

Nautilus Bulletin #2

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The Moment-Arm Factor

If you are sitting off to one side of a table, with your eyes on exactly the same level as the edge of a plate upon the table, and if a bug is walking around the near edge of the plate – then it may appear, from your viewpoint, that the bug is walking in a perfectly straight line; but in fact, the bug will be moving in a circular fashion – if he continues moving long enough in the same direction, he will eventually complete a full circle, having walked entirely around the edge of the plate.

Or, if your eyes were slightly above, or below, the edge of the plate, then it might appear that the bug was walking in a curving fashion – but was following a curve with a larger radius than the actual radius of turn; in effect, the bug would appear to be curving less than he actually was.

In the above examples, I said "may appear" and "might appear" very pointedly; because, if you were aware of the actual facts, then you could ignore "appearances" and see things as they actually were. While no amount of "understanding" will assure good results from weight-training, it nevertheless remains perfectly true that actual knowledge is required for producing good results – actual knowledge possessed by "somebody", if perhaps not by the trainee himself; if the trainee doesn't understand, then at least the coach must understand – but somebody has to be aware of the actual facts, and in a position to enforce a style of training in accordance with the facts.

Different people will unavoidably have different viewpoints – the trainee may see the bug as walking in a straight line, the coach may think it is walking in a slightly curving line; in which case nobody is aware of the facts – but both parties will very naturally have strong opinions on the subject, opinions which they will sincerely feel are based on solid observation and undeniable personal experience, and yet they are both wrong.

Additionally, your distance from the situation will influence your viewpoint – literally and figuratively; in the case of the bug on the plate, in order to see the situation properly, you would have to be directly above the center of the plate, looking down – but you would also have to be an infinite distance away, because, from anything less than an infinite distance, your perspective would be distorted. In training situations, your relationship to the overall environment – and your relationships with the people who are a part of that environment – will always distort your perspective to at least some degree.

If you are training in a gym with the current Mr. America, and if you like him personally, you will rather naturally look upon his advice as sound, "...after all, he did win, didn't he?" But in fact, with his potential, perhaps he should have won earlier – maybe his own firmly held beliefs have delayed his progress enormously.

You think otherwise? Well, let me give you a case in point; I have just finished a year devoted to (among other things) the training of Casey Viator, who recently won the Mr. America title in the most spectacular style in history – together with the Mr. America title, he won five of the "subdivisions", most muscular, best arms, best back, best legs, and best chest, so, all in all, he took home six out of a possible seven trophies from that contest; additionally, during the year that he trained under my supervision, he won every other contest that he entered – the Teen-Age Mr. America, the Mr. U.S.A., and the Jr. Mr. America; and on top of that, he is undoubtedly the most massively muscular bodybuilder in history, fully as defined as any major physique contestant has ever been, literally "because of his size" rather than in spite of it, because his size is muscular size, not fatty tissue, and he is one of the strongest men in the world, and certainly by far the strongest bodybuilder in the world.

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Under the circumstances, you would probably expect Casey to be extremely well-informed on the subject of proper training; but is he, in fact? Quite frankly, I simply don't know; all I can do is judge his knowledge on the basis of my experiences with him. And since I like Casey, this becomes difficult to do; because it puts me in an unavoidably biased position.

When Casey first came to Deland, Florida to train under my supervision, he weighed 198 pounds in well-defined, muscular condition; his largest upper-arm measured exactly 18 1/6 inches; and while he was fairly strong for a bodybuilder of his size, he could not have squatted once with 500 pounds if his life had depended on it.

A bit less than a year later, his largest upper-arm measured exactly 19 15-16 inches; he weighed 218 pounds in even more defined condition; and two days before the Mr. America contest that he won, he squatted 13 repetitions with 502 pounds – after "pre-exhausting" his legs with 20 repetitions with 750 pounds in the leg-press and 20 repetitions with 225 pounds in the thigh-extension machine. All three of which exercises, leg-presses, thigh-extensions, and squats, were performed in rapid succession, with no rest between sets.

And while the "actual gains" that Casey made during that time are really not exceptional – his "relative gains" are almost unbelievable; since the larger you become, the harder it becomes to get even larger – the first part of the trip up a mountain may not be too hard, and you may move quite rapidly, but wait until you get near the top and see how fast you are moving. You may reduce your time for the mile from six minutes to five minutes with very little training – but then see how long it takes you to reduce it to four minutes.

Yet, the simple truth of the matter is that Casey probably could have gained at least twice as much as he did during that period of time – and I really expected him to do so; I wanted him to weigh-in at the Mr. America at a bodyweight close to 240 pounds, with a "cold" upper-arm measurement in excess of a legitimate 20 inches – and I think he could have done so, if I had actually trained him during the entire period while he was in Florida.

Casey never failed to cooperate fully when I was training him – if I told him to do something, he did it – If I told him to avoid something, or change something, he did it; I have no slightest complaint regarding his cooperation – but, unfortunately, I simply did not have time to supervise all of his workouts.

Up to November 1st, 1970, I did supervise almost all of his workouts – and he gained in size, in strength, and in muscularity (definition) during that period; when we took a photograph of his back and another photograph of his arm on November 1st, Casey could hardly believe that they were actually pictures of him, and said so.

But from November 1st until April 1st – a period of five full months – I was simply too busy to supervise Casey's training; so during that period he trained with several people for different periods of time – still in the Deland High School gym, still using all of the Nautilus equipment and a large variety of conventional equipment, but without my supervision.

And for a period of five full months, his muscular size, strength, and degree of muscularity steadily declined – and if you think not, then compare the pictures that were taken on November 1st, 1970, and that were published shortly afterwards in Iron Man, to the picture of Casey that was on the cover of Muscular Development magazine a few months later.

Peary Rader, the publisher of Iron Man Magazine, wanted a good color photo of Casey to use on the cover of his magazine for the issue that appeared just prior to the Mr. America contest – and in an attempt to get a good picture of Casey, we took literally hundreds of color photographs; but none of them were satisfactory – Casey looked "smooth" in all of them, he looked "fat", because he was fat.

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So, on the first of April, with the next contest – the Junior Mr. America contest – only six weeks away, I realized that I had to start supervising Casey's workouts again; or take the risk of having him lose the contest. So I did start supervising his workouts again – every repetition of every set of every exercise during each workout.

While he had been supervising his own training, Casey had fallen back into the habit of training almost every day – and always at least five days each week; so the first thing I did was get him back on a schedule of three workouts each week – and the second thing I did was cut out about half of the exercises he had been doing while supervising his own training – and the third thing I did was cut his number of sets to two per exercise in most cases, and one per exercise in some cases; for example, only one set of squats, three times weekly – and the fourth thing I did was to assign a very strong football player the job of training with Casey in order to "push" him – and the fifth thing I did was push them both.

And immediately, Casey started moving in the other direction – we could literally see him grow from workout to workout; his high-repetition sets of leg-presses moved from 400 pounds to 750 pounds within less than a month, his squats (after "pre-exhaustion") moved from less than 400 pounds to over 500 pounds in the same period of time – he got larger, noticeably larger, by the workout – he became more defined, day by day – and within four weeks he was almost back into the shape that he had attained earlier, the peak of condition that he reached the previous November 1st – and within six weeks, by the time of the Junior Mr. America contest, he was in almost unbelievable condition, larger, stronger, and more defined than he had ever been before. When Red LeRille (Mr. America of 1960) saw him – and Red prepared Casey for the Mr. America contest the previous year, eleven months earlier, and thus was very familiar with Casey's physique – he stated that he ". . . would not have believed that Casey could improve that much in a year if he hadn't seen it personally."

Yet, in fact, it hadn't "actually" been a year – it was more like six weeks; or, if you want to include all of his training that produced gains instead of losses, you could call it twelve weeks – six weeks "up", five months "down", and the six weeks "up" again.

So – did Casey actually learn anything while training here? I don't know; but from all appearances, I can only say that he certainly displayed very few signs of any real learning – and no practical results at all, except negative results.

Now – it may well be true that Casey is an individual who cannot – or will not – push himself; and you must be pushed by somebody to produce the size and strength that he attained while I was supervising his training –if you can't, or won't, push yourself, then somebody else must do the pushing for you.

Ellington Darden was present during Casey's last week of training just before the Mr. America contest, and he remarked ". . . it would be interesting to know just how much of the results are produced by the machines and how much by Jones' pushing."

Which is certainly an interesting question – and one that I obviously can't answer; but it should also be obvious that you can't push with a rope, you must have a pole – regardless of how much I push, the machines must still be able to do the job, otherwise the results would not be produced. And anybody familiar with my writing should certainly be aware that I have always clearly stated that the machines are merely tools – and that like any tool, they will do nothing by themselves; they must be used, and used properly, and like any tool they are subject to misuse.

Then two or three days before the Mr. America contest, I overheard Casey tell somebody in the gym that, ". . . I learned long ago that it is impossible for me to overtrain."

All I can say is, ". . . did he?"

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Now – let there be no slightest doubt on one point; Casey trained hard –Casey performed actual workouts – Casey made the gains – and Casey deserves the credit for these gains. But that is not my point; my point is, ". . . did Casey actually learn anything from the experience?" Under the circumstances, I can only judge from my experiences with him – and using that experience as a guide, I am forced to say that he apparently learned very little.

But I certainly learned something from those same experiences. I was able to demonstrate just what could be done with a subject who has far better than average potential and a willingness to work hard (even if he apparently does require outside pushing; which most of us do at one time or another, in one way or another), and I also learned that I must personally supervise every workout if I am going to be sure of best-possible results.

And using these lessons as a guide, I know what to do next time – and just wait and see what we do for next year's contest; but I can tell you very clearly in advance that you will probably be literally shocked when you see the results of a year of proper training on the Nautilus machines – again with a subject who has far better than average potential, but this time with my constant supervision of all of his workouts.

And please do not misread any of the above as criticism of Casey – in spite of my generally bad opinion of bodybuilders as a group, I enjoyed supervising Casey's workouts; it is only a shame that I couldn't find the time to supervise all of them while he was here.

And what does the future hold for Casey now? Again, all I can say is that I don't know; he originally intended to stay here and train at least until the time of the Mr. Universe contest in London, in September of 1971, but then he got married, and things changed insofar as his immediate plans were concerned. For the benefit of any readers who may be interested in my personal advice to Casey upon the occasion of our last conversation just before he returned to his home in Louisiana, I will mention that I advised him to go back to school – and to get clear out of the bodybuilding scene; but since my opinion of the current bodybuilding scene has very little in common with Casey's opinion of the current bodybuilding scene, and since Casey is 19 years old, and since I am . . . well, older than that, and since my ambitions are not the same as Casey's, I really don't know what he intends to do, and I doubt if even he knows at this point. How many people do – at nineteen?

I made him an offer that involved staying here, and working, and going back to school – but he apparently has something else in mind; or maybe he just wants to get out on his own and see the world a bit – which at his age is perfectly normal.

But, wherever he goes, and whatever he does, I wish him the best of luck; in today's world, at nineteen, with an almost unbelievable physique and perhaps too much publicity, he is going to need lots of luck – especially if he stays on the bodybuilding scene.

So – there is one case in point, a recent case, a case based on personal knowledge and experience, involving a young man with perhaps the greatest physique up to this point in time, and certainly the greatest at his age; and is he an expert? Would his advice be sound?

So don't look to the "experts" for advice; instead, try to understand at least the basic facts involved – and when you do, then you can at least base your training on facts, instead of on perhaps well-meant but probably faulty opinion.

In the direction of understanding the first of the required facts – or factors – let us now examine some basic laws of physics; starting with a simple, clear look at something called a "moment-arm."

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It is easily possible to move almost any amount of weight an actually great distance, and you can do so while producing almost nothing in the way of power – if the VERTICAL distance of movement is not great, and if you do not attempt to induce sudden acceleration; if your car is parked on smooth, flat pavement, you can push it quite easily – if you start the movement very gradually. But just try lifting the same car.

In the first instance, when you are pushing the car on a flat surface, the "moment-arm" is effectively ZERO; in order to move the car, it is only necessary to overcome the inertia of the unmoving mass (or, in fact, since everything is always moving in several directions, from the rotation of the planet, the rotation of the galaxy, etc., you must "overcome the inertia by changing the direction of movement" – even though, because of your viewpoint, you may not be aware of the actual movement that existed prior to the movement initiated by your own efforts), and, of course, you must also overcome the friction involved in such a situation – all of which is rather easy to do, if you start the movement slowly and smoothly.

But in the second instance, when you are attempting to lift the car, the situation is entirely different – from a moment-arm of zero, you have moved to a moment-arm of 100 per cent, every inch of movement will be an inch of VERTICAL movement; in effect, you have changed the situation from one where you had an almost infinite leverage advantage to a situation where you have no leverage advantage at all.

While the above example is not perfectly valid in technical terms – it is, I think, a worthwhile example of the points I am trying to get across.

Now let us again imagine that the same car was parked on the end of a diving board – and that the diving board, instead of being rigidly attached on the opposite end, was supported by an axle – and, for this example, let us suppose you have a very light car – one weighing 1000 pounds. Let us also suppose that the length of the diving board – from the center of the axle to the center of the car – is exactly 10 feet long.

The "downwards" force exerted by the car would be attempting to rotate the diving board around the axle – and this rotational force would be properly known as "torque." In this example – when the diving board was perfectly horizontal – the amount of torque would be exactly 10,000 "foot-pounds". The distance from the center of the axle to the center of the car would be 10 feet – and that 10 feet would represent the "moment arm" – and the torque (the twisting force applied to the axle) would be determined by multiplying the moment-arm by the weight of the car; 10 times 1000 – or 10,000. There would, of course, also be some torque resulting from the weight of the diving board – but in this example we will ignore it, assuming that the diving board was infinitely rigid and infinitely light in weight.

The 10,000 foot-pounds of torque would be the "maximum-possible" amount of torque in this situation – and you would have the amount of torque ONLY when the diving board was perfectly horizontal. If ANY movement occurred –either up or down – then the torque would be reduced; never INCREASED –always REDUCED.

If the diving board was rotated 90 degrees – either up or down – and assuming that the car was attached to the diving board so that it could not fall off, then there would be no torque, literally NONE. Because, then, the moment-arm would be zero – and zero multiplied by any amount of weight is still zero.

And just how did we determine the moment-arm? Very simply; when the diving board was horizontal, we drew a VERTICAL line through the center of the axle, and another VERTICAL line through the center of the car – and then we measured the HORIZONTAL distance between these two vertical lines, and that distance is the moment-arm.

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But when the diving board was rotated 90 degrees, so that the car was hanging straight down (or sitting on top of the vertical diving board), then a vertical line that passed through the center of the axle would also pass through the center of the car – if you drew two vertical lines, one through the center of the axle, and one through the center of the car, then the lines would have zero horizontal distance between them. The moment-arm would be zero.

If you stood under the car, while the diving board was perfectly horizontal, and attempted to rotate the diving board by pushing straight up on the car, then you would have to exert something in excess of 1000 pounds of force to produce movement – exactly 1000 pounds of force would be required to merely support the car, to prevent it from pushing you down; but literally ANYTHING IN EXCESS OF 1000 POUNDS of force would produce movement upwards – and the greater the force, the faster the upwards movement would be.

However, if you wanted to move the diving board (and the car) while the diving board was in a vertical position, then only a very slight amount of force would be required – only enough force to overcome the momentum and the friction involved.

In both cases you would be rotating the diving board and the car around the axle – but in one case it would require a great amount of force, and in the other case it would require only a very small amount of force.

Because – when you were pushing upwards, you were trying to move the diving board and the car VERTICALLY, but when you were pushing "across", you were trying to move the diving board and the car HORIZONTALLY.

For all practical purposes – in the field of exercise – we can (and should) ignore anything except VERTICAL movement of resistance; it makes no slightest difference in which direction we are pulling or pushing, and the "total amount" of movement is of no importance – what matters, and all that matters, is the vertical movement of the resistance.

All human movements involved in exercise are very similar to the example of the diving board and the car – all such movements are ROTATIONAL movements; and as an unavoidable consequence, the moment-arm (and thus the torque, the actual resistance) is constantly changing – in some areas of movement there is literally no resistance, and in other areas of movement the resistance is 100 per cent of its actual weight. And it makes no slightest difference that the actual weight is not rotating in some instances – because SOMETHING is ALWAYS rotating; if not the weight, then the involved body parts – or perhaps the rotation is shared, part of the actual rotation may be on the part of the weight and part of it on the part of the involved body parts –but it amounts to exactly the same thing in the end. Such rotation is unavoidable – it cannot be eliminated; and it must be understood – and allowed for.

When "compound rotation" (rotation around two or more separate points) is involved – as it is in a press, a squat, and in many other exercise movements – then the situation becomes a bit more difficult to understand; but the factors are the same in all cases – and the results are unavoidably the same. In an effort to avoid unnecessary complexity of explanation, I will simply skip any detailed mention of compound rotation – and will limit my examples to single-rotation situations, such as the curl.

In a standing barbell curl, there is literally no resistance at the start of the movement – because in that position, the moment-arm is zero. Likewise, at the end of a curl, there is no resistance – for exactly the same reason.

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Viewed from the side, the performance of a curl goes about as follows; at the start, the forearms are in line with the upper-arms and the center of the barbell is directly below the center of the elbow joint – thus a straight, vertical line drawn through the "axis of rotation" (the elbow) will also pass through the center of the barbell. Thus the moment-arm is zero – and the torque is also zero, regardless of how much the barbell weighs.

The movement can be started with almost literally no power – since, at the start, you are moving the barbell perfectly horizontally, there is absolutely no vertical movement at that point; but as the curl progresses, the "direction-of-movement" rapidly changes from horizontal to vertical –after the first 45 degrees of movement, the direction-of-movement has become equally divided between horizontal movement and vertical movement, and (for the average man) the moment-arm has increased from zero to about 8 1/2 inches, and the torque has increased from zero to approximately 850 "inch pounds" (assuming a barbell of 100 pounds weight).

During the first part of a curl, the effective resistance will increase very rapidly – and during the next 45 degrees of movement it will continue to increase, but at a slower rate of increase. So, at the so-called "sticking point" in a curl, after the first 90 degrees of movement, when the forearms are bent 90 degrees in relation to the upper arms, and when the forearms are parallel with the floor (perfectly horizontal), the moment-arm will be at its highest point – the moment-arm will be about 12 inches, and the torque will be approximately 1,200 inch-pounds, or 100 "foot-pounds". In either case, of course, the torque is calculated by multiplying the moment-arm by the resistance; 12 inches times 100 pounds equals 1,200 inch-pounds – or one foot times 100 pounds equals 100 foot-pounds.

Thus during the first 90 degrees of movement in a curl the resistance is constantly changing – at first it increases very slowly, then it starts increasing more rapidly, and then it slows down again; but it is constantly increasing throughout that first 90 degrees of movement.

After the first 90 degrees of movement, the resistance continues to change – but from that point on to the end of the movements moment-arm, and thus the torque, decreases; and by the time the curl is finished, the moment-arm has returned to zero – and there is no resistance at all.

So now we should add the following points to our list of basic points . . .

36. You cannot learn the proper method of training a race horse by asking a race horse.
37. If left up to their own devices, most trainees will not train properly.
38. In order to produce maximum-possible results, "somebody" has to push the trainee, any trainee; some trainees can and will push themselves – most will not, or cannot.
39. The moment-arm of the resistance must be considered in order to determine the actual resistance imposed on the muscles.
40. All exercise movements are rotational in nature.
41. The resistance imposed upon the muscles in all conventional forms of exercise is constantly changing as movement occurs.
42. There is literally no resistance in the finishing position of many conventional exercise.