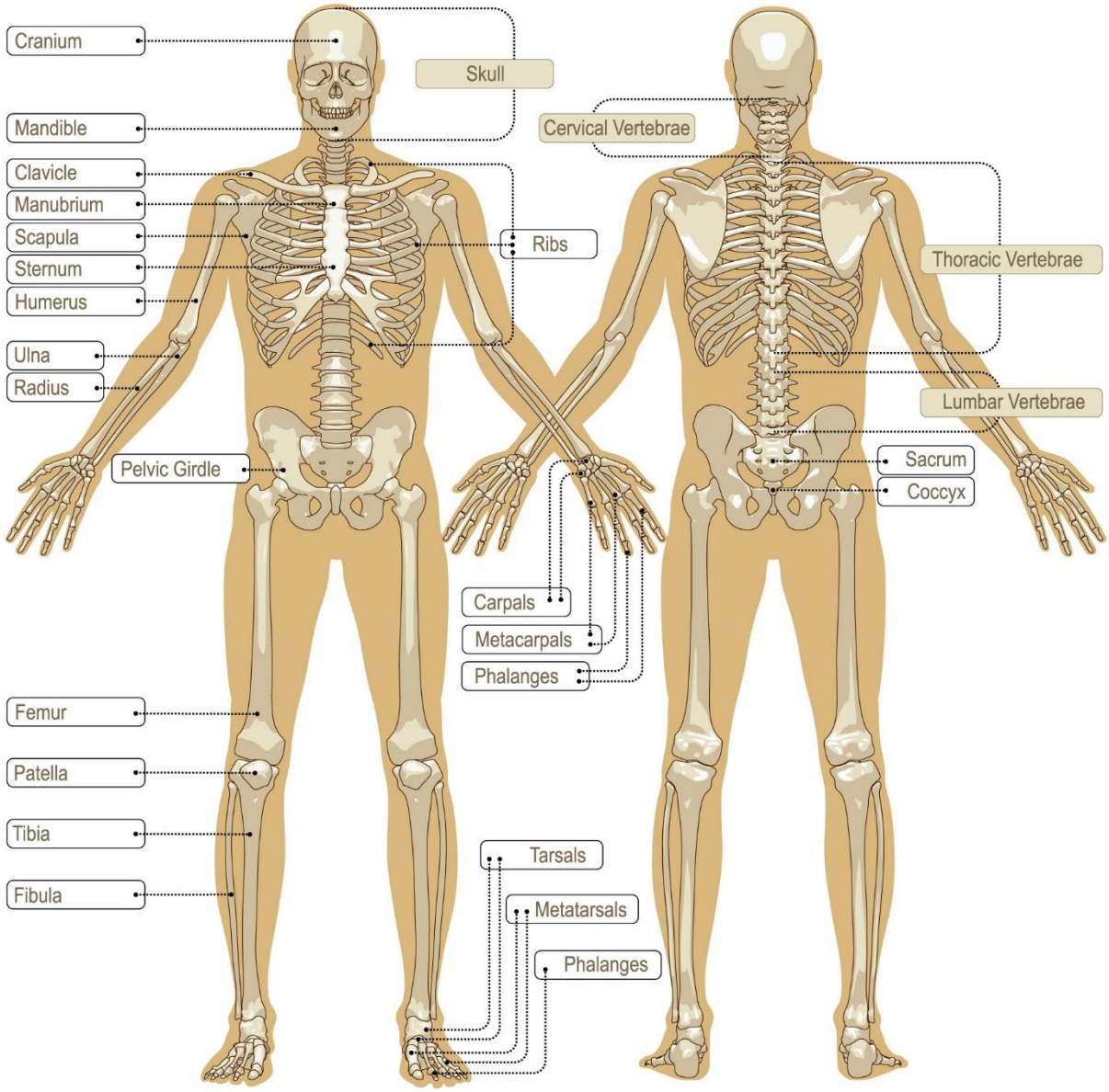
» **Rate Coding (Frequency) –** Rate coding is the ability of a neuron to increase its firing frequency. Speed and power related training activities seem to have a positive effect on rate coding capabilities. Adaptations to rate coding improvement seem to be maximized at loads between 40-60% and 85-100% in relation to a 1 RM.

Skeletal System

The skeletal system is composed of the more than 200 bones in the body along with its accessory structures. The skeletal system works in conjunction with the muscular system to form the Musculoskeletal System**,** which allows for human movement and plays a vital role in human performance. The musculoskeletal system contains the physical structure and levers that are moved in response to muscle fiber activation.

Chronic Adaptations

There has been overwhelming evidence over the last 30 years to support a positive correlation between the effects of resistance training and bone density. Bone Mineral Density (BMD) has been shown to increase after prolonged bouts (>12 months) of resistance training. These adaptations are linked to the increased force exerted on bones as participants gain strength through resistance training. Bones increase in size and strength to support the increases in force production, but only to the bones that are placed under an increased mechanical load. Current research suggests that the load must be greater than 70% of a 1RM for 2-3 times per week over consecutive months.



Energy System

Human movement and function require energy. Energy is also needed for thermoregulation and fueling all of the metabolic activities of the body. The transfer of chemical energy that we ingest (carbohydrates, protein, and fat) is broken down into usable energy that fuels our body systems. There are 3 main energy systems that provide valuable ATP. It is important to note that all 3 energy systems are working in some capacity, however the extent of participation in the process is dependent on the characteristics of the activity.

- **Phosphagen System** (Anaerobic Alactic System)
  The phosphagen system, also commonly known as the alactic energy system, fuels movements that typically last up to around 10 seconds and is intensity specific. Activities that are both high in intensity and short in duration, such as strength and power movements, typically use this system as the predominate energy source.

- **Glycolytic System** (Anaerobic Lactic System)
  The glycolytic system fuels movements that typically last from 30 seconds to 2 minutes in highly trained athletes. Circuit Training and HIIT use this energy system as its primary energy source.

- **Oxidative System** (Aerobic System)
  Aerobic metabolism has the ability to produce almost unlimited amounts of energy and is the main source of energy for activities that last more than 2 minutes. For this reason, the aerobic energy system is the primary system that fuels most endurance events such as jogging, hiking, and walking.

ENERGY SYSTEMS	PHOSPHAGEN SYSTEM	GLYCOLYTIC SYSTEM	OXIDATIVE SYSTEM
Metabolism Type	Anaerobic Metabolism	Anaerobic Metabolism	Aerobic Metabolism
Intensity Requirements	Very High	High	Low to Moderate
Duration	Very Short (up to 10 sec)	Short (up to 2 min)	Long Duration (over 2 min)
Lactic Acid Production	No	Yes	No
By-Products	Inorganic Phosphate (Pi) ADP	Lactic Acid Hydrogen Ions (H+) ADP	CO_2 H_20 Heat
Speed of Energy Productions	Instantaneous	Fast	Medium
Chemical Process	Simple	Longer	Complex

Chronic Adaptations

- **Creatine Kinase**
  Resistance training can increase the amount and activity of the enzyme Creatine Kinase, which facilitates the separation of Phosphate from Creatine Phosphate to phosphorylate ADP and form ATP.
- **Improved Alactic Energy System Function**
  Research suggests that with specific training of this energy system, its relatively brief energy contributions might be extended.
- **Neuromuscular Adaptations**
  Training of the neuromuscular system and the alactic energy system go hand and hand, and it is impossible to differentiate between the two. Training this energy system results in all of the speed, strength, and coordination gains expected with neuromuscular training.

THE RESEARCH

Recent peer reviewed studies (Frost 2008 and Frost 2012) have validated the "power" of pneumatics. Let's take a look at what we can learn from both acute and chronic adaptation comparisons between mass and pneumatics.

Acute Comparisons

Acute comparisons help us understand why two distinct resistances will exhibit diverse force, power, and velocity qualities while being utilized to perform the same movement with an equivalent load. Acute comparisons tell us what is happening in real time.

Frost's study, "*A comparison of the kinematics, kinetics, and muscle activity between pneumatic and free weight resistance",* is summarized below. All participants were tested to determine their 1RM (one rep max) on the bench press utilizing both free weights and pneumatics. Once a 1RM was determined, all participants completed sub-maximal testing utilizing both resistances at predetermined loads (15, 30, 45, 60, 75 and 90% of a 1RM). Data points were captured and the results were analyzed to compare various independent mechanical qualities. Results are listed below:

FREE WEIGHTS

- Greater Mean Force at every submaximal load except 15% 1RM
- Greater Peak Force at loads between 60-90% 1RM

- **KEISER PNEUMATICS**
  - Greater Peak Force at 15-45% 1RM
  - Greater Mean and Peak Velocity at every load
  - Greater Mean and Peak Power at every load
  - Greater Peak Acceleration at every load
  - Reduced deceleration phase at every load
  - Greater velocity contribution to power production at every load
  - Greater agonist and antagonist muscle activity at every load

Chronic Adaptation Comparisons

Chronic adaptation comparisons aid in identifying the expected changes to force, power, and velocity capabilities while utilizing a mass-based resistance versus a pneumatic resistance. Chronic adaptations help us understand what results we can expect from different forms of resistance.

These chronic adaptation comparisons serve as a synopsis of the force, power, and velocity differences observed in Frost's study, "*Changes in maximal strength, velocity, and power after 8 weeks of training with pneumatic or free weight resistance*". A group of 18 experienced, weight trained men were tested to determine their 1RM (absolute/maximal strength) and corresponding pre-determined sub maximal resistances (15, 30, 45, 60, 75, 90%) while performing a bench press movement. Force, velocity, and power were measured at all resistances on both free weights and the pneumatic-based Keiser rack. This group was then randomly divided into 2 groups and completed identical workouts. Group 1 utilized free weights only, while group 2 utilized pneumatics only. After eight weeks of periodized training were completed, participants were retested on both free weights and pneumatics to establish a new FW 1RM and retest at their original sub maximal loads.

- **FREE WEIGHTS – 1RM RESULTS**
  - » Increased FW 1 RM by 10.4%
- **FREE WEIGHTS – SUBMAXIMAL LOADS**
  - » **Force:** No increase of dynamic force at any resistance
  - » **Power:** The FW Trained Group may have a slight advantage at resistances above 60% 1RM (Note: This falls above optimal max power training zone)
  - » **Peak Velocity:** The FW Trained Group has an advantage at increasing joint velocity at loads greater than 60% 1RM (Note: This falls outside of optimal speed development zone)

- **KEISER PNEUMATICS – 1RM RESULTS**
  - » Increased their FW 1 RM by 11.6%
- **KEISER PNEUMATICS – SUBMAXIMAL LOADS**
  - » **Force:** Substantial increase of dynamic force at 15% and trivial increases between 30-60% 1RM
  - » **Power:** The PN Trained Group saw substantial improvements at max power and loads less than 60% 1RM
  - » **Peak Velocity:** The PN Trained Group has an advantage at increasing joint velocity at loads less than 60% 1RM

Discussion

The specific inherent qualities observed in the acute comparisons give understanding into what happens in real time. These results can also give insight to what unique adaptations may occur. However, long term adaptations can have differing outcomes compared to the acute results. For example, the FW trained group had higher mean force at almost every resistance on the strength continuum but was less efficient in increasing a 1RM FW Bench Press as compared to a PN trained group [10.4% FW, 11.6 % PN]. Selecting the correct resistances for each desired result can be imperative to the performance specialist. Also, consideration must be given to factors unrelated to kinetic and kinematic markers such as the following:

- Safety
- Inability to successfully execute movements at speed (i.e. FW machines)
- Technical efficiency (Lack of technical efficiency reduces the ability to display Force, Power, and Velocity)

MARKET APPLICATIONS

HEALTH CLUBS

- **WHY KEISER FOR GYMS & HEALTH CLUBS**
  Exceeding expectations is what our company is built on. Keiser is all about setting the bar higher - higher than the status quo and higher than traditional, iron-based weight systems. Instead of just gaining more memberships and clients, think about dramatically improving closing rates with the value you're providing. That's what really matters. We want to help you move forward.

- **MAKE THE MOST OF YOUR SPACE**
  If you're a gym-goer, fancy digital displays are great; but they don't move the needle. What really matters is that the machines actually work. And if you've only got an hour to work out, what really matters is that you make the most of it.

  By the same measure, as a personal trainer or health club owner, what really matters is that your fitness equipment is safe, effective, and reliable to keep your clients and members coming back - and telling their friends. Be confident that the equipment you're offering is backed by fitness science. Keiser's pneumatic, variable-resistance machines are suited to any client or club member, and will help them retrain their bodies to quickly reach their fitness goals with increased strength, speed, AND power. We want to help you enhance value and add punch to your selling story. Our products and programs bring a new level of versatility and improve bottom line results that your members will be smiling about and talking about. That's what matters.

- **KEISER BENEFITS**
  - » **WE'RE PROVEN**
    Keiser is proven to offer better, safer results – the results that keep members and clients coming back to the gym. An integral part of training programs for every baseball team in the majors, the football champions of nine countries, multiple American football champions, and countless Olympic athletes, Keiser training products are trusted and used by those who make physical performance their livelihood.
  - » **NEXT GENERATION**
    With Keiser, clubs are equipped with what it takes for current and future workout protocols, such as drop sets, eccentric overload, speed training, etc.
  - » **RETURN ON INVESTMENT**
    Keiser is a strategic partner in your business's financial success, providing a unique and versatile selling story, and safer, more efficient equipment that shows a direct impact on the bottom line.
  - » **VERSATILITY**
    Keiser's unique pneumatic resistance system allows for training at speed, and provides the appropriate workout for ANY client or club member. From the most fit to the de-conditioned, any client or member can confidently use Keiser equipment to meet their own personal goals. In addition, Keiser equipment has a small footprint, is light weight, and very quiet. You can configure your gym efficiently and not worry about the noise or placement of certain equipment.
  - » **SAFETY**
    Keiser is an industry leader in safety with equipment that works the muscle without overstressing the joints or connective tissue, meaning your members/clients have less risk of developing an injury that disrupts the workout habit and potentially leads to a loss in retention.
  - » **WE'RE GROWING**
    Keiser is installed in health club facilities including Athlete's Performance, Peak Performance, Mike Boyle Strength and Conditioning, and LA Fitness.
  - » **WE IMPART KNOWLEDGE**
    With Keiser Education, trainers and instructors are equipped with the certification, skills, and tools to ensure that your clients train the right way, enjoy greater results, and keep coming back for more.

SPORTS PERFORMANCE

- **HIGH PERFORMANCE**
  We're just as relentless as you are. The demands of elite athletic competition inspired Keiser to create performance training products and programs that help your athletes safely achieve the highest level of performance possible on the field of play.

- **TRAIN MORE EFFECTIVELY. AT GAME SPEED. SAFER. WELCOME TO THE NEXT LEVEL.**
  With Keiser's range of patented pneumatic equipment, explosive movements can be replicated at the speed of competition, conditioning the muscles to fire faster. A single 6.5-centimeter diameter cylinder on one of our machines produces up to 225 kilograms of force. It comes down to better science, and training the brain to respond more quickly to specific demands.

  "We wouldn't be here today without our powerful partnership with Keiser." Those are the words of Exos founder and president Mark Verstegen. Based in Arizona, EXOS is focused on proactive health and human performance, working with many of the top athletes on the planet. The company relies on the versatility of Keiser strength, functional, and cardio equipment to safely unlock the potential of world-class athletes and prepare them for everything from the NFL Combine to the Olympics to Major League Baseball's Spring Training. Verstegen calls Keiser the company's "competitive advantage." Thanks to resistance that works the muscle without overstressing the joints or connective tissue at game speed, Keiser's technology also helps reduce the chance of injury and can accelerate the rehab process.

- **KEISER BENEFITS**
  - » **WE'RE PROVEN**
    By using Keiser's equipment and/or processes – already in place at many pro athlete facilities worldwide, including those used by every baseball team in the majors, the football champions of nine countries, multiple American football champions and countless Olympians – trainers can turn elite athletes into stronger, quicker, and healthier assets for the team.
  - » **TRAIN AT SPEED**
    Moving a traditional stack of weights up a cable column can only happen so quickly. Because it utilizes pneumatic resistance, Keiser equipment enables athletes to be able to train at the speed and strength required on the field of play.
  - » **EASY IMPLEMENTATION**
    Adding Keiser equipment to your training program and facility doesn't mean a clear, immediate departure from iron. Keiser equipment can be used to supplement your existing programs by integrating a functional training approach.
  - » **VERSATILITY**
    Athletes can push themselves to new levels in both performance and recovery from injury with the ability to quickly change resistance/weight at any speed in the middle of an exercise using Keiser's easy push-button system. And weight can be adjusted in precise increments – down to the ounce.
  - » **SAFETY**
    Equipment that works the muscle without overstressing the joints or connective tissue lets your athletes push themselves to their limit without fear of injury. Through a rigorous focus on biomechanical design and human interface, combined with our patented technology, Keiser is an industry leader in safety.

MEDICAL/REHABILITATION

- **TAKE A LOAD OFF**

  Medical rehabilitation practices have a lot to manage — patients with a diverse array of rehabilitation needs, the demands of government regulation, and insurance compensation. Keiser's next-generation resistance technology takes a load off by bringing science-proven fitness to your practice.

  With virtually zero shock loading, our equipment prevents extra stress on tissues that are already in repair. Simply put, Keiser machines are the safest, most effective machines for rehab available. Several pieces of equipment carry the Class 1 Medical Certification. Please speak with a Keiser Representative for more information.

- **THE FAST TRACK TO BETTER HEALTH – SAFER. SCIENCE-BACKED. MORE EFFECTIVE.**

  While each therapist has a diverse array of patients, Keiser programs and range of fitness equipment align in the ability to help return patients back to their personal speed of life quicker AND more safely. Our machines are engineered to maximize results, re-training patients' neuromuscular systems so they regain agility, coordination, strength, power, and control.

  By optimizing each individual's rehab treatment, Keiser can also help drive practice efficiencies to improve business results. Additionally, the compact design of Keiser equipment will save valuable space in your practice. Keep in mind, too, that pneumatic-based resistance technology offers special advantages to the medical rehab industry:

  - Zero lb./kg starting resistance on most machines (important to prevent overload during rehab process)
  - Zero shock loading to muscles, connective tissues, and joints (prevent extra stress on those tissues already in repair after damage during surgery)
  - Ability to build strength more efficiently and effectively with controlled, consistent air resistance
  - Ability to train for speed and power while not limited by iron weights, with a power display option for tracking performance improvement

- **KEISER BENEFITS**
  - **WE'RE PROVEN**

    Keiser equipment is specified by the most demanding providers in the medical rehab field, including the Mayo Clinic.
  - **SAFETY**

    Through a rigorous focus on biomechanical design and human interface, combined with patented pneumatic technology, Keiser has created equipment that works the muscle without overstressing the joints or connective tissue, so your patients can push themselves to their limit with reduced fear of injury or re-injury.
  - **TRAIN THE BRAIN**

    Enhancing neuromuscular capabilities will help them achieve their rehab goals. By simultaneously training the patient's muscles and nervous system, Keiser equipment allows practitioners to train for speed and power earlier in the rehabilitation process than they would with traditional methods.
  - **FUNCTIONAL TRAINING**

    Training can only be considered functional if it is done at speed with the appropriate resistance necessary to build strength — something not possible with iron. Keiser helps therapists build true functional training into their workout programs, providing results that are directly realized in their client's chosen activities.
  - **STRATEGIC PARTNER**

    More than an equipment manufacturer, Keiser is a strategic partner in your facility's success, providing the rehab equipment and programs that help increase positive patient results, wellness, and satisfaction.
  - **OUR EXPERIENCE**

    Keiser pioneered the first pneumatic exercise machines in 1978, and spent the three decades that followed testing and optimizing the equipment and programs to meet the high standards of users at the top of their field. Most recently, Keiser has partnered with the Council on Aging and Adult Development, supporting research on aging and exercise.

OLDER ADULT

- **WHY KEISER FOR OLDER ADULTS**

  As a life plan community, you have an immediate opportunity to make a difference in residents' quality of life by using Keiser fitness technology, including our innovative, pneumatic resistance machines and M-Series indoor cycles. How does Keiser make a difference? We've been proven to help older adults improve function, leading to greater independence and quality of life. In fact, we have the most senior-specific exercise equipment and programs on the market.

- **ACTIVE AGING = A BETTER QUALITY OF LIFE**

  Today, as part of overall wellness promotion programs, residents of older adult facilities are demanding more from their fitness center. "We must continue to be active as we age," company founder Dennis Keiser explains. Studies show that between the ages of 30-80 you lose approximately 50% of your strength.

With a wide variety of residents in varying degrees of physical well-being, Keiser equipment's versatility, effectiveness, and ease of use is key, as is its design to fit the community and meet growing demand. The 50-plus market now comprises nearly 50 percent of the U.S. adult population, so the need for better fitness technology and programs for your residents isn't getting any less important.

That's why we offer more than just a full range of fitness equipment. We also provide wellness programming backed by best-in-industry Keiser quality. Our wellness programming can help reduce avoidable hospital readmissions, improve resident well-being, and act as a bridge to therapy services. At Keiser, we empower older adults with the knowledge and tools they need to maintain their optimum level of health. Research is our ammunition; with it, we are able to start educating older adults about the benefits of physical activity.

- **KEISER BENEFITS**
  - » **WE'RE TRUSTED**

    Keiser is installed in over 1,000 Older Adult Facilities across North America.
  - » **EXPERTISE**

    Keiser has over 27 years of research, amounting to a database of over 150 peer-reviewed studies and articles. You can trust Keiser as a resource and trusted partner for older adults.
  - » **WE'RE PROVEN**

    Using Keiser equipment and programs helps achieve better, happier outcomes more quickly, more efficiently, and more safely.
  - » **EASE OF USE**

    Keiser equipment is quiet and space efficient with simple, push-button controls that allow you to control resistance in 1 pound increments.
  - » **SAFETY**

    Through a rigorous focus on biomechanical design and human interface, combined with patented pneumatic technology, Keiser has created equipment that works the muscle without overstressing the joints or connective tissue, allowing your residents to push themselves to their limit with reduced fear of injury.
  - » **STRATEGIC PARTNER**

    More than an equipment manufacturer, Keiser is a strategic partner in your community's success, providing the training and programs that help increase resident health, wellness, and satisfaction, combined with product design that allows for multiple configurations to easily fit a community's floor plan. And keeping residents healthier reduces a community's manpower needs.

GOVERNMENT

- **GOVERNMENT TRAINING – WHEN LIVES ARE AT STAKE**
  Used by fitness professionals globally, including multiple military installations, NASA, and fire departments across the U.S., we're a trusted equipment provider for those who need to perform at their peak — when there's more than just performance on the line.

- **DEMAND A BETTER PERFORMANCE – BE READY FOR ANYTHING**
  Keiser has always been the equipment choice for those who demand peak performance, from elite athletes to first responders. In the mid-'90s, NASA recognized the potential of Keiser's technology and initiated a partnership to develop equipment that limits muscle degradation on long-duration space flights. Today, government agencies globally, including the U.S. Armed Forces (Navy SEALs and Special Forces included), rely on Keiser fitness technology to do its job in their group and target training programs.

  The key to Keiser's success with groups like firefighters and the military is how it allows professionals to train at the speed they perform their jobs in the real world, since our pneumatic (or "air resistance") machines aren't slowed down by gravity. Moving a traditional stack of weights up a cable column can only happen so quickly.

  It's a difference you'll feel – and we have the results to prove it. Make sure you have the most effective, science-backed training equipment available to assure that you and your crew are ready for whatever comes your way.

- **KEISER BENEFITS**
  - » **WE'RE TRUSTED**
    More than 80% of the top sports teams in the world train on Keiser, including every Major League Baseball team, a majority of the top UK and European football teams including multiple World Champions, numerous American football champions, and countless Olympic athletes.
  - » **FUNCTIONAL TRAINING**
    Training can only be considered functional if it is done at speed with the appropriate resistance necessary to build strength — something not possible with iron. Keiser helps build true functional training into workout programs, providing results that are directly realized in your work activities.
  - » **SAFETY**
    Through a rigorous focus on biomechanical design and human interface, combined with patented pneumatic technology, Keiser has created equipment that works the muscle without overstressing the joints or connective tissue, letting your team push themselves to their limit with reduced fear of injury.

HOSPITALITY

- **GREAT PRODUCT – GREAT SERVICE**
  Keiser has always been the choice for those who demand peak performance: from elite athletes to the members and staff at discerning commercial fitness clubs and organizations. In fact, there are over one hundred peer-reviewed and published studies showing how the use of Keiser's pneumatic resistance technology provides a safe and effective way to lose weight, increase bone density, increase strength, and increase power.

  Keiser equipment is suitable for any guest to exercise on and, with unilateral and bilateral movement training opportunities, it allows you to satisfy more guests without having to financially invest in a large amount of equipment.

- **HERE TO HELP YOUR CLIENTS**
  With Keiser Education, trainers and instructors are equipped with the certification, skills, and tools to ensure that your clients train the right way, enjoy greater results, and keep coming back for more.

- **KEISER BENEFITS**
  - » **WE'RE PROVEN**
    Keiser is proven to offer better, safer results – the results that keep members and clients coming back to the gym. An integral part of training programs for every baseball team in the majors, the football champions of nine countries, multiple American football champions, and countless Olympic athletes, Keiser training products are trusted and used by those who make physical performance their livelihood.
  - » **NEXT GENERATION**
    With Keiser, hospitality fitness facilities are equipped with what it takes for current and future workout protocols, such as drop sets, eccentric overload, speed training, etc.
  - » **RETURN ON INVESTMENT**
    Keiser is a strategic partner in your business's financial success, providing a unique and versatile selling story, and safer, more efficient equipment that shows a direct impact on your bottom line.
  - » **VERSATILITY**
    Keiser's unique pneumatic resistance system allows for training at speed, and provides the appropriate workout for ANY guest using our equipment. From the most fit to the de-conditioned, anyone can confidently use Keiser equipment to meet their own personal fitness goals.
  - » **SAFETY**
    Keiser is an industry leader in safety with equipment that works the muscle without overstressing the joints or connective tissue, meaning your guests have less risk of developing an injury that disrupts the workout habit and potentially leads to a loss in retention.
  - » **WE'RE GROWING**
    Keiser is installed in leading hotels and cruise ship lines across the world.

SUMMARY OF ADVANTAGES

Versatility

- **The Keiser Resistance Training Platform** consists of a Strength line of equipment, Infinity Series, and Racks (with and without air).
- **Any Speed.** Keiser's unique pneumatic resistance system allows for training at any speed on all Keiser lines of equipment.
- **All 5 training qualities** (strength, power, speed, muscular hypertrophy, and muscular endurance) can be trained with any one of our pieces of equipment.
- **Pure Resistance.** All pieces of equipment within the Keiser Platform use the purest form of resistance (with the exception of the Rack without Air). With the Keiser Platform, you can be assured that a kilogram is always a kilogram, regardless of velocity.
- **Better Built**. Whether being used in a commercial or private setting, the Keiser Platform is focused on quality and built to commercial grade.
- **So Much Space.** Keiser equipment has a small footprint, while also being lightweight and very quiet. You can configure your gym efficiently and not worry about the noise or placement of certain equipment.
- **A solution for every application** whether using a rack, functional trainer, or machine. A piece of equipment is not truly functional unless the movement can be performed at the speed of life.

Usability

- **Ease of Use.** Push button resistance control that can be changed during the repetition if needed.
- **Spotless.** During eccentric overload, no partner is needed for assistance unloading or loading resistance.
- **Every Increment Counts.** Ability to increase or decrease by 100 grams with Infinity Series and Racks as well as 1 kilogram increments with the Strength Machines.
- **Instant feedback** with our power display. Track reps, peak power, and % of peak power.
- **Easy Implementation.** Adding Keiser equipment to your training program and facility does not mean a clear, immediate departure from iron. Keiser equipment can be used to supplement your existing programs by integrating a functional training approach.
- **X, Y, and Z.** Infinity Series and Racks with air allow training in all 3 planes of motion, regardless of velocity.
- **Eccentricity.** Keiser's pneumatic technology allows for concentric and eccentric loading.

Safety and Education

- **Less Stress.** Through a rigorous focus on biomechanical design and human interface, combined with patented pneumatic technology that includes dynamic variable resistance with force curves to match the human body's biomechanics, the Keiser Platform reduces stress to the joints or connective tissue with a focus on neuromuscular development.
- **We Impart Knowledge**. With Keiser Education, trainers and instructors are equipped with the certification, skills, and tools to ensure that your clients train the right way, enjoy greater results, and keep coming back for more.

Testing Capabilities

- **Identifying Power.** Identification of Keiser Optimal Power Resistance (KOPR) through the use of the Keiser 6-Rep Test.
- **Zoning In.** Utilizing the KOPR, one can determine the Max Power (Watts) and speed generated for a particular exercise. The KOPR can also be used to determine training zones for power and speed.
- **Fitness Photo.** The Air420 software has the capability to give the coach/trainer and athlete/client a snapshot of their strength profile. Designed to produce accurate velocity, power, and acceleration information, it is capable of capturing data at any moment throughout the range of motion that can then be charted to provide an accurate look at a user's performance.
- **Iron vs. Air.** Regardless of the way you tested for strength (i.e. 1RM or 1RM rep test) in the past, the same methods can be used with the pneumatic platform.

COMMONLY ASKED QUESTIONS

"It is human nature to want to hold onto the past. Whether it is past success, tradition, the only thing you know, your comfort zone, or a love of the tool, method, or process, we all have difficulty letting go."

– Dennis Keiser

1. **How can I implement the Keiser system into my athletes'/clients' workouts?**
There is no one right answer, however we recommend starting out by using our equipment the way you would use any other piece of equipment in order to familiarize your athletes to it. Then, we would recommend using our Keiser testing protocols to get valuable information about your athletes. Once you have this you can begin to build your training plan based on their needs. Remember, Keiser equipment can do it all in regards to training, so your imagination as a coach/personal trainer is your only limit.

2. **How can I best use the results of the 6-rep test to formulate a plan for our athletes?**
The 6-rep test and our other testing protocols will give you baseline information, creating a snapshot of your strength profile. You can use this information for retesting purposes to determine if the training program is meeting your goals. Additionally, baseline information is helpful by assisting the coach/trainer with developing training zones relevant to desired training themes. (*See Keiser Testing Protocols*)

3. **What market is Keiser equipment best suited for?**
The great thing about Keiser equipment is that it is truly versatile. Keiser equipment is in all 6 major markets which include: Health Club, Sports Performance, Medical/Rehabilitation, Older Adult, Government, and Hospitality. There is a solution for every need with a pure resistance that improves all 5 trainable qualities via Keiser racks, machines, and the Infinity Series. Having Keiser equipment allows the end user to decide on how to best utilize the machines for their specific training needs as opposed to the equipment dictating what they can and can not do. (*See Market Applications*)

4. **Why does Keiser pneumatics feel different from my standard selectorized equipment that I am accustomed to? It feels easier.**
There are two parts to this answer. First, when using a mass-based resistance (i.e. iron, weight stack, etc.), the onset of the movement will feel heavier because you have to exhibit high forces to get that mass moving. The greater the speed you want to move it, the higher those forces become. Secondly, the strength machines have a built in variable resistance that utilizes force curves, matching the biomechanics of the human body. Consequently, heavier resistance is placed where the muscles need it most and easier (lighter) resistance is placed where we are at a mechanical disadvantage and more susceptible to injury. (*See Why Does the Type of Resistance Matter?*)

5. **What does Keiser think about coaches and trainers that will find it hard to adopt a "new" way to train?**
Too many people view Keiser as a novel approach and secondary form of resistance training when, conversely, the science shows that it should be the primary form of resistance. They can still use our equipment the same way as traditional equipment but now they have the added benefit of exploring and adapting to a safer, more effective workout no matter what their intended training goal is. The most elite programs and facilities in the world trust Keiser because we are backed by science and you should too. (*See The Research Behind Keiser Pneumatics*)

6 **If I'm over the age of 40, is it safe to say pneumatics with the proper resistance curve is one of the absolute best ways to train my body?**
You have already incurred some damage with age so why take on more damage than is necessary? Regardless of your age, training with Keiser pneumatics is one of the absolute best ways to train your body. The pneumatic, biomechanical design and human interface work the muscle where it is needed most without overstressing the joints or connective tissue. A pound is always a pound with Keiser. (*See Why Does the Type of Resistance Matter?*)

7 **Why is Keiser considered a safer form of resistance?**
Understanding that for every action there is an equal and opposite reaction is the key. Pneumatics is not governed by the Laws of Motion like mass. For example, 20 kilograms of air equals 20 kilograms because you are only loaded with the forces associated with the numeric resistance. 20 kilograms of mass (iron, etc.) is actually more than 20 kilgorams when you initiate the movement because you are loaded with both the numerical forces AND the additional Newtonian forces to accelerate the load. This extra collateral damage and shock loading when utilizing a mass-based resistance is evident during the transition from eccentric to concentric phases where our joints and soft tissue are most susceptible to injury. (*See Why Does the Type of Resistance Matter?*)

8 **I have Elite Form, why do I need Keiser?**
Elite form is a capturing data device that still utilizes a mass-based form of resistance which we know doesn't allow for effective power and speed training. Keiser allows the user to utilize air as the resistance, where Newton's Laws of Motion do not apply because we are not using a gravitational-based resistance. Thus, we are not constrained by the limitations that inertia and momentum exhibit on a mass-based resistance. (*See Why Does the Type of Resistance Matter?*)

9 **How is Keiser resistance measured and how does it compare to iron?**
Keiser's air resistance is measured relative to atmospheric pressure and can be set specific to the altitude where the machines are installed. With precise computations of air pressure within the cylinders, you can be assured that inputted resistance will be equal to that of iron. To compare, hang a 5 kilogram plate to the Functional Trainer and put 5 kilgorams of resistance on the machine. They will balance out.

10 **Can I train for hypertrophy (muscle size) and absolute strength with Keiser machines?**
Yes! You can actually train all 5 Trainable Qualities and get more functional benefits than you would with traditional methods because you can train at speed. The three most influential contributing factors for hypertrophy (mechanical tension, metabolic stress, and muscle damage) can all be performed on pneumatics AND with less stress to joints and tissue. In addition, science has shown that pneumatics are just as effective at improving absolute strength as iron. (*See The 5 Trainable Qualities & The Research Behind Keiser Pneumatics*)

11 **Can you combine air and iron with the Keiser Racks?**
Yes, you can, as long as you have the Keiser racks with air (as we do offer a rack without air). Our racks with air allow you to train up to 91 kilograms of air resistance using just the Keiser lightweight bar or you can train with a standard Olympic bar with air by using the Keiser collar attachment rings. Additionally, with the standard Olympic bar, you can also use a combination of air and iron to really open up the endless possibilities of training. Lastly, you can use the racks with just iron as you would any other rack.

12 **Why is it necessary to train fast?**
Life and sport happen fast. It is important to train your nervous system to fire quickly. Simply put, training with speed and power equals performance in our daily life and in sport. In order to continue to function and excel at life and at sport we need to challenge the neuromuscular system. Training with speed does just that. (*See Human Body Systems and Adaptation*)

13 **What is the difference between Keiser pneumatics and hydraulic resistance?**
Hydraulic and pneumatic resistance both deal with the mechanical properties of compressed gases or liquids. Hydraulic resistance only allows for a concentric contraction (pushing and pulling) whereas Keiser pneumatics allows for both a concentric and eccentric resistance. With pneumatics, you can move faster because the resistance remains constant.

14 What is the difference between Olympic lifting and Keiser Pneumatics for power development?

The two resistance movements can be very complimentary. When executed correctly, both Olympic lifting and Keiser Pneumatics have the ability to display high levels of power. Olympic lifting is traditionally used to exploit the inertial properties of mass in order to improve rate of force development, typically at heavier resistances. Olympic lifting requires a lot of time to ensure proper technique and safety before becoming efficient at displaying power. Research suggests that Keiser Pneumatics has proven to be efficient at increasing rate of force development at lighter resistances (Frost, 2012). Additionally, Keiser Pneumatics can train all five of the trainable qualities in targeted muscle groups and multiple planes of movement. Olympic lifting is limited to triple extension movements, whereas Keiser Pneumatics can be used to develop power in all upper and lower body pushing/pulling movements.

15 How does Keiser's pneumatic resistance and isoinertial (flywheel) resistance compare?

Exactly like mass, flywheel devices rely on moving mass to provide resistance, with the difference that the mass is being spun rather than being displaced vertically. Considering there is no vertical displacement of mass, there is no gravitational force (M x G), but only inertial force (M x A). If you recall, Force = (Mass x Gravity) + (Mass x Acceleration), so a flywheel relies solely on the (M x A) portion of the formula to create force. A flywheel's resistance is also dependent on the size (mass) of the wheel and is purely inertial and, therefore, completely variable and dependent on execution (speed of movement). The most prominent feature of a flywheel is the capability and ease of achieving eccentric overload, but this overload only comes with specific execution. This novel approach to eccentric training relies on utilizing a shorter application of eccentric force because any independent system can only return the same energy that was put into the system (input on concentric, return on eccentric). Keiser's pneumatic resistance is a constant, fully controlled resistance that can be changed at any point during the range of motion by the push of a button. Unlike flywheels, Keiser machines have the ability to return more energy on the eccentric portion of the same concentric movement simply by increasing the resistance after the concentric action. In addition, flywheel training does not allow any rest between repetitions, as there must always be constant movement to supply the force.