

Keeping Up With Arthur Jones

An Interview by William Zucker, Ph.D.

Perhaps the most expensive, generally non-life-threatening, medical problem in this country today is chronic spinal pathology; estimates of the total annual cost vary, from \$40 billion to more than \$100 billion, but such costs certainly represent a very substantial part of total costs for healthcare in this country. If, as recently estimated, annual healthcare costs have reached a total of \$900 billion, then chronic spinal pathology probably represents at least five percent of that total and perhaps as much as 11 percent.

Unfortunately, even with the use of the most sophisticated scanning technology (X-rays, CT scans and MRI scans), the vast majority of patients with chronic spinal pathology can never be provided with a specific diagnosis; in most cases, clinicians must deal with idiopathic situations. This, unavoidably, leads to controversy; one unfortunate result being the current use of a wide variety of treatment protocols of no proven value.

A second factor contributing to this controversy is due to the fact that about 80 percent of the people in this country, at one time or another, will suffer from acute bouts of lower back pain; pain that comes and goes for no apparent reason; pain that usually will go away within a few days or a few weeks almost without regard for any treatment utilized. Spontaneous improvement of acute cases of lower back pain has produced a situation wherein the most recently applied protocol is given the credit in many cases where the treatment had no real benefit.

But the real problems, and most of the costs, come from chronic cases of spinal pathology; pain that comes but does not go away. In such cases there are only two intelligent choices; surgery or rehabilitation, or a combination of the two. And when it comes to rehabilitation there is only one intelligent choice: exercise. Other protocols may help to temporarily reduce or remove pain, but only exercise is truly productive; only exercise is capable of producing the tissue changes that are required for true rehabilitation (a return to normal functional ability).

This leads to the next problem: in order to evaluate the results of rehabilitative exercise, we must be able to provide specific measurements of functional ability, strength, range of motion and muscular endurance. But providing accurate and specific measurements of functional ability turned out to be far more difficult than most people expected; and this produced even more controversy, and the use of many testing procedures that are incapable of performing any of their intended functions; procedures that are worthless for any purpose.

Arthur Jones, founder and retired chairman of Nautilus Sports/Medical Industries Inc., now chairman of MedX Corporation has been working for more than 50 years in continuous attempts to improve both exercise and testing procedures; work that eventually produced the current line of MedX equipment for testing specific functions of the spine and the knee.

When did you first become interested in exercise?

About 55 years ago, in the late 1930s. I was never the proverbial 90-pound weakling, but wanted to increase my size and strength and become involved in gymnastics and weightlifting.

Where did you initially go for advice on the subject?

The problem then, and a large part of the problem today, resulted from the fact that there was far too much in the way of advice on the subject; most of which was worthless and some of which was dangerous. In the end, if you learn anything along the way, it is usually from your own experience; and I sincerely believe that we learn primarily from our mistakes. As somebody once said, "Success comes from good judgement, good judgement comes from experience, and experience comes from bad judgement."

Quite a few people have given you the credit for the current widespread interest in exercise; how do you view your contribution?

To begin with, I have never claimed any credit for the current interest in exercise; I believe it was primarily a matter of

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being in the right place at the right time, and accident. Second, I also believe that if I had not introduced the improvements now incorporated in MedX equipment that sooner or later somebody else would have. We are dealing, after all, with simple laws of physics; physical law that is still not generally understood, but that cannot be denied in the end.

While I learned nothing from his much earlier work and was not even aware of his work until long after I had discovered the same things he first noticed, a man in Sweden, Dr. Gustav Zander, designed and built a very sophisticated line of exercise machines before the America Civil War, in the 1850s. He was clearly aware of the actual requirements for proper exercise that I introduced in early Nautilus machines. Some of his machines, built about 140 years ago, were at least the equal of most of the exercise machines now on the market. His only real problem resulted from the fact that he was too far ahead of his time; another accident of time and place. While it is certainly possible to be too late, it is also possible to be too soon.

Apart from the accident of time and place, two other circumstances contributed to our later discoveries and developments; income from the sales of Nautilus machines provided me with the funding for many years of continuous research; without which later developments could never have been produced. Second, the tax code during most of those years of research was very favorable for research and development projects. Current tax codes are much different, far less favorable; and I believe this change was a mistake and has resulted in a major reduction in research and development projects. Many things that might have been discovered may now be overlooked; and while it is impossible to anticipate scientific discoveries, it is also impossible to evaluate discoveries that were not made.

How much have you invested in research during the last 20-odd years?

A lot more than I expected; much more than I would have believed possible at the start. In January of 1972, I published an article that was very critical of the testing procedures then being used, and clearly explained several of the problems with such procedures. I then went on to state my intention to design and build a machine that would be capable of providing all of the requirements for meaningful testing of functional ability.

Our first project was an attempt to design a machine for testing knee functions, and I initially estimated that this would involve about six months of work and an investment of about \$200,000, neither of which estimates represented my true opinions. In fact, at the start, I believed we could design and build such a machine within a period of about three weeks, and at a total cost of less than \$10,000.

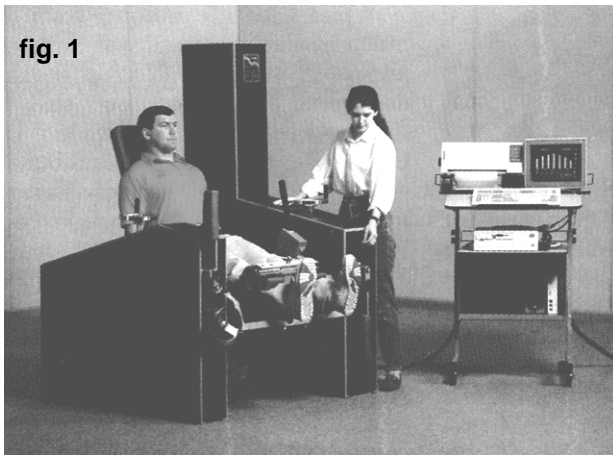


fig. 1

Initial research to develop accurate testing tools for the muscles of the knee was started in January 1972, more than 21 years ago, but we were not satisfied with this equipment until 1991. Features and functions of this machine were first submitted to the FDA in April 1991. But research was conducted at the Military Academy, West Point, in 1975, nearly 16 years earlier. This was followed by several years of research at the University of Florida College of Medicine in Gainesville. In both cases, research was done using prototypes of our current equipment.

How wrong can you be? While the knee machine was our first project, it turned out to be the hardest. An acceptable version of such a machine was not produced until April 1991, 19 years and three months after we started. Even a few months earlier, and after years of continuous work, it still appeared to be an impossible undertaking; every time we solved one problem we became aware of other, previously unsuspected problems. *See figure #1.*

Research for the development of spinal-testing machines started later but was successful earlier. During the last 14 years that I owned and directed Nautilus, we invested a total of more than \$40 million in continuous research. It was an average of about \$3 million a year during that period, with no end in sight. *See figure #2.*

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Since I sold Nautilus more than seven years ago (editor: this interview took place in 1994), we had invested an additional total in excess of \$43 million in research, an average during that later period of about \$6 million per year. Total investment as of January 1993, 21 years after we started, was something more than \$83 million. Funding provided by sales of Nautilus machines during the years that I directed the company and by income from the sale of Nautilus in 1986; supplemented by sales of MedX machines during the last six years and by other income.

When I sold Nautilus I owned a large farm located just north of Ocala, FL, about 600 acres of prime real estate that included the largest privately owned airport I the world, a total of five multiengineed jet-powered aircraft (including one four-engine, intercontinental jumbo jet), and the largest privately owned collection of exotic wild animals in the world (nearly 100 African elephants, more than 4,000 crocodilians, rhinos, an adult gorilla and a wide variety of other exotic animals).

During the last seven years I sold about 250 acres of land, all of the airplanes and all of the exotic animals, and these sales provided millions of dollars of additional income. So, one way or another, the funding for our years of continuous research was always available – without the need to borrow money, without outside investors or stock holders and with no partners. I own 100 percent of the stock in MedX Corporation. This is certainly not intended to imply that the development of MedX machines has been a one-man show. Quite the contrary, literally hundreds of people made very meaningful contributions over the years, without which contributions MedX machines could never have been produced. The best of these people are still with us and still working.

When was the first Nautilus machine produced?

The first machine was delivered to a customer on November 30, 1970; but I had been building prototype machines for nearly 30 years before that, trying to solve problems that I was aware of but did not then yet understand.

If I had been aware of and had understood Dr. Zander's much earlier work, I could have avoided many mistakes and saved a lot of both time and money. But then not being aware of his earlier discoveries I was forced to learn the hard way, by trial and error.

The need for a variable source of resistance during exercise was obvious to me as far back as 1938; your strength varies from one position to another throughout any full-range movement, which means that a constant level of resistance will limit your exercise in proportion to your strength in the weakest position. In a first attempt to provide that requirement for the most productive form of exercise, I welded hooks to a barbell in 1939; hooks that enabled me to add chains to the barbell in an attempt to vary the resistance during the exercise. This was not a practical solution to the problem, but it was a start.

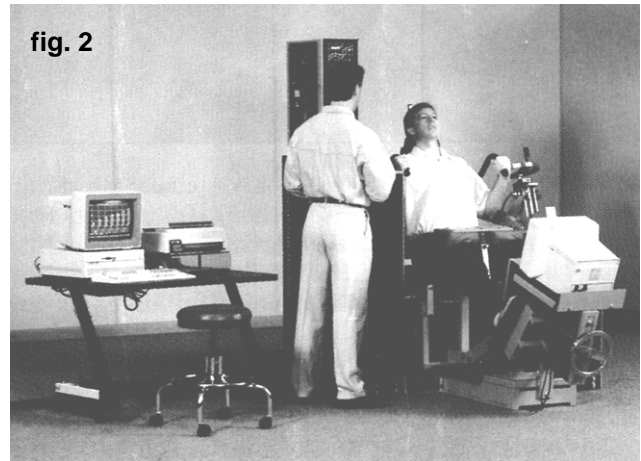
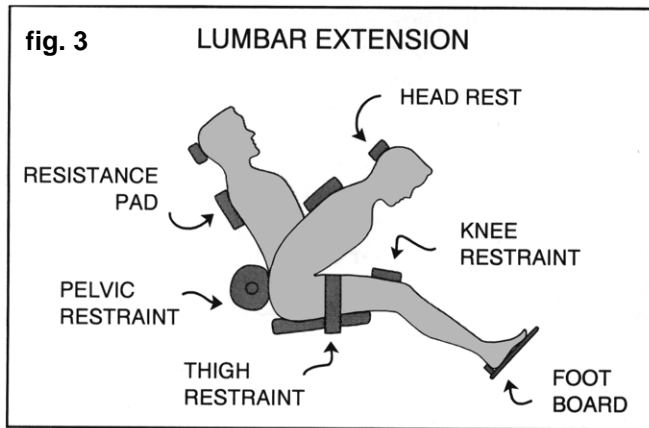


fig. 2

TESTING REQUIREMENTS: Meaningful testing of the muscles that extend the lumbar spine involves several considerations: 1) The lower spine must be isolated by anchoring the pelvis to remove forces produced by muscles of the hips and thighs. 2) The torso, head and arms must be counterweighted to compensate for torque produced by gravity acting upon the mass of these body parts. 3) All other sources of non-muscular torque must be measured by the machine and factored into the test results by the computer. 4) True muscular strength must be measured in several positions throughout a full range of movement. 5) Tested levels of strength must be correlated with the positions in which they were measured.



PELVIC RESTRAINT: Total isolation of the lumbar spine requires anchoring the pelvis so that no pelvic movement is possible. Force imposed against the bottom of the feet is transmitted to the knee end of the femurs by the lower legs and will then produce resulting forces in two directions. Approximately 70 percent of the force will drive the femurs toward the rear, thus pushing the pelvic-hip sockets to the rear, while an equal force will push the knee ends of the femurs upward, which upward movement is prevented by the knee pads. Thus, the wide belt above the upper thighs becomes a fulcrum that redirects the upward force on the knee to a downward force on the pelvic-hip sockets. The result being forces that push the pelvis toward the rear and downward.

The first exercise machine designed for the purpose of increasing the strength of the lower back muscles was the so-called (but misnamed) Nautilus Lower-Back Machine. When I designed that machine I was clearly aware that it provided exercise for the hip and thigh muscles, but I also believed that it provided productive exercise for the muscles that extend the lumbar spine – an assumption that we now realize was a mistake. Such machines will do nothing for the strength of the lower back muscles.

People have become stronger by using the machine, but it is not the lower back muscles that are becoming stronger. Benefit is limited to the hip and thigh muscles. But this lack of benefit for the lower-back muscles was not apparent for a period of several years. It was not apparent because it was then impossible to measure the isolated strength of the lower back muscles. Later, when it did finally become possible to accurately measure the isolated strength of the lower-back muscles, it was immediately apparent that these earlier machines were worthless for their intended purposes.

What are the requirements for accurate testing of specific functional ability?

There are several requirements, most of which were not even suspected at the start of our research, and many of which are still being widely ignored. While it is impossible to compare the importance of these various requirements (that is, impossible to say which is the most important), it is obvious that a failure to provide any one of these requirements will invariably result in meaningless test results. So the following list of requirements is in no particular order or importance.

First, meaningful testing requires total isolation of the joint being tested. In the case of the lower back muscles, this means that the lumbar spine must be isolated by anchoring the pelvis. If the pelvis is free to move, then the measured output of torque will be a result of forces produced by hip and thigh muscles as well as the lower back muscles, and it is then impossible to determine just how much (if any) of the measured torque was actually produced by the lower back muscles.

What is your opinion of exercise performed with barbells?

Apart from Zander's machines, a barbell was practically a miracle when compared to any earlier tool intended for the same purpose. It was capable of producing results that were simply impossible with any other tool. But it does not follow that a barbell is a perfect tool for its intended purposes; my efforts during the last 50-odd years have been directed toward improvements in barbell exercises. Yet, 140 years after Zander's first machines and 20-odd years after the first Nautilus machines, many people believe that a barbell is superior to any existing exercise machine. In fact, any result that can be produced with a barbell can be produced with any properly designed machine. And many important results that can be produced by exercise machines cannot be provided by a barbell.

For example, we know that probably the most important, and certainly the most critical, muscles in the body are those that extend the lumbar spine; and we now know that most of the exercises being used in attempts to strengthen these important muscles are utterly worthless for their intended purposes. Such exercises will strengthen the muscles of the hips and thighs while having no effect on the lower-back muscles.

In practice, it took us 14 years to figure out how to isolate the lumbar spine; in the end, we were successful only after we used the femurs as part of the pelvic-restraining procedure, thereby providing the bone-to-bone restraint that is required to prevent unwanted pelvic movement. See figure #3.

Second, gravity acting upon the mass of the torso, head and arms of a large man during a test of lower back muscles may reduce the subject's level of measured strength in the flexed position of the spine by as much as 150 foot-pounds of torque, while increasing the level of tested torque by as much as 60 foot-pounds in the extended position. The result is a measured level of strength that is far too low in some positions and too high in other positions – a meaningless test result. See figure #4.

This critical source of nonmuscular torque must be removed by careful counterweighting, and can be removed; in practice it is still being ignored during many current testing procedures.

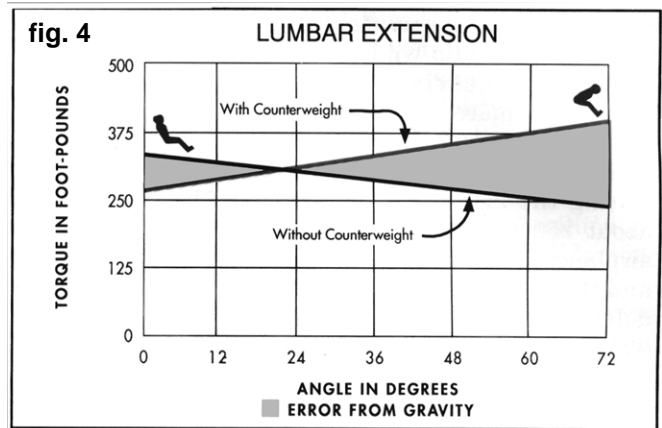
Third, during any dynamic testing procedure, friction tends to produce an understatement of the true level of strength during a test of positive (concentric) strength while over-stating the true level of strength during a test of negative (eccentric) strength. This influence of friction can be avoided by testing performed in a static (isometric) fashion, where friction is not a factor. See figure #5.

Dynamic test procedures also produce impact forces that are then usually mistaken for measurements of torque; impact that is avoided by static testing.

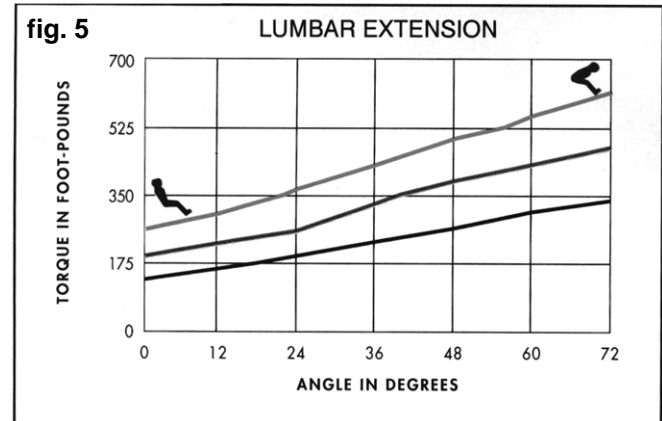
Fourth, movement of the body in any direction away from a neutral (relaxed) position produces internal resistance against continued movement; in the case of movement of the lumbar spine, moving forward toward the flexed position compresses soft tissue in the front of the spine while stretching soft tissue behind the spine. And this compression and stretching of soft tissue produces stored energy; stored energy that will then produce torque that will tend to return the spine to the neutral position. See figure #6.

Such nonmuscular torque from stored energy cannot be removed or avoided, but it can be and must be measured and factored into any measurement of total torque. If not considered, this factor will lead to a gross understatement of the true level of muscular strength in some positions and an overstatement in other positions. This critical factor can be measured only with a static testing procedure.

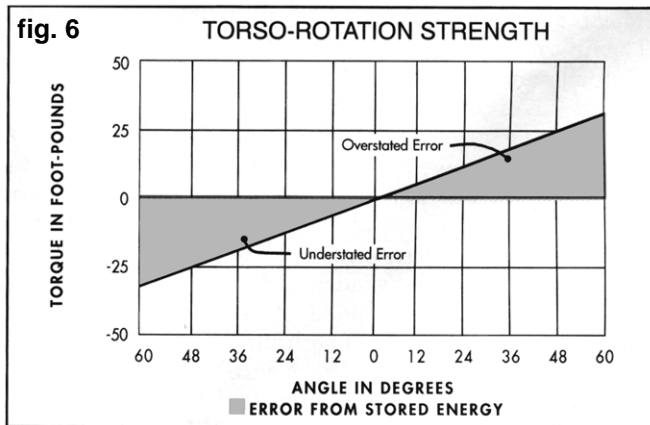
When all of the above listed requirements are provided, the result is a test of the true level of muscular strength, torque produced only by the force of muscular contraction and unbiased by any source of nonmuscular torque, Net Muscular Torque, NMT.



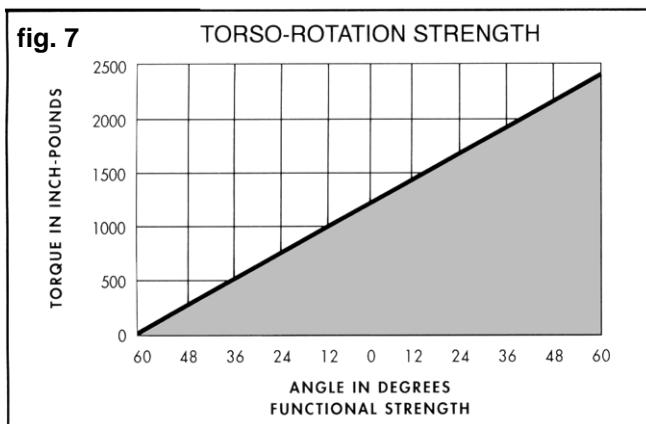
GRAVITY: This chart illustrates the effect of gravity on full-range strength of the totally isolated extensors of the lumbar spine.



FRICTION: Shown are three coexisting levels of fresh, full-range strength, influenced by friction, positive strength (bottom line) is too low while negative strength (top line) is too high; only the test of static strength (middle line) shows the true levels of fresh strength.



STORED ENERGY: On the right side of this chart, non-muscular torque from stored energy will produce an overstatement of the true level of strength, while on the left side of the chart torque from stored energy will produce an understatement of true strength.



POSITION: From the lowest to the highest level of measured torque through a full-range torso-rotation test, this subject's average strength varied in excess of 240,000 percent, an average change of more than 2,000 percent per degree of movement. The need for accurate measurement of the relative positions of the involved body parts is thus obvious.

with the School of Medicine at the University of Florida, Gainesville, and a team of researchers headed by Michael Pollock, Ph.d., has now conducted a total of 45 research programs using MedX equipment. This research has involved approximately 4,000 subjects, 20,000 testing procedures and more than 100,000 exercise procedures.

For the last two years we also have been associated with the Department of Orthopaedics and Rehabilitation of the School of Medicine of the University of California, San Diego, and a team of researchers headed by Vert Mooney, M.D., is conducting both research and clinical rehabilitation with thousands of chronic spinal patients.

Additional clinical research, involving thousands of chronic spinal patients has been conducted (and is still being conducted) in several other locations in this country, in Europe and in Japan.

Fifth, tested levels of NMT must be correlated with equally accurate measurements of the relative positions of the involved body parts. Changing from one position to another position in any full-range movement produced changes in strength, so you must be able to determine the exact position in which a test was performed. If not, then an apparent increase or loss in strength might be indicated when no actual change in strength had been produced. See figure #7.

Looked at collectively, the need for these requirements for meaningful testing procedures is sometimes intimidating. At first glance, it may appear that it is simply too complicated to be clearly understood.

But looked at individually, all of the requirements are actually quite simple and can be understood by almost anybody. And, in any case, all of these requirements are based upon simple laws of physics, and all of them can be clearly demonstrated in undeniable fashions.

Then why are they still being ignored by many people?

Because they are still being overlooked by many people, and because people sometimes continue to believe things long after they have been shown to be meaningless. A lot of people simply cannot bring themselves to admit that their earlier opinions were wrong.

How much research as been conducted with MedX equipment?

Initial research, using prototype machines, was first performed in DeLand, FL, in 1972; later research was performed at Colorado State University, in Ft. Collins, in 1973, which was followed by research at the United States Military Academy, West Point, in 1975. During the last 12 years we have been directly associated

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On July 5, 1993, the Dutch Government agreed to provide funding for a two-year-long clinic study to be directed by W.S. Zeegers, M.D., in Holland, utilizing MedX equipment for rehabilitation of chronic spinal pathology. Results of this study will probably not be published in scientific journals for at least three years; but if the results are consistent with those that have already been produced (and we have every reason to believe that they will be), this should lead to an enormous expansion of our business in Europe and elsewhere. Two years of investigation by the Dutch Government was conducted before they agreed to fund this research program, so a total of about five years will have passed between the initial application and publication of the final results. This is typical; science usually proceeds at a snail's pace, universal acceptance of any relatively new technology (regardless of its value) does not come quickly. Remember, the Wright Brothers were flying for a period of about six years before anybody in the scientific community would even admit that it was possible.

My age being what it is, universal acceptance of what we are now doing may not come within my lifetime; but it will come, because what we are doing is clearly established by simple laws of basic physics that cannot be denied forever.

You recently published a book entitled "The Lumbar Spine, the Cervical Spine, and the Knee." Where can copies of that book be obtained?

A free copy of that book will be sent to any clinicians who write on their professional stationary; requests should be sent to MedX Corporation, 1401 NE 77th Street, Ocala, FL 34479.

What is your relationship with Nautilus now?

None. I sold that company more than seven years ago in order to provide myself with both the funding and time for additional research. Research that eventually produced the first truly meaningful tools for the purpose of testing functional ability.

Where do you go from here. What comes next?

I don't know; if I knew the answer to that question then continued research would not be required. Very little turns out with much in the way of a similarity to what you expected. As somebody once said, "Life is what happens while you are planning something else."

What other projects do you now have in development?

Several, but since I cannot anticipate final results I will not discuss them until after the fact. Do it and then talk about it.

How have sales of MedX equipment compared to earlier sales of Nautilus machines?

The first five years of sales of MedX equipment were 5.5 times as high as the first five years of Nautilus sales; when corrected for the effect of inflation, that works out to an increase of 90 percent; that is, MedX sales, corrected for inflation, were 1.9 times as high as Nautilus sales for the same period.

Nautilus, while I owned and operated the company, was by far the most successful company in this field; if current projections prove to have any meaningful relationship with actual results, MedX Corporation will do much better. In the end, clinical results are the most important factor for success in this field; and since very good clinical results are now being produced worldwide, eventually this will be universally recognized.

What is your policy concerning computer software?

You have probably heard the expression, "GIGO: garbage in, garbage out." This means, quite simply, that the raw data fed to the computer must be both accurate and specific. Personally, my attention has primarily been directed toward the development of equipment that is capable of measuring exactly what we want to measure, the true level of strength of muscular endurance; until you have done that, nothing else matters.

Having done that, it then becomes necessary to deal with the raw data in a manner that is both accurate and practical; many people are neither willing nor able to deal with raw data, so the computer must perform several critical functions.

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It must record and store the data, present the results to the therapists in a simple manner, and explain just what the test results indicate. Both the computer and the software must be “user friendly;” they must not require a computer expert for proper utilization.

And the software must not be “fixed in time;” it should, instead be constantly changing as new information becomes available as a result of both clinical research and experience in the field. We are currently investing more than \$1 million annually in a continuously ongoing program to improve and expand our compute software. Then, as these improvements become available, all of them are incorporated into our current software programs; and, additionally, all of them are sent to all of our earlier customers without charge. Clinics that purchased out equipment six years ago now have the same computer software programs that they would have if the equipment had been purchased yesterday; and 10 years from now they will have the same software that they would have had if they purchased it then.

When you purchase a new airplane you can be sure it represents the current state of the art; federal law requires that the airplane must be capable of performing in exact accord with the manufacturer’s claims. That is not the end of the matter: Federal law also requires the manufacturer to provide the owner with continuous updates. During the first 10 years of ownership you may receive a hundred or more such updates – some of which will be suggestions for improving the airplane’s performance or safety, others being mandatory changes that must be incorporated. When these changes require structural modifications they will be paid for by the manufacturer, at no cost to the owner.

While such a policy is not required by law in regard to our equipment, we have adopted this policy as a matter of choice; because, in my opinion, anything less would be irresponsible. Black or white, right or wrong, shades of gray are not acceptable. As they say, “Close is meaningful only with horseshoes, hand grenades or nuclear bombs.” If, or when, it becomes possible to improve either our equipment or our software, it is our responsibility to retrofit any such improvement into every piece of our equipment then in use. Apart from the policy mandated by federal law in regard to aviation, our warranty to our customers is unprecedented in any industry that I am aware of.

In the field of medical devices, regulation by the FDA is now much more strict than it was even a few years ago – monitoring of equipment, claims being made on behalf of that equipment, and manufacturing standards used in the production of the equipment is a continuously ongoing procedure. Our standards are so far above the requirements established by the FDA that repeated investigations by the FDA have never resulted in any sort of suggested change.

If I understand the implication of what you have said, your equipment will ever become obsolete.

There is no reason why it should ever become obsolete. While most people are not aware of it, the average age of the airliners now in use in the country is about 20 years, and some of them are more than 50 years old. The B-52 bombers used in the Gulf War have been in continuous service for more than 40 years.

With very little in the way of routine maintenance, our equipment should still be in use 100 years from now; thousands of Nautilus machines that I sold more than 20 years ago have been used continuously ever since, and MedX machines are designed and manufactured in accord with much higher standards than those that were applied to early Nautilus machines.

If automobiles were built to the same standards that we use, future sales of cars would probably drop by 90 percent; once having bought a car, there would never be a reason to replace it. Things that are built right should never wear out. I would not be surprised to learn that some of Dr. Zander’s machines, built 140 years ago, were still in use. According to Dr. Tom DeLorme, medical director of Liberty Mutual Insurance Company, some of Dr. Zander’s machines were still being used in several major hospitals in this country as recently as 40 years ago.

Dr. DeLorme, by the way, is generally considered to be the “father” of rehabilitative exercise; he wrote the first article ever published on the subject, an article that was published in a medical journal in 1944. Dr. DeLorme also was responsible for making me aware of Dr. Zander’s much earlier work in this field, and he provided me with a copy of a book about Zander’s work that was published in Germany in 1906; a book that we republished about two years ago.

I believe your policy, but how has that policy been applied in practice?

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The first testing tool that was capable of providing accurate, specific measurements of lumbar-spinal functions, the MedX Lumbar-extension machine, was produced seven years ago; but our attempts to provide a perfect tool for its intended functions did not stop at that point; since then, meaningful improvements have been developed, and the original machine has been modified five times as a consequence. Improvements have been incorporated into our current equipment and have been retrofitted into every machine delivered to a customer earlier.

The functions of the earlier machines have not changed, but later improvements made it easier to use the equipment. At the moment we are investigating the value of the two other suggested modifications; and if these changes prove capable of improving the machine, they will also be retrofitted into all earlier machines.

What is the most important thing that you have learned since the MedX Lumbar-extension machine was first developed?

We have learned, among other things, that the muscles that extend the lumbar spine appear to be unique in several ways. One, most people have the potential for enormous increases in strength in these critical muscles. Two, an increase in strength in excess of 100 percent can be produced by almost anybody within a period of only 10 to 12 weeks, providing only that the exercise is specific. Three, such strength increases can be produced as a result of only one exercise each week. Four, having increased the strength of the lower back muscles to a very high level in response to specific exercise, that high level of strength can be maintained by a schedule of only one exercise each month – once a week for 10 or 12 weeks to build it and then once a month to maintain it.

No other muscle in the body that we are aware of responds to exercise in such a similar manner. But given this unique response of the lumbar-extension muscles, this knowledge can be applied in a manner that is both very productive and cost effective. A coal-mining company in Montana that is plagued by lower back injuries recently started a program of specific exercise in an attempt to prevent such injuries by increasing their employees' lower back strength. If such a program required several hours of exercise a week, it would not be cost effective; but this program requires only five minutes a week during the first 12 weeks and then only five minutes a month.

While our machines are certainly very valuable for rehabilitation of chronic spinal pathology, I believe they have an even greater potential in the area of prevention. It will require a period of several years to determine just how effective such exercise is for the prevention of injury, but even a 10 percent reduction in the number of such injuries would provide enormous savings. Personally, I believe the reduction in injuries will be much greater than 10 percent, perhaps as much as 50 percent. If it is stronger, then it should be less likely to break; and if it does not break, then you do not have to fix it.

In addition to your very sophisticated and computer-monitored machines for medical testing and rehabilitation, I understand that you have also introduced a full line of exercise machines for health clubs and fitness centers. How do these compare to other equipment being sold to that market?

Based on what we have learned for many years of research for the development of machines for medical purposes, we have used that knowledge in order to design a full line of exercise machines for general use. These new machines are, quite literally, a "great leap forward" when compared to anything else on the market.

We have carefully considered and have provided solutions for all of the problems associated with any earlier type of equipment. For example, most competing machines provide only 20 or 30 levels of resistance, while our machines provide a minimum of 140 levels of resistance. Second, other equipment allows a minimum change of resistance in increments of at least 20 foot-pounds; in contrast, our machines provide changes in increments of only two foot-pounds, which permits the user to select the exact level of required resistance regardless of their level of strength. Both friction and kinetic energy have been reduced to levels far below those that are found in other equipment, the result being a form of exercise that is almost perfectly smooth. Without exception, people who have tried this new equipment found it far superior to anything else now on the market.

A full listing of all the improvements incorporated into this new line of machines would require far too much space, but people who are interested can get all of the information by writing MedX.