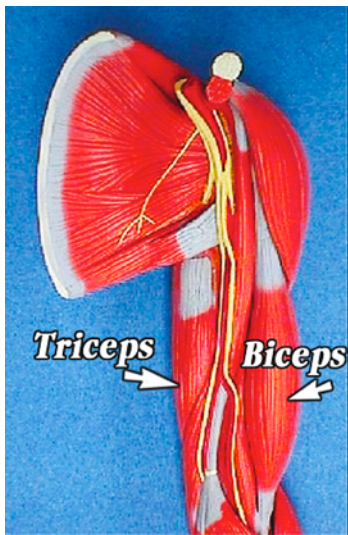


# BIOMECHANICS & AIKIDO

*John Turnbull*

Biomechanics is the application of mechanical principles to living organisms, especially their anatomy (structure) and physiology (function). At the macro level it examines the way Newtonian mechanics describes the leverage of muscles on bones, but precise details of this activity at the molecular level requires the use of continuum mechanics.

At the Newtonian level it's important to understand that muscles can only apply leverage by **pulling** on bones, for they can only **contract** - they cannot **push**. Which leads us to wonder how it is possible to push things!



The answer lies in the way bones have opposing groups of muscles attached to them in pairs so that joints can be either straightened or flexed, depending on which group is active.

When the triceps in the upper arm are contracted, for example, they shorten and pull the arm out straight. When

the triceps relax and the opposite muscles (the biceps) are activated, they pull the bones in the opposite direction, making the elbow bend so it draws the forearm toward the shoulder. Thus the hand can be raised or lowered.

Other muscle groups in the shoulder and back are co-ordinated with these two groups, enabling the arm (and its extremity the hand) to be extended, withdrawn and rotated through a wide range of

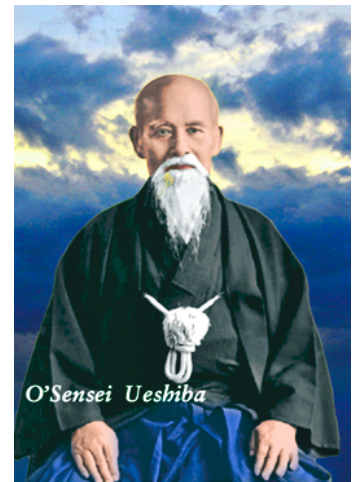
movement. This enables us to lift, push and rotate things as well as pull them. A further complexity of muscles and joints in the forearm, wrist and hand provide the extraordinary dexterity found only in humans.

During the late 1800s, when an understanding of how opposed pairs of muscles behave was beginning to become public knowledge, one of the most important discoveries in the history of athletics was made. It happened this way.

In Munich a German teenager named Max Sick decided that despite his small stature he wanted to become the world's strongest man. Most young men have similar dreams, but few have gone about it as dedicatedly, intelligently and successfully as Max.

Like those two greats of Japanese martial art, Morehei Ueshiba and Jigoro Kano, he was extremely ill as a child, and like them he developed an immensely strong spirit while fighting to survive. Born at a time when shorter working hours were bringing increased leisure to the masses, he entered his teenage years just as physical culture was becoming popular, and began training with weights.

He soon noticed with surprise, however, that the men with the largest muscles were not always the best weightlifters, gymnasts or wrestlers. Trying to understand this, he theorized that it might be because of the way muscles can only apply force in one direction, for this means that each muscle's power will be counteracted by any tension in the opposing muscles.



If this were so, he realized, then when training particular muscle groups for greater power, one must be very careful to also train the opposing muscles to totally relax.

For when tensing the biceps to lift a dumbbell toward the shoulder, for example, it is also essential to totally relax the triceps. Otherwise any tension in them will work to counteract the power being applied by the biceps.

Which would be like trying to push a cart forward while an opponent is trying to push it backwards!

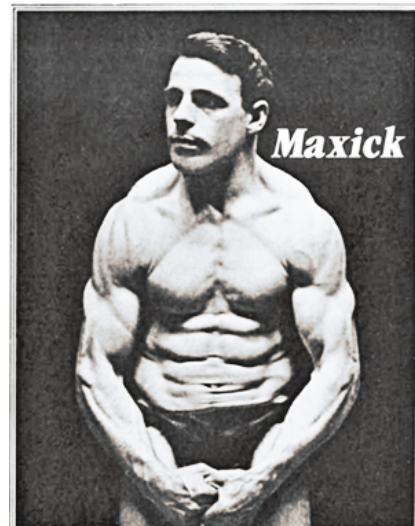
And this, he suspected, was the reason for the then common problem of weightlifters developing huge muscles but becoming "muscle-bound".

With this in mind he began experimenting with methods of contracting just one particular muscle group at a time, while carefully relaxing the opposing group. As he learnt how to do this, he found himself growing surprisingly powerful, even though he was rarely lifting weights. And to the amazement of his club members he was soon outlifting grown men.

One of the stories about this concerns a regional weightlifting competition. At the beginning of such contests each club traditionally paraded around with the strongest member in front waving the club's flag on a big pole - quite a feat of strength in itself.

When Max's team was about to enter the stadium, officials saw it being led by a smallish youth. They stopped them and explained that the strongest person should be the one in front with the flag, and were astonished when assured that Max was the strongest. They thought this was a joke, but eventually allowed him to carry the banner. Imagine their astonishment when he won not only his own weight category, but all the divisions in the tournament, including the heavyweight!

Later, when fully developed, Max was only 162cm tall and weighed barely 68 kgs, but had phenomenal muscular development. His neck had a 43 cms circumference. When he exhaled his chest measured 93cm but could expand to 114cm. His upper arm expanded from 34 cm to 40cm when flexed. He could easily lift **twice** his own body weight overhead with one hand! This and many other amazing feats of strength made him a weightlifting legend!



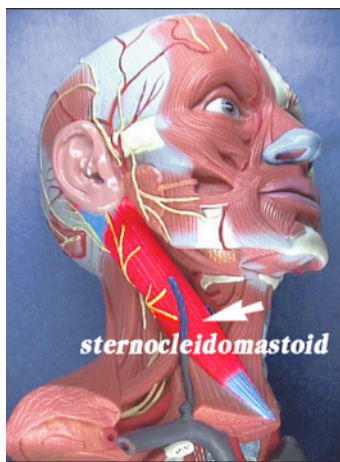
He was not alone in his groundbreaking approach to training, however, for in England another famous strongman named Court Saldo was also discovering the secrets of muscle isolation and control. He and Max eventually formed a partnership, touring Britain and Europe for many years and astounding audiences with their feats of muscle control and strength. As their fame spread, body builders began clamouring for their secret.

Max adopted the stage name Maxick and combined this with Saldo's name to develop a mail-order business called "Maxalding". Through it and a series of illustrated books their discovery was revealed to the world. People signing up for their monthly courses received illustrated instructions tailored to their age, body type and exercise history. These revealed the details of how to isolate the major muscle groups so each one could be individually and progressively trained for maximum power. It was a very sophisticated and effective system which produced many extraordinary athletes, including Australia's famous strong man Don Athaldo, and world-renowned athletics coach Percy Cerutti. More than half a century later this writer is still deeply grateful for its benefits.

While Maxick and Saldo were developing their muscle control system in the Northern Hemisphere, a young Tasmanian named Frederick Alexander was making another vital discovery about muscle control. He had a superb voice and wanted to become a great actor. But in those days before microphones and amplifiers, an actor's voice had to be powerful enough to reach the back rows of auditoriums, and even the greatest voices sometimes failed during long performances in big halls. Alexander was plagued by this problem.

On one occasion when his voice completely failed during an important performance, he became so distraught that he sought specialist medical advice. When none of the experts could help he became determined to solve the problem himself.

Surmising that tension in his throat was at least part of the problem, he set up mirrors in such a way that he could study his head from both sides as well as the front. Eventually he made a breakthrough discovery - during long and difficult orating the sternocleidomastoid muscles at each side of his neck tightened slightly, tilting his head back fractionally and putting pressure on his larynx, slowly choking his voice off.



On realising this he thought the problem was solved, for all he had to do was keep his sternocleidomastoids relaxed. But just as weightlifters and martial artists can have enormous difficulty breaking long-term habits of **unconscious** muscular tension, so Alexander found he could not break

the lifelong habit of unconsciously tightening his neck when under emotional pressure, as people usually are when performing before audiences. So ingrained was this habit of what eventually became

known as “anxiety-tension”, that it seemed as if his muscles had a life of their own, and were completely beyond his control.

He kept working on the problem, however, and after several more years of study and experimentation discovered what he named “the prime control”. This involves the alignment between the head, neck and torso. Only when this is optimal can the body be properly “used” the way Nature intended, for only then can unconscious tension be clearly identified - and then inhibited - so energy can flow freely along the spine.

Misalignment - as when the sternocleidomastoids pull the head back from its proper position of balance atop the spine - pulls curves into the back. This stresses the entire spinal column and thus the whole body, for anatomically the spine is the centre of the body's structure - all five branches - legs, arms and head - are attached to it.

The spine, from the coccyx to the top of the head, is known as “the Governor Channel” in Chinese Medicine, for it is the body's major pathway of energy flow (chi or ki). This has important ramifications for everyone, especially martial artists.

In the short term any tensing of the sternocleidomastoids interferes with voice production - in the long term it causes degeneration of the lumbar discs and leads to chronic back pain. When this degeneration becomes excessive it creates a vicious circle, for the pain discourages aerobic exercising. Lack of aerobic exercise leads to deterioration of the heart-lung-vascular system, causing a loss of muscle tone which eventually leads to heart disease, today's most common killer.

Because it also tilts the head out of its correct relationship with gravity and the horizon, it affects the balance mechanisms in the inner ears, distorting sensory perception

This affects balance, exacerbating the problem of inadequate exercise while also degrading the subject's reasoning ability and increasing the likelihood of senility.

Alexander's method for restoring proper functioning of the "prime control" tutors students in how to develop awareness of previously unconscious tensions. When identified, these can then be inhibited so the spine "loosens and lengthens" - Alexander's phrase - to its full and proper length. Inhibiting tension is learnt through a teacher's hands-on guidance, and has become known as "the Alexander Technique". It has invaluable applications for martial art, as my Aikido teacher, Seiichi Sugano Shihan, pointed out to me many years ago.

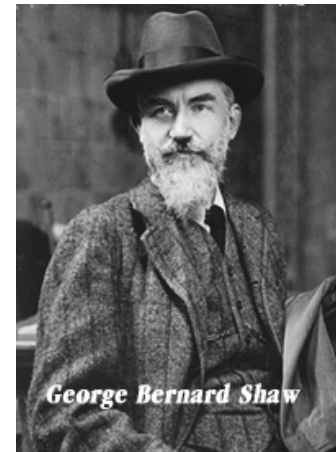


Word of Alexander's voice control method quickly spread throughout the theatrical world. Famous actors and singers from all over the globe began visiting Australia to learn it. They found it so beneficial that before long he was being urged to go to London so he would be more accessible. He eventually did so, becoming established in Harley Street as the voice guru of the world's theatrical stars.

His Technique was so effective that it soon became fashionable for leaders in government, academia and society to be "Alexandered", not only for better voice

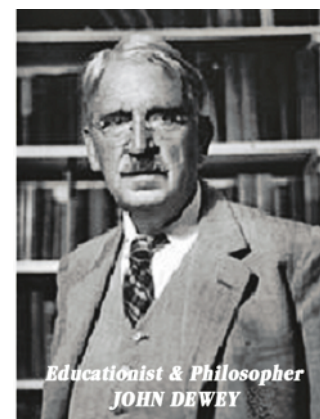
control but for its health benefits. For it was soon apparent that his Technique not only improved voice production, but cured a wide range of illnesses, particularly those caused by unconscious muscular tension creating premature wear in the spine and joints.

There were also dramatic improvements in other areas, for in learning to inhibit unnecessary tensions, students found they could defuse the negative emotions causing anxiety and depression. Improvements in balance and co-ordination also brought increased self-esteem, for once the "prime control" was mastered there was no longer any need to remain trapped in unwanted habits.



The health of the Irish author and playwright George Bernard Shaw, winner of the Nobel Prize for Literature, improved greatly after being "Alexandered". Years later he stated that his extended life span and fitness in old age were due to Alexander's lessons.

The renowned American educationalist, John Dewey, was so amazed and delighted by the improvements in his health and mental acuity after learning to use the prime control that he wrote glowing reports about it, causing it to be adopted in many schools.



The famous Australian athletics coach, Percy Cerutty, also benefited from these discoveries. In his youth he had been a good runner, but in middle age became so ill that he was given only months to live and ordered to remain in bed. But lying helplessly in bed one day he decided that if he was going to die he might as well die trying.

So he dragged himself off the bed and managed to struggle to the door before collapsing. He didn't die, and encouraged by this he kept at it. A few months later he was making his painful way to the front gate and back every day. Although knowing these efforts might kill him he persisted, and eventually was able to stagger all the way around the block.

A few years later, long after the medical experts had forecast his death, he set a national record for running 100 miles which stood for more than 20 years.



As athletes heard of his amazing feats they began flocking to the training establishment he built at Portsea in Victoria. There he began turning out national champions, Olympic medal winners and world record breakers in numbers no other coach had previously achieved.

Like Maxick and Alexander, his understanding of the importance of inhibiting unnecessary muscular tension not only made him a superb athlete, but one of the greatest coaches in history. He not only developed better running technique than any coach before him, but inspired many athletes to attain their full potential. The lesson from all this is that it's not merely the ability of muscles to powerfully contract and apply leverage to

bones that is needed for athleticism, but **muscle control**. And that can only be achieved by firstly developing the ability to identify unnecessary tensions, and then to banish them.

If a tension is so habitual that it has become unconscious and cannot be recognised, it cannot be inhibited. And without freedom from the muscular conflicts created by unnecessary tensions, it is impossible to achieve either maximum power or speed - and speed is even more important than power for martial artists, especially against multiple attackers.

Unnecessary tension also blocks the flow of Ki. Research in China shows that Ki is electromagnetic in nature and is transmitted mainly through the fascia, the transparent tissue surrounding muscles, tendons and ligaments so they can easily slide over neighbouring tissues. Ida Rolf showed that chronic muscular tension degrades the fascia by causing layers of muscle to adhere to each other, leading to physical and emotional problems. Her deep massage technique, though extremely painful, frees the muscles, ligaments and tendons, allowing the fascia to re-establish itself so it can again function properly.

Her muscle freeing treatment promotes a wider range of joint movement and often dramatically relieves emotional problems, apparently because the body's memory of the original trauma which caused the muscles to "freeze" is relieved. It also alleviates the "body armouring" so common in people experiencing chronic anxiety, caused by muscles hardening to protect against assaults from perceived threats, often dating from childhood.



These discoveries show that learning to inhibit unnecessary *muscular* tensions tends to break down the *mental* barriers which so often prevent people attaining their full potential. (Alexander used the word “inhibiting” for the prevention of tension because it is more appropriate than “relaxing”: muscles can only *relax* if they are *already* tense.)

Psychological inhibitions cause muscular tensions which block the flow of ki, so a reduction in tensions not only releases more energy, but ensures better mental and emotional equilibrium, freer movement and improved decision making.

In the genuine combat arts - those where training is for life-and-death situations rather than for sports where nothing is at risk except the conceits of the ego - it is essential to stay calm and completely relaxed when facing death. The way for doing this in the advanced sword arts (and Aikido is predominantly a sword art) is to inhibit tension while focussing *ki* and relying on it to do whatever is necessary. This relaxed “Zen state” requires much training, but enables the mind-body organism to act spontaneously, creatively and appropriately in emergencies without the delays involved in *conscious* decision-making.

This is completely different from sports training, which relies on the development of conditioned reflexes through repetitive training - reflexes which switch on when triggered by a particular stimulus. The Zen way does not rely on reflexes but develops a “superconscious” which relies on the flow of Ki. This freely and appropriately adapts itself to changing circumstances, and is the reason Zen is called “the Watercourse Way”.

Once a conditioned reflex is triggered (as by a punch at one’s face) the reflex-trained boxer has no control over it. He may have developed superb skill in countering a punch with another punch for example, due to hundreds of thousands of

repetitions, but cannot modify the counter once it’s underway. For it is then out of his control, just as Pavlov’s dogs could not prevent themselves reflexively salivating once trained to do so by the ringing of a bell.

Repetition training is essential in the ki-based arts too, but is of a different nature. It trains Ki as well as muscles. Ki is a whole-of-organism experience. Proper training co-ordinates the entire being in ***shin-shin-toitsu***, which translates as mind-body-co-ordination, but means much more.

Techniques created this way are not conditioned reflexes, for they can be modified by the flow of ki at any instant, often faster than a skilled watcher can perceive unless also trained in Ki awareness. This training produces faster actions than conditioned reflexes because it is not a response to stimuli: there is no need to wait on data input via the physical senses.

A properly ki-trained individual can “feel” the intention to attack, so may move before it occurs and preclude it from happening, as when avoiding a hidden ambush. It is not necessary to have formal ki-training for this - “ki awareness” is a genetic inheritance we all have. But high levels of skill are best developed through proper training.

The ability to move just before an attack is launched is what O’Sensei Ueshiba was referring to in his oft-quoted statement that “When an enemy attacks I am already standing behind him”. Cruise You Tube and you’ll find examples of this.

The really intriguing aspect of this is the way techniques, even when applied with lightning speed, spontaneously modify themselves. The “doer” is often unaware of this until it’s all over, for such actions arise from the *superconscious* (a term from Tai chi) and are too fast for the conscious mind to follow.

This can frighten students at first because it seems as if some force greater than their ego selves has taken over. It's most obvious when weapons are used, for it seems as if the weapon is doing things by itself. In swordsmanship it's described as "*the essence of the sword manifesting itself*". Don Bradman's famous cricket bat often behaved this way - it's what made him such a great cricketer. What a fencer he would have been!

The reasons for how and why this can happen lead us into the realms of psychology, human spirituality and Zen, for which there is no room here, except to note that developing a "superconscious" is the aim of advanced training in Zen, Aikido, Tai Chi and other "inner" arts. It is the reason Tai Chi was named the "Grand Ultimate" boxing art.

Developing the superconscious increases an organism's efficiency. The rules of biomechanics still apply, but act more effectively due to increased awareness, sensitivity and energy flow. Ki training is, above all, training in awareness and sensitivity.

Another beneficial effect of this is that learning to "extend Ki" improves the way muscles, tendons and ligaments relax: instead of merely *slackening*, as in sleep, they soften and *extend* - lengthen without tautness - as they do in children, becoming more flexible and reducing the chance of injury. Which is why children are seldom hurt during falls.

An important part of learning this is Aikido's *kokyu-ho* exercises, which utilise breathing and visualisation to gather Ki. From this comes the ability to circulate energy throughout the body. This stimulates blood flow through the capillaries, so they better nourish the cells and flush toxins out. It is the reason why practitioners' complexions assume that healthy glow which cosmetics merely imitate.

This essay has attempted to expand the boundaries of vision about the way our body-mind organism works. In exploring this fascinating subject we should realise that it has been studied in enormous detail for many centuries by the martial art and meditation schools in India, China, Japan and elsewhere. When the Indian sage Bodhidharma arrived at China's Shaolin Temple 1600 years ago, he was visiting an institution established a century earlier to translate **ancient** Sanskrit texts about these matters into Chinese!

Some years ago a student brought me a picture of a statue recently discovered during archaeological research in China. Depicting a warrior doing one of the Ki-focussing *kokyu-ho* exercises practiced in Aikido today, it was about 5,000 years old!

Biomechanics is an excellent starting point for understanding how our bodies function, but there is much more we need to know. It is my gut feeling that quantum mechanics may (hopefully before too long) reveal how people such as Ueshiba were able to do things with Ki that cannot yet be explained by modern science.

