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EDITORIAL MISSION STATEMENT

The editorial mission of the EWF – Scientific Magazine is to advance the knowledge of human movement based on the assumption that it is firstly, by any standard, the expression of muscular strength and secondly, a way of life and an ethical approach entrusted to professionals who not only are highly qualified, but also have full knowledge of the scientific facts, as well as being specifically competent. From its first issue, EWF – Scientific Magazine, has set itself the ambitious goal of bridging the gaps between the scientific laboratory and the operator on the field, enhancing both the practical experience of the coaches and the results of applied research. Consequently, the editorial rule will be a constant reference to practice and the publication of recommendations on how to apply the results of research to the practice of movement and sport.

SUMMARY

The pull is one of the most important movement-phases in weightlifting for a good and successful lift. It plays a central role in lifting heavy weights. The technical execution depends on the distribution of the acceleration along the distance of propulsion and also on the amount of the acceleration

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We talked about a Body that moves 24 hours a day, that performs a pirouette, that carries an oval ball over a line, that jumps long, high and sometimes low; a body which, in moving, exerts a function; and that, by working, changes its Shape and the shape of the world around it. Nothing more. But also, nothing, absolutely nothing, less.

EDITORIAL

Training and competing: two sides of two different coins?

In this issue I would like to take into consideration two fundamental aspects of sport: training and competition. Two elements of a much larger complex, the human machine, often unknown or little known to those actually involved in sport, often ignorant of well-known facts, but that's another story.

Training seen as a function of competition, and competition seen as the cause for which one trains, but is that really so? I train, so can I compete? That would seem to be the case: I train, I prepare, so I am in the condition to compete. Let's take some points into consideration:

1) What is the margin of similarity between training and competition?

2) The psychophysical differences with which you approach training and competitions.

3) The logistics of one and the other.

4) Time zones, weather conditions, diet.

5) Spectators.

6) The expectations of the athlete, trainer and Federation.

The answer to these six points leads to a consideration of the two complex phenomena within a further complex phenomenon that contains them. It is rather simplistic to say that an athlete trains to compete, or is it really so? Or have we standardized the two things, making one become a consequence of the other?

As always, let's start from the etymology of the word. Compete: dictionaries define this term as a word deriving from the Latin *compĕtĕre*, composed of *com* - and *petĕre* «to ask, to head towards, to go, to ask together».

Competition is therefore going towards something or someone.

An illustrious Italian dictionary, Treccani, refers to the definition of training given by Prof. **Pasquale Bellotti** as follows: training is a physical and mental commitment, in various working and intellectual activities, training allows the human being to acquire ability skill and dexterity through regular and planned exercise. More specifically in the world of sport, training is a methodic activity of physical, psychological and tactical preparation, aimed at achieving maximum efficiency in competitions, or keeping in good shape. The organism's adaptations, which are the purpose of sports training, are caused by the physical load, or workload, in other words the series of exercises whose intensity and specificity varies depending on the athlete's abilities.

We could simply define training as the functional preamble to competition. I train, I prepare, I adapt so that I can compete. This flowing of acquisitions from one process to another is taken for granted, but

in reality, the form and substance of the two are not that easily transferrable.

The conditions in which one trains, particularly in weightlifting, are dictated by the repetition of the movements used in a competition and may include the following:

- different logistics to a competition venue;
- the addition of exercises not performed in a competition;
- the volume of work in training is not reproduced in a competition;
- variations of intensity that differ from that in a competition;
- training session times often much longer than competition times;
- no spectators, judges or opponents;
- different clothing used during training;
- competition times often different to training times.

In addition, competitions are often held in different continents or latitudes:

- different food in terms of quality and quantity;
- jet lag without enough time to recover from it;
- time taken in moving to and from competition and training venues;
- different training and competition equipment;
- high numbers of spectators or total absence.

So, what do training and competition have in common? We can say that both require the development of a certain quality - competence. Because to train and compete, one must be competent.

Competence also derives from the Latin term "cum – petere", which generally indicates an individual's ability to combine, in an autonomous, implicit or explicit way, and in a particular context which is not always reproducible, the various elements of the skills and abilities they possess.

Another etymological take on the word suggests that a "competent" individual is one who has authority in a certain field. Somebody who is competent therefore, is considered suitable, with legitimate jurisdiction and the power to judge something.

Guy Le Boterf, Associate Professor and Advisor at the University of Sherbrooke (Canada 2004) defines competence as "a set recognised and tried by representations, knowledge, capacity and behaviours mobilised and combined pertinently in a given context". Representations, knowledge, capacity and behaviours can be summarised with the term resources, leading us to affirm that competence is a specific quality of an individual: knowing how to combine different resources in order to manage and face situations effectively in a given context.

Michele Pellerey, Full Professor of General Education at the Salesian University of Rome, defines competence as follows: "an integrated set of knowledge, ability and attitudes, all necessary to carry out a task effectively and efficiently". Competence and Ability to carry out a task or a set of tasks, being capable of activating and orchestrating one's own inner, cognitive, emotional and volatile resources and using the available external resources in a coherent and productive manner.

Rosario Drago: "Competence is essentially what an individual shows he is able to do (physically and intellectually) effectively, in relation to a specific goal, task or activity in a certain disciplinary or professional field. The conclusive and observable result of this competent behaviour is performance".

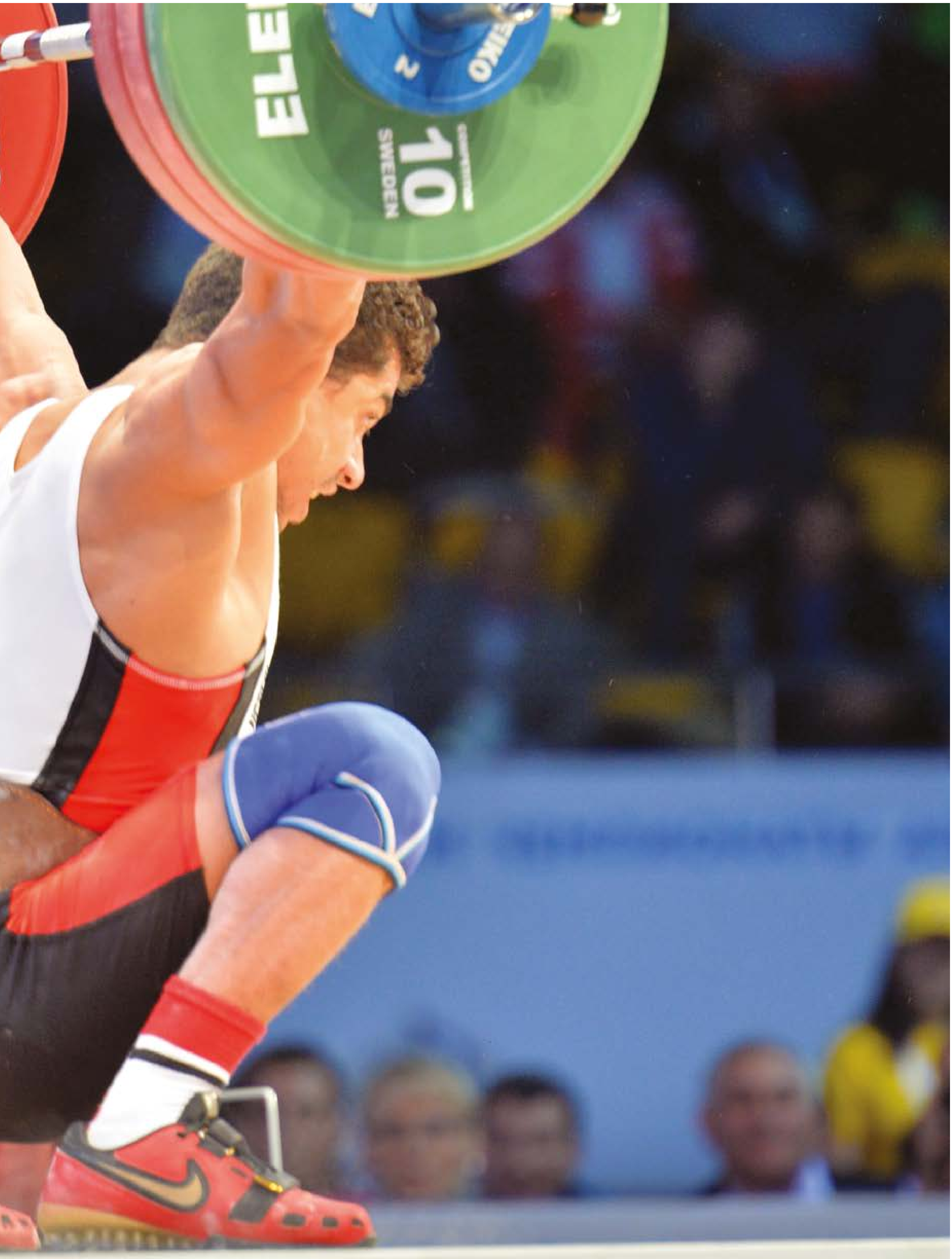
To transfer the training process into the competition process therefore, the head must work. A head that knows how to transform learning and experience into solutions. And once again, this process must start from the coaches, who have already understood and put these elements into practice in their profession.

If they lack this competence, then the risk is that training and competing are actually two sides of two different coins.

Antonio Urso
EWF President

SNATCH TECHNIQUE OF MALE INTERNATIONAL WEIGHTLIFTERS: A LONG-TERM ANALYSIS

BY INGO SANDAU, JÜRGEN LIPPMANN, ILKA SEIDEL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The official journal of the European Weightlifting Federation

The purpose of this study was to explore changes in snatch technique from 2004 to 2014 based on kinematics of the barbell. For this purpose the first six male athletes in all eight weight categories in four international weightlifting championships were examined. To assess long-term changes, snatch technique were analyzed using two-dimensional videometry of the barbell. The results of the long-term analyses show a clear shift in velocity production from the first pull to the second pull over time with a decrease in maximal velocity in the first pull and an increase in the maximal vertical velocity in the second pull. Consistent with the overemphasis of the second pull, there is a worse execution of the turnover and catch phases. By changing the way the barbell is accelerated to achieve the necessary velocity for a maximum lift, the propulsion can theoretically be improved because of preventing a velocity dip in the transition. However, this lifting technique change in the acceleration phase is accompanied by drawbacks in succeeding movement phases. As a result, there was no increase in the maximum weight lifted in the competitions from 2004 to 2014. Weightlifting coaches should be aware of an overemphasis of the second pull and the accompanied negative effects on the turnover and catch phase.

INTRODUCTION

Every weightlifting exercise can be described based on four main movement phases [16]: (a) start, (b) pull (acceleration), (c) turnover, and (d) catch and stand up. The pull is one of the most important movement-phases in weightlifting for a good and successful lift. It plays a central role in lifting heavy weights. The technical execution depends on the distribution of the acceleration along the distance of propulsion and also on the amount of the acceleration [10]. Both characteristics contribute to the velocity of the barbell at the end of the acceleration phase. With respect to the process of acceleration, velocity and the movement of the lifters body, the pull in weightlifting can be further divided into three separate phases: (b1) first pull, (b2) transition and (b3) second pull [4,5,7,16]. Execution of the acceleration phase without any drop in velocity in the transition is considered to be the better and more efficient technique [9,16]. The loss of vertical barbell velocity in the transition phase results in a large knee extension at the end of the first pull or an excessive barbell velocity at the end of the first pull [2,4]. The high velocity of the barbell leads to a velocity drop, even when the knees are not very extended, because the athlete cannot realign his body in the transition quickly enough to produce an active force on the barbell. The lifter and barbell are a fixed mechanical system in the lifting movement ("barbell-lifter-system") [20,22]. Hence, the lifter's body motion is widely reflected in the barbell movement, and the lifting technique can, therefore, be analyzed through quantitative parameters of the barbell. The assessment of lifting techniques by analyzing the movement of the barbell alone is a standard procedure [5,8,11,12,18]. A technical error, e.g., a drop in velocity in the transition, can be objectified by measuring the vertical barbell velocity. Typical kinematic parameters for rating the lifter's technique through the analysis of the barbell's motion are the (vertical) linear velocities at the end of the first pull as well as in the transition and at the end of the second pull. The vertical velocity of the barbell is a key parameter in weightlifting [1]. The underlying acceleration of the velocity is at a first peak in the first pull (after lift-off), has its minimum in the transition and has a second peak in the second pull. Few data exist in the literature regarding vertical barbell acceleration, although information regarding the acceleration is very important when rating lifting techniques [22]. Drop-under time, drop distance and drop velocity of the barbell are commonly used for rating the turnover and catch phase. Until now, no scientific investigations regarding possible technical changes to separate phases of the snatch over time have been published. The aim of this study was to investigate if there were changes in snatch technique, specifically the way the acceleration phase is executed by elite male international athletes with respect to time. Additionally, this approach is based on the great importance of the acceleration phase in scientific studies [4,14,15]. We hypothesized that technical changes occurred over time and that these changes would be reflected in the kinematics of the barbell in the pull, turnover and catch phases of the snatch. Additionally, in cases of technical changes, we also expected changes in maximal weights lifted in the competition.

METHODS

EXPERIMENTAL APPROACH TO THE PROBLEM

This study is a descriptive analysis. The main concern was to evaluate kinetics of the barbell of elite male athletes over several years and to check for changes in snatch technique in context to the snatch performance. The outcome of this study will help to further specify the technical model of snatch technique and to give scientific based recommendations for coaches to teach and correct snatch technique for a maximal performance.

SUBJECTS

For our analysis, we selected the first six ranks in male weightlifting in all eight weight categories in the 2004 Olympic Games (OG) and the 2007, 2011 and 2014 World Championships (WC). Because the biomechanical characteristics in weightlifting depend on body weight [3,4], the total sample for every year (N = 48 athletes) was divided into two weight category groups (n = 24) for a differentiated analyses. The first group (group 1) represented the four lighter weight classes (-56 kg, -62 kg, -69 kg, -77 kg), and the second group (group 2) represented the four heavier weight classes (-85 kg, -94 kg, -105 kg, +105 kg) **(table I)**.

PROCEDURES

The competitions were analyzed using Realanalyzer (IAT, Leipzig, Germany) two-dimensional video software to study the lateral movement from one side of the barbell. This software is a custom-built system for analyzing techniques in weightlifting by automatically tracking the barbell while it travels through the lift. The video sequences were captured with a dv-camcorder (Panasonic NV-GS500) that operates at a frequency of 50 fields per second. For more information regarding the software and hardware, see Jentsch [13]. The reliability of the system was confirmed for distance parameters (ICC = 1.000), velocity parameters (ICC = 0.994) and acceleration parameters (ICC > 0.994) [17]. The classification of the pull was realized by barbell vertical barbell kinematics and matched with the lifter´s body motion by visual inspection of the video recordings The following kinematic parameters of the barbell were selected for the long-term comparisons in this study **(fig. 1)**:

F1 = maximal vertical Force of the barbell in the first pull (% of barbell load)
F2 = minimal vertical Force of the barbell in the transition (% of barbell load)
F3 = maximal vertical Force of the barbell in the second pull (% of barbell load)
v1 = maximal vertical velocity of the barbell at the end of the first pull ($m \cdot s^{-1}$)
v2 = maximal vertical velocity of the barbell at the end of the transition ($m \cdot s^{-1}$)
vmax = maximal vertical velocity of the barbell at the end of the second pull ($m \cdot s^{-1}$)
sdown = drop distance from the highest point of the barbell to the sit position (m)
vmin = maximal drop velocity after the turning point of the barbell ($m \cdot s^{-1}$)
tdrop = drop-under time (time from vmax to vmin, ms)

SNATCH RESULTS AND AGE										
		OG 2004		WC 2007		WC 2011		WC 2014		
Weight Category	Subjects	Snatch (kg)	Age (y)	Snatch (kg)	Age (y)	Snatch (kg)	Age (y)	Snatch (kg)	Age (y)
Group 1 (light weight)	n = 24	147.4 ± 6.5	27.1± 1.8	142.5± 5.9	24.7± 1.5	145.7±5.9	23.6± 1.4	145.5± 6.5	23.9 ± 1.4
Group 2 (heavy weight)	n = 24	186.0± 5.1	26.4± 1.5	182.2±4.9	26.1 ± 1.8	184.7± 4.7	24.2±1.3	183.9 ±4.7	24.8 ± 1.1

Note: OG = Olympic Games, WC = World Championship

TABLE NO. 1 Snatch results and ages of athletes in 2004, 2007, 2011 and 2014 (M ± 95%-CI)

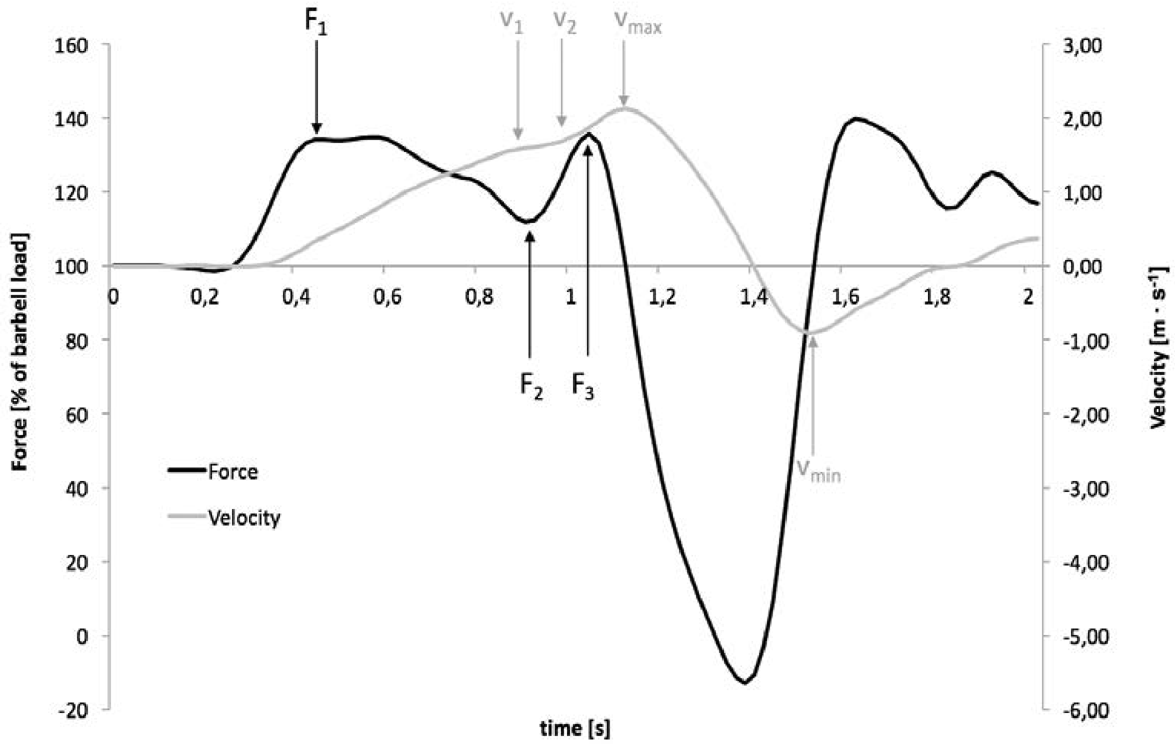

FIGURE NO. 1 EXAMPLE OF FORCE (ACCELERATION) AND VELOCITY OF THE BARBELL IN SNATCH

Additionally we looked for differences in ages (years) of the athletes and snatch results (kg).

STATISTICAL ANALYSIS

The statistical analyses were calculated using IBM SPSS 19 (IBM Corp., Armonk, NY, USA). Descriptive data are reported as mean (M) plus/minus 95% confidence interval (95%-CI). The statistical significance of global differences over time (year-effect) of the lifting technique was tested using a one-way analysis of variance (ANOVA). Eta-squared (η^2) was used as effect size for ANOVA. Post hoc tests were performed using t-tests with Bonferroni corrections. Cohen's d was used as effect size (ES) for the t-tests. According to the convention of Cohen [6], $\eta^2 > 0.01$/d > 0.20 corresponds to a small effect, $\eta^2 > 0.06$/d > 0.50 corresponds to a medium effect and $\eta^2 > 0.14$/d > 0.80 corresponds to a large effect. Only medium and large effect sizes will be reported for pairwise comparisons. The criterion for statistical significance (STS) was set at an alpha-level of 5 %.

RESULTS

Descriptive data of the snatch results, ages and the kinematic parameters are presented in table 1 and 2, respectively.

For group 1 there is a statistical significant time effect for the acceleration peak in the second pull (F3) ($F(3,92) = 4.791$, $p = 0.004$, $\eta^2 = 0.142$). Longitudinally, there is an increase in F3 from 2004 to 2011 (d = 0.68), from 2004 to 2014 (p = 0.003, d = 0.68) and from 2007 to 2014 (d = 0.72). For upward velocity parameters, we found a statistically significant time effect for v1 ($F(3,92) = 3.417$, $p = 0.021$, $\eta^2 = 0.105$) and vmax ($F(3,92) = 5.126$, $p = 0.003$, $\eta^2 = 0.150$). The v1 decreases from 2004 to 2011 (d = 0.52), from 2004 to 2014 (p = 0.042, d = 0.92) and from 2007 to 2014 (d = 0.76). In contrast to v1 the vmax increases from 2004 to 2007 (d = 0.54), from 2004 to 2011 (p = 0.008, d = 1.03) and from 2004 to 2014 (p = 0.005, d = 1.02). Despite not being statistically significant in the ANOVA, there is a trend of decrease of v2 from 2004 to 2014 (d = 0.89) and from 2007 to 2011 (d = 0.68). There are no statistical significant effects for time of δdown, vmin and tdrop. Visually based comparisons exhibit an overall systematic tendency for an increase of vmin from 2004 to 2014 (d = 0.51). With respect to the competition results in snatch for group 1, there is no time effect and, there-

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fore, no dependence of any of the measured changes on the weights lifted in the competitions. Furthermore there is a statistical significant time effect for age ($F(3,92) = 4.546$, $p = 0.005$, $\eta^2 = 0.132$) with younger athletes in 2007, 2011 and 2014 compared to 2004 (2004 to 2007 ($d = 0.58$), 2004 to 2011 ($p = 0.007$, $d = 0.88$), 2004 to 2014 ($p = 0.017$, $d = 0.88$)).

For group 2 there is a statistical significant time effect for the acceleration peak in the second pull ($F(3,92) = 2.849$, $p = 0.042$, $\eta^2 = 0.086$). There is a trend for an increase in F3 from 2004 to 2011 ($d = 0.51$), from 2004 to 2014 ($d = 0.62$), from 2007 to 2011 ($d = 0.58$) and from 2007 to 2014 ($d = 0.82$) over time. For upward velocity parameters, we found a statistical significant time effect for v1 ($F(3,92) = 5.307$, $p = 0.002$, $\eta^2 = 0.149$), v2 ($F(3,92) = 3.696$, $p = 0.015$, $\eta^2 = 0.109$) and vmax ($F(3,92) = 4.340$, $p = 0.007$, $\eta^2 = 0.125$). There is a decrease in v1 from 2004 to 2014 ($d = 0.53$), from 2007 to 2014 ($p = 0.004$, $d = 0.97$) and from 2007 to 2011 ($p = 0.013$, $d = 1.04$). Also for v2 there is a decrease from 2007 to 2011 ($d = 0.76$) and from 2007 to 2014 ($p = 0.018$, $d = 0.92$). As previously reported for group 1 there is also a systematic increase of vmax from 2004 to 2007 ($p = 0.029$, $d = 0.91$), from 2004 to 2011 ($p = 0.038$, $d = 0.86$) and from 2004 to 2014 ($p = 0.013$, $d = 0.91$) for group 2. Further statistically changes exists over time for δdown ($F(3,92) = 3.881$, $p = 0.012$, $\eta^2 = 0.113$) and vmin ($F(3,92) = 4.734$, $p = 0.004$, $\eta^2 = 0.135$). There is an increase of δ down from 2004 to 2011 ($p = 0.034$, $d = 0.88$) and from 2007 to 2011 ($d = 0.52$). From 2011 to 2014 δ down starts to decrease ($d = 0.71$). An identical trend exists for vmin with increases from 2004 to 2011 ($d = 0.52$) and from 2007 to 2011 ($d = 0.67$) and decreases from 2011 to 2014 ($p = 0.004$, $d = 0.91$). Despite not being statistically significant in the ANOVA, there is the same trend also for tdrop with increased times from 2004 to 2011 ($d = 0.68$) and decreased times from 2011 to 2014 ($d = 0.53$). Snatch results and age show no significant time effect. The average maximal weight lifted in the competition was steady over time.

DISCUSSION

The results have identified a systematic change in the way the acceleration phase is performed in both groups.

Over the course of ten years, the athletes changed the acceleration to a greater extent in the second pull, which is evidenced by a higher F3 in the second pull in connection with a faster velocity in the second pull (lesser v2 and higher vmax).

The measured acceleration parameters show only a small change in the first pull and the transition, but do show a significant increase in the maximal acceleration in the second pull. In contrast to the acceleration parameters, the velocity parameters show distinct changes over the studied years in every aspect: v1 and v2 decreased while vmax increased. Finally these changes do not lead to higher results in snatch. This phenomenon is paradoxical. On one hand, the acceleration impulse in the first pull shows a decrease (lower v1), which theoretically improves the execution of the transition because of the lower initial velocity at the end of

	Year	F1	F2	F3	V1	V2	VMAX	δ SDOWN	VMIN	TDROP
Weight Category		(%)	(%)	(%)	(m · s-1)	(m · s-1)	(m · s-1)	(m)	(m · s-1)	(ms)
Group 1 (light weight)										
	2004	136.4 ±2.9	105.9±4.0	134.6 ±5.7	1.24 ± 0.09	1.29 ± 0.07	1.74 ± 0.05	-0.14 ± 0.02	-0.74 ±0.05	368.5± 7.5
	2007	136.9±2.7	108.5 ± 3.7	140.3 ± 4.4	1.22 ± 0.10	1.27 ± 0.08	1.80 ± 0.05	-0.15 ± 0.01	-0.75 ± 0.05	378.5± 6.1
	2011	136.5 ± 3.5	107.6 ± 2.5	143.8 ± 5.0	1.12 ± 0.10	1.21± 0.08	1.84 ± 0.03	-0.15±0.02	-0.77 ±0.05	375.6 ± 6.0
	2014	132.6 ± 2.3	107.8 ± 2.7	147.4 ± 3.5	1.06 ± 0.07	1.16 ± 0.05	1.84 ± 0.04	-0.16 ±0.02	-0.79 ± 0.04	376.3 ± 5.5
Group 2 (heavy weight)										
	2004	139.3 ± 2.6	92.0 ± 4.5	137.7 ± 5.9	1.43 ± 0.06	1.31 ± 0.07	1.79 ± 0.04	-0.16 ± 0.01	-0.78 ± 0.05	382.5 ± 4.7
	2007	139.0 ± 2.5	95.7 ± 4.4	137.3 ± 3.8	1.50 ± 0.05.	1.42 ± 0.06	1.89 ± 0.04	-0.17 ± 0.01	-0.78 ± 0.03	387.1 ± 7.5
	2011	140.7 ± 3.7	95.5 ± 6.2	145.8 ± 7.4	1.35 ± 0.07	1.29 ± 0.07	1.88 ± 0.05	-0.19 ± 0.02	-0.87 ± 0.04	395.8 ± 10.0
	2014	139.4 ± 2.6	97.6 ± 5.5	146.0 ± 4.6	1.33 ± 0.09	1.27 ± 0.07	1.90 ± 0.05	-0.16 ± 0.02	-0.75 ± 0.07	381.8 ± 11.1

TABLE NO. 2 KINEMATIC PARAMETERS OF THE BARBELL IN 2004, 2007, 2011 AND 2014 (M ± 95%-C) the first pull and the smaller vertical distance the bar is traveling [2,4,9]. Concurrently with this type of execution, a lower start of the second pull on the thighs could result in a longer propulsion path for the second pull.

Additionally, the lower initial velocity at the beginning of the second pull enables the lifter to produce more acceleration impulse to the barbell due to the force-velocity relationship, which is also important in preventing a velocity drop in the transition. From this perspective, a lower initial velocity at the beginning of the second pull is beneficial for an enhanced performance output. On the other hand, the analysis shows that this type of propulsion distribution over the entire acceleration phase considerably increases the vmax. The maximal velocity at the end of the second pull is essentially responsible for the distance the bar travels after the end of acceleration to the maximal height as well as for the flight time of the barbell. Thus, with respect to the same muscular requirements (strength abilities) of two athletes, the one who needs a lower maximal vertical velocity for a complete lift can, theoretically, lift a greater barbell weight and consequently is the better lifter. The presence of a high vmax at the end of the second pull makes it an ineffective technical solution for lifting the heaviest weights possible [4,12]. In agreement with results from Baumann et al. [3], better lifters perform with lower barbell heights and lower maximum barbell velocities at the end of the second pull. Evidently, a high acceleration impulse in the second pull is unfavorable for dropping under the bar. The increased vmax can be rated as a way to counteract the worse turnover phase. The negative effect of an overemphasized second pull (high F3) for the turnover phase is proven by increases in δ down, vmin and tdrop. This is in agreement with findings from Kipp and Harris [15] who showed that higher weight snatch lifts not only depend on small decreases of acceleration in the transition but also depend on smaller peak acceleration in the second pull.

We found a possible explanation for the worse execution of the turnover phase in the work of Weide [19] and Zahran [21]. They concluded that a forceful acceleration of the barbell in the second pull can be associated with a large vertical acceleration and velocity of the athletes' center of mass (COM). This vertical acceleration of the COM results in a disadvantageous position for reversing the movement of the COM to move under the barbell. Additionally, for identical barbell weights, the athletes with faster maximal velocities also need greater speed strengths (power), which is a limiting quality in weightlifting [8].

Because of the limitation of our study to two-dimensional analyses of the barbell, we can only give an implicit answer to the question of changes in barbell kinematics by a changed body posture. It is possible that a lower v1 is a result of a changed starting position. Böttcher & Deutscher [4] showed that the vertical acceleration of the barbell in the pull is very sensitive to changes in body posture at the start. Surprisingly, these changes in lifting technique are not suitable for lifting higher weights during competition.

PRACTICAL APPLICATIONS

The presented results show a change in the way the pull is executed. At the present time, based on our understanding of effective lifting techniques in snatch, the change in the pull is assessed rather negatively because of the deterioration of the turnover and catch phase. Additionally, the trend toward an increase in drop velocity by time contains considerable dangers for injuries, such as to the elbow joint, during the catch phase. Our opinion is supported by the fact that there is no increase in the competition load from 2004 to 2014. The different manners of accelerating the barbell are most likely two different ways of solving the lifting task. The supposed benefits of a low vertical velocity of the barbell at the end of the first pull (longer propulsion phase, no dip in the barbell velocity in the transition) will not compensate for the worsened impact on the turnover and catch phase. In the end, a better performance is not achieved. Based on these findings it is not rational to knowingly slow down the velocity in the first pull in order to prevent a dip in velocity in the transition. The amount of velocity at the end of the first pull has an optimal peculiarity that is slow enough to execute the transition without any drop in velocity and is high enough to prevent excessive acceleration in the second pull. Coaches should bear this in mind when teaching and correcting the pull in snatch.

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REVERSE ENGINEERING INJURY MECHANISM

"If you find from your own experience that something is a fact and it contradicts what some authority has written down, then you must abandon the authority and base your reasoning on your own findings."
Leonardo da Vinci (1452 – 1519)

(quoted from "Seeing the Body: The Divergence of Ancient Chinese and Western Medical Illustration", Camillia Matuk, Journal of Biocommunication, VOl. 32, No. 1, 2006)

BY ANDREW CHARNIGA


TBILISI
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SWEDEN

The considerable research into the problem of female ACL injury in sports such as volleyball, soccer, basketball and even softball is terribly flawed. It is based on bias stemming from false assumptions:

- the widely accepted bias that peculiarities of female biomechanics and distinguishing features in gender physiology, perceived as biological shortcomings; are principal mechanisms predisposing women to disproportionate rates of injury;
- ligaments stretched or otherwise stressed by movements of the lower extremities outside arbitrarily established parameters of motion are to be avoided and controlled by special exercises and techniques;
- the focus of research on exercises and techniques to correct the female defects, this despite the differences in female biomechanics remain unchanged;
- the ultimate confusion, a blurring of lines, distinguishing science from commerce; created by an infrastructure of commercial products which is an inevitable consequence of academic speculation and questionable research.

THE ANKLE IS FOR BENDING THE KNEE

A list examples of purportedly safe exercise techniques for knee bends, lunge exercises and so forth would be too long to present here. Unequivocally, with the overwhelming majority of these safe techniques one can find a connection to the academic community, physical therapy, or personal training business. Most advocate movement at the knee and hip as if the person exercising had no muscles, tendons and ligaments situated in calf and foot which would be of any use to perform a simple knee bend. And, of course, one is left to assume they would not be of any use in take – off in jumping, landing, changing directions, amortizing and dissipating forces on the lower extremities and so forth. For instance, consider these instructions to perform knee bends from the National Strength and Conditioning Association; an organization which certifies strength and conditioning coaches.

"Avoid bending the knees to initiate the movement."

"Allow the hips and knees to slowly flex…Continue flexing the hips and knees until the thighs are parallel to the floor.

"Keep the heels on the floor and the knees aligned over the feet… ensure that the knee does not move beyond the toes.." (Brown, L., 2007; Baechle, T., 2000)

Of these instructions of how to perform knee bends, is it oxymoronic, that one should "avoid bending the knees to initiate the movement"? The underlying assumptions about tight ligaments presented in part II that one should bend in such a way as to minimize stretching ligaments and maintain a linear stress on the knee joint are obvious from these instructions. As already noted, the technique instructions would seem to exclude participation of the foot, ankle joint and musculature of the shin in performing this natural, simple exercise. Which of course begs the question what are the roles of the ankle joints, muscles, tendons and ligaments in bending and straightening the lower extremities?

Consider the following from a Kinesiology textbook which has been widely utilized in American universities:

"the long tendons cross the ankle in a way that makes for lack of bulkiness and for good leverage but contributes little to stabilization". (Arnheim and Prentice, 1998) cited by Luttgens, 2002

"Consequently, this joint is unusually susceptible to strains, sprains, dislocations and fractures". Luttgens, 2002

This single idea, the human ankle joint has evolved over tens of thousands of years in such a way as to make it "unusually susceptible" to injury is not a fact based on some proven functional insufficiency; but a conclusion based on observation of anatomy. The central idea from the textbook cited, conveys, tendons contribute little to stabilization. And, it is that single word "stabilization" which creates the backdrop for confusion and ultimately misinformation. The pervasiveness of this term is the foundation of both an academic and commercial infrastructure built around a conservative approach to the problem of ankle injuries in sport. Although not intentional, an idea like this in the context from where and whence it originates in academia can spawn an entire commercial infrastructure.

For instance, the practice of taping ankles to prevent and/or support the joints from injury in sports like football, basketball, volleyball and others is so commonplace the term athletic trainer and ankle taping (and knees) are practically synonymous. Annually, thousands upon thousands of miles of athletic tape for taping joints are sold in the USA. Moreover, the US market for ankle and knee braces is more than $1 billion annually. It is pretty obvious that the conservative nature of ankle taping practitioners and use of braces to protect the ankle joints from injury is elicited by a fear of stretching ligaments, a fear of bending; especially as it pertains to what are perceived to be acceptable movements of the ankle joint. Consider a position paper by the National Athletic trainers Association:

"In sport, ankle injuries are the most common injury, with some estimates attributing upward of 45% of all athletic injuries to ankle sprains.

In their systematic review, Fong et al2 noted that the incidence rates of ankle injury and sprain are highest in field hockey, followed by volleyball, football, basketball, cheerleading, ice hockey, lacrosse, soccer, rugby, track and field, gymnastics, and softball...... Managing these injuries appropriately is clearly problematic for sports health care professionals". (T. Kaminski, et al, 2013)

The question that must be asked is why the high rate of ankle injuries in sports which do not involve maximum strain (track and field excluded)? And, can reverse engineering to weightlifting shed light on this problem where stresses on the ankle are extremely high, prophylactic taping and bracing non – existent, yet injury rates extremely low? Luttgen's statement that the tendons crossing the ankle joint "lack bulkiness and for good leverage but contributes lit-

FIGURE NO. 1 ILLUSTRATIONS OF TRAINING TECHNIQUES (FROM UPPER LEFT) FEATURING IDEAS FOSTERED BY A FEAR OF STRETCHING OF LIGAMENTS; OF BENDING TOO FAR. IN BOTH HALF SQUAT EXERCISES DEPICTED, FEET ARE IN A STRAIGHT LINE, THIGH AND SHIN BONES ARE MOVING LINEARLY, WITH MINIMAL MOVEMENT AT THE ANKLE JOINT. UNFORTUNATELY, FEW ATTEMPT TO MAKE A CONNECTION BETWEEN THESE TRAINING TECHNIQUES AND A PREDISPOSITION FOR INJURY (POST SURGERY INJURED KNEE PICTURED) UNDER THE NATURAL CONDITIONS AN ATHLETE CAN ENCOUNTER ON THE COURT, ATHLETIC FIELD, SKIING AND SO FORTH. ON THE OTHER HAND, WEIGHTLIFTERS (UPPER RIGHT AND LOWER RIGHT) SUBJECT THE LOWER EXTREMITIES TO HIGH SPEED, MASSIVE LOADING WITH UN-CHOREOGRAPHED, UNRESTRICTED JOINT MOVEMENTS AND FOOTWEAR SANS ARTIFICIAL SUPPORT; YET EXPERIENCE LOW INJURY RATES OF LOWER EXTREMITIES.

FIGURE NO. 2 DESPITE THE MASSIVE FORCES ON THE ANKLE AND FOOT IN WEIGHTLIFTING, ANKLE INJURIES ARE RARE. THE WEIGHTLIFTING SHOE PROVIDES NO SUPPORT FOR THE ANKLE; NOR ARE TAPING AND BRACES USED TO SUPPORT THIS JOINT. CHARNIGA PHOTO.

tle to stabilization" is a bias which serves as the foundation for the entire approach to the ubiquitous ankle injury in American sports. This bias stems from a single idea that the ankle joint is inherently unstable because this joint does not have "bulky" tendons. For example, the term "ankle stability" appears no less than 48 times in the National Athletic Trainers Association position paper; the title of which is "Conservative management and prevention of ankle injuries". Clearly, this group's approach to care and prevention of ankle injuries is focused on this idea of ankle stability; regardless of how arbitrary and vague as to just what would constitute ankle "instability". In one form or another, the management and prevention of ankle injuries is focused on taping the joint or bracing for practice and competitions; and, balance exercises for conditioning the joint to resist movement outside a relatively narrow range of motion.Against this backdrop consider the following:

"The Achilles tendon is much thinner in proportion to the strength of its muscles, than most other tendons. If it were thicker it would stretch less and be less effective as a spring."

"When humans and other mammals run, the body's complex system of muscle, tendon and ligament springs behaves like a single linear spring ('leg spring'). (Alexander, R. McN., 1992)

Now we have contrasting conceptualizations of one and the same thing. On the one hand from the viewpoint of Luttgens and ultimately the athletic training/medical disciplines, the ankle tendons are lacking in bulk which makes the joint unstable. This idea, in its turn, is the centerpiece of an academic discipline and commercial enterprise where the focus is to address this poorly designed joint.

These ideas persist, despite the fact that the human ankle joints and of course feet have evolved over tens of thousands of years, adapting to walking on two legs, instead of four.

However, according zoologist Alexander, there is nothing wrong with the tendons or other structures of the ankle. The body's tendons and ligaments are biological springs; the form of which are in harmony with function. The tendons and ligaments of the ankle are biological springs connected to the biological springs of the foot. All of which, are connected to spring mechanisms of the knee, thigh and hip. Hence the notion that spring mechanisms arranged in series, i.e., muscles, tendons and ligaments connected by bones and joints can considered a single spring; a 'leg spring' (Alexander, 1992; McMahon, 1990; Farley, 1996).

It is this idea which explains how humans and animals adjust to greater stride frequencies in order to run faster: the leg spring, consisting of the muscles, tendons, and ligaments from hip to foot, stiffens to abbreviate ground contact time. Consequently, shortening a sprinter's contact time with the track translates into a longer period of time with both feet off the ground, i.e., the sprinter who is "flying" down the track spends a longer time, literally, flying (Novachek, 1998).

The important idea to be inferred from the concept of a leg spring, is this: if the leg spring can stiffen as

FIGURE NO. 3

THE PHOTO IN UPPER LEFT CORNER ILLUSTRATES ANTICIPATED CONSEQUENCES OF TURNING THE ANKLE ON A FOOTBALL FIELD, VOLLEYBALL COURT, BASKETBALL COURT ETC; WHILE IN MANY INSTANCES WITH ANKLE JOINTS TAPED OR EVEN WEARING ANKLE BRACES. THE FEMALE WEIGHTLIFTERS TWISTING ANKLES, KNEES AND HIPS; WHILE HOLDING (FROM LEFT TO RIGHT) 130 KG (206% OF BDWT) AND 127 KG (169% OF BDWT); FREE OF INJURY, RETURNED TO LIFT THE SAME WEIGHT MINUTES LATER.

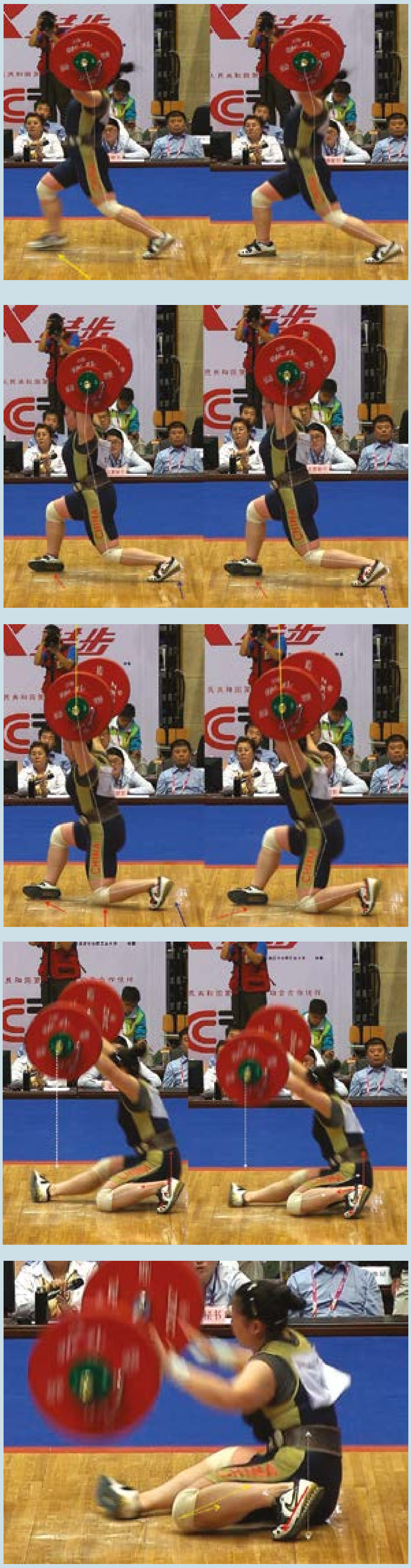


FIGURE NO. 4,5,6,7,8

a single spring it can also release tension as a single spring; and, in turn function as a reactive protective mechanism.

So, here are two antithetical concepts applied to one and the same anatomy:

- One, which believes the ankle joint is poorly constructed for stability; joint movement needs to be supported (fear of stretching ligaments) taping and/or bracing; and, which is bolstered by a profession and commercial infrastructure which has developed around the concept of supporting the joints with taping and braces;
- the other, which believes the form of the ankle is in harmony with its function as a biological spring mechanism and of course is interconnected with other springs from hip to toes.

"The body is filled with springs that are just as good (as the artificial feet of Oscar Pisitoris). They are called ligaments. They are called tendons. In addition the body has muscles which can do far greater things than just springs." Hugh Herr MIT, NBC evening news 8/6/12

Consider the following photos.

The young female lifter in these photos is lifting a 127 kg barbell. She rearranges her feet to scissor her legs in order to drop under the weight. The rear (left) foot returns to the platform first followed by the front foot. Her right ankle proceeds to roll under the pressure of the athlete's bodyweight and the weight as she struggles to balance the barbell and her body as a single unit, called the athlete – barbell system. This certain injury in the making was a non – event. Tension released from hip, knee and ankle joints reflexively, as one; elastic tendons and ligaments, stretched and recoiled. Both leg springs having stiffened to raise the barbell, released tension as well: muscles from hip to foot relaxed. The release of tension and the lifter's, in the words of Moroz, "extensibility reserve", redistributed and dissipated the force of the falling barbell and body. She simply got up, walked away; returned 1.5 minutes later to successfully lift that weight; and, three minutes after that to raise 133 kg.

Curiously, an antithetical evolution in philosophy can be observed between the design of footwear for weightlifting and sports like American football, volleyball, basketball and others; as it relates to problems with the ankle, knee injuries; and, consequently, convoluted solutions such as taping/bracing ankle joints, and so forth.

The design of weightlifting shoes have evolved from supporting to exposing the ankle joint, i.e., sans support. The basic idea driving this evolution in philosophy, reflected in the design of the footwear was to permit and facilitate bending the ankle to lift bigger weights (A. Charniga, "Why weightlifting shoes"?). Moreover, weightlifting has a relatively low injury rate for knees and an almost non – existent injury rate for the ankle.

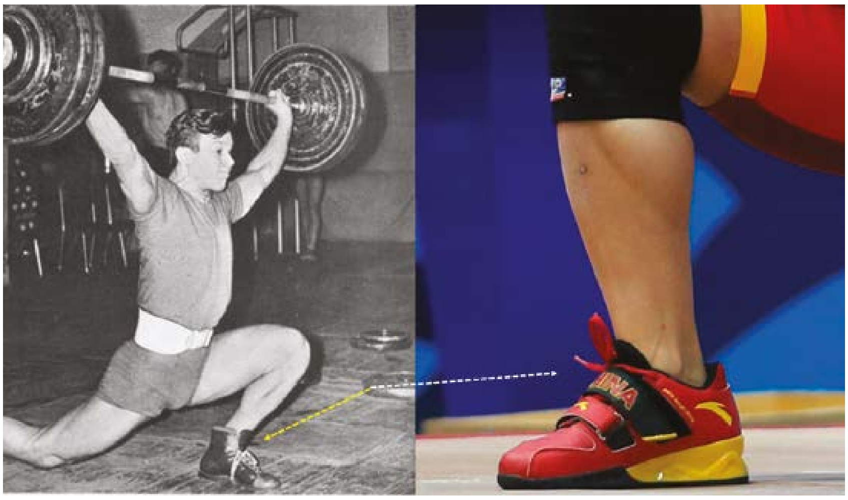


Figure No. 9

Soviet made weightlifting shoes of the late 1950s with high top design covering the ankle joint; contrasted with modern weightlifting shoe of the female lifter on the right. The evolution of the design of the shoes conforms to the idea that freedom of movement in the ankle joint is desirable and most importantly: the ankle joint does not require artificial support under the high loading conditions of weightlifting. The Russian lifter on the left has laced the shoes only half way to permit ankle bend. Also, the lifter has fashioned a tarsal strap by wrapping the laces around the mid – foot area of the shoes. In contrast, the modern weightlifting shoe with exposed ankle joints and tendons which in this example, sans socks, are clearly visible. (Kono and Charniga photos)

Figure No. 10

Contrast in design between modern low cut with ankle joint exposed, weightlifting shoes; a military boot featuring high ankle lacing, restricting movement; female volleyball players with similar "military" footwear: low cut shoes with ankle braces similar to the one depicted in far upper right corner and "spattaping" the shoe to the ankle to play football.

For instance, the footwear of American football, volleyball and basketball, in contrast to weightlifting, at the very least, preserved the design of a high top shoe for ankle support; even though this design has been discarded by manufacturers of the shoes for some of these sports. See figure10. The American philosophy, reflected in the contrasting evolution in design of shoes with weightlifting, still centers around minimizing and supporting ankle movement through taping/bracing of ankle joints. Essentially this philosophy stipulates support and /or minimal movement of the ankle joint is safe. This of course is in stark contrast to the design of the modern weightlifting shoe which pretty much permits unrestricted, unsupported ankle movement. A philosophy of taping and bracing ankles to play sport reflects a fear of stretching ligaments, a fear of bending knee and especially ankle joints while in engaging in sport. It is a disaster in the making.

Consider the set of photos in figure 11: Two of the above photos of a volleyball player with rigid ankle supports and professional football player with ankles taped to shoes illustrate two underlying assumptions, unsubstantiated bias: a fear of stretching ligaments and that the ankle joint is inherently unstable. On the other hand, in the weightlifting community; for the barefoot weightlifter pictured, these ideas don't exist. It is a logical assumption that the links in the body's kinetic chain have evolved such they are designed to work together; movements of any link inter-conditional with movement of all the rest, and vice versa. Consequently, one can logically assume taping and or bracing one set

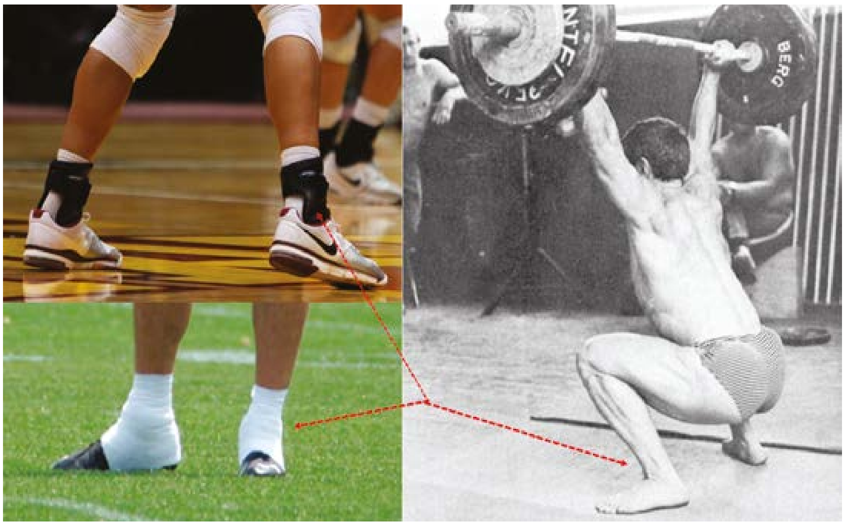


Figure No. 11

Three examples of preparing the ankle for sport; relative to radically differing philosophies of ankle stability. Upper left female volleyball player on the court wearing low cut volleyball shoes with braces to support ankle joints. Lower left photo of a football player with ankles heavily taped to shoes forming a unified bond from lower portion of shin across the arch of the foot to the heel. Unlike literature emanating from the American medical and athletic training communities, the weightlifting literature is devoid the term 'ankle stability' (Vorobeyev, 1972; 1988). Hence, photo on lower right of Olympic champion David Rigert (Kono photo) playing around in the gym snatching 130 kg in bare feet.

of joints relative to another would at the very least alter the harmony between form and function which nature has so tediously crafted.

Consider the following:

"An additional issue that needs to be evaluated is whether bracing or taping the ankle has any negative effect on other joints in the lower extremity, specifically the knee. To date, bracing or taping the ankle does not seem to increase prevalence of knee injuries. However, most studies included a very small number of people who had sustained knee injuries, so definitive conclusions are difficult to make. " (T. Kaminski, et al, 2013)

From this statement it is obvious the vagaries of science, bias and commerce collide; conspiring to cloud the issue. Were sufficient objective evidence allowed to emerge; proving taping and or bracing ankles "increase the prevalence of knee injuries", what then? What of all those graduates of university athletic training programs who have acquired ankle taping skills; only to learn how to cause more harm than good? Likewise, what about the credibility of those institutions and the staffs? Moreover, further muddying the water is the influence of commerce. If ankle taping can cause knee injuries what about the companies who annually sell thousands upon thousands of miles athletic tape purchased to address 'ankle stability'? Furthermore, how would more harm than good research affect the 1 billion dollar a year bracing market?

REVERSE ENGINEERING A CONCLUSION

Reverse engineering can help explain the extremely low rate of ankle injury in weightlifting and why weightlifters who have fallen or otherwise experienced a "black swan" event without injury. The following theory appears to fit.

Weightlifters have to switch instantaneously from raising a barbell to receiving it on the chest or overhead on straight arms. In effect, it is analogous to switching from throwing a heavy object to instantaneously catching it. The weightlifter "throws" the barbell by forcefully straightening the trunk and lower extremities; in the process stiffening the leg spring, i.e., the muscles, tendons and ligaments from the hip to foot. The weightlifter has to relax the very same muscles used to straighten up in order to switch to dropping down. Tension is released in the leg spring.

A lifter can suddenly experience some problem with balance or coordination in the process of receiving the barbell. The tension which has returned to the leg spring once the athlete's feet return to the platform in the process of descending can be released (as in the examples shown) such that the mechanical energy of the athlete's descending body and the barbell can be redistributed and/or otherwise dissipated; preventing injury.

For instance, the example of the female lifter twisting her ankle and falling to the floor. In the first two photos she is rearranging her legs after thrusting the barbell, i.e., the leg spring stiffened by a half squat

Figure No. 12
The ability to release tension in the leg spring extremely fast allows a highly skilled weightlifter's body to exceed the acceleration of gravity while dropping into a low squat. Soviet sport scientist I. Zhekov (1976), theorized the possibility of a weightlifter dropping under a barbell with an acceleration of 2Gs. However, it is only possible to outstrip the acceleration of a free falling body by holding onto something, which in this case is the very slow moving barbell. (Charniga photos).

to thrust the barbell, releases tension from hip to foot when the lifter switched to scissoring the legs. The athlete's leg springs stiffen as the feet are returned to the platform to fix the barbell. Subsequently, the lifter turns her ankle struggling to balance the barbell overhead. At one and the same instant, both of the athlete's legs from foot to hip relax, i.e., the stiffening process is reversed. The high speed relaxation of the leg spring, both a skill and a special quality cultivated by the high class weightlifter, to switch from lifting to receiving the barbell; in this situation, becomes a reactive protective mechanism. The release of tension coupled with the weightlifter's flexibility prevent injury. Now, consider the following:

"A 2009 study published in the "International Journal of Exercise Science" studied 17 subjects during warm-ups and 60 minutes of touch football and found spatting to be more effective than taping at limiting range of motion." A 2011 study from researchers at Drake University published in the same journal found spatting and taping together to be as stable as bracing." R. Axon 2013

It is unlikely a reactive protective mechanism designed to release tension in the leg spring will work in the desired manner if one or more of the joints in the spring is artificially stiffened with tape or bracing designed specifically to limit range of motion. Inhibiting or otherwise tampering with this natural, reactive protective mechanism can create conditions, for a probable outcome; where taped feet, ankles and knees and/or otherwise trained to restrict range of motion, suffer disproportionate injury rates in sports with less stress on the joints than a maximum strain sport like weightlifting. So, to return the question as to how a basketball player suffers a skin protruding shin bone fracture, (raised in part I) from falling on a basketball court. An explanation with a high degree of probability can be deduced when several of the factors presented here are taken into account. The general fear of stretching ligaments and fear of bending the lower extremities only in a certain way, embraced by the athletic training/physical therapy/personal training communities means these fears are incorporated into the supplementary training of athletes. In all probability the ankles both basketball players whom suffered shin bone fractures, were taped, braced or otherwise artificially supported. These athletes typically would not practice large range of motion exercises like deep knee bends, lunges, vertical jumping from a low squat, etc where knee, hip and ankle joints are subjected to stretching tendons and ligaments through a large amplitude of motion. Consequently, reactive protective reflexes, designed to release tension in the entire leg spring upon landing or falling; would at very least be inhibited by taping and the internal resistance of the athletes' muscles, tendons and ligaments, i.e., a general lack of unencumbered freedom of movement. Unlike weightlifting; the knee, hip and ankle joints of the basketball players taught to bend a certain way by conditioning coaches, personal trainers, physical therapists and so forth, would likely direct the forces acting on the body to go somewhere other than soft tissues, to the shin bones for instance.

AFTERWORD

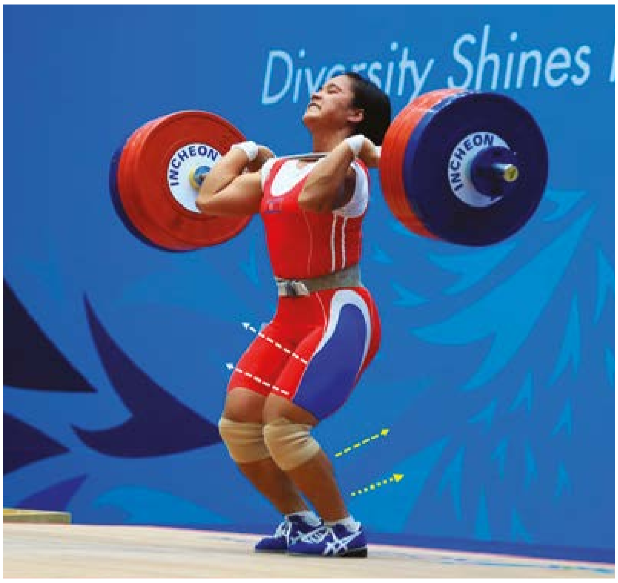
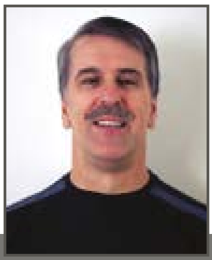


Figure No. 13
When weightlifters preform a knee bend to jerk the barbell a significant portion of the force is generated by calf muscles. These muscles straighten the tilting shins in what can be described as a reverse origin insertion contraction of the soleus muscle.

The shortening soleus straightens the knee because shin bones are connected to thigh bones by a coupling called the knee joint. The soleus pulls the tilting shin towards the vertical (yellow arrows), which in turn pulls the thigh towards the vertical (white arrows) along with the quadriceps muscles, by a process called inertia coupling . The shin and thigh bones are interconnected via the knee joint; so the movement of one affects the another: the movements of the long bones of the lower extremity are interconnected, interdependent and inter-conditional.

The muscles tendons and ligaments of the thigh, shin and foot arranged in series act as a single spring, sometimes referred to as a leg spring. Consequently, the forces generated to raise a barbell are produced from the ground up and the stress is distributed from foot to hip and not concentrated in the knee joint, regardless if the knees bow inward or not. Compare this sudden jolt at the instant the athlete switches from bending to straightening with such power as to bend the barbell to the forces experienced by American female athletes in events with body weight only, such as basketball, soccer, volleyball where ACL injuries are common.



Andrew Charniga Jr.
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"The ankle bracing and supports market includes rigid ankle braces such as ankle stirrups and trainer braces; and ankle supports including semi-rigid supports, lace-ups, and elastic and neoprene supports. Growth will be driven by the increasing use of ankle braces for prophylaxis to treat injuries and for postoperative support. The increasing prevalence of sports injuries and obesity will have a positive effect on this market."

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THE PHYSICS OF THE SQUAT

The squat exercise is for many people a natural and spontaneous movement, but for many others it represents a real challenge...

BY PAOLO EVANGELISTA, GIAMPIETRO ALBERTI


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INTRODUCTION

The squat is used both in athletic training and rehabilitation programmes, therefore - although it is not an actual contest - the Sports Science graduate will have to face this exercise sooner or later. He/she will be surprised to find totally heterogeneous case studies: some individuals squat right to the ground, as if they were born to make this movement, whereas others will have to make significant effort to achieve a sufficiently correct movement.

In fact, when dealing with the "*squat problem*", it should not be underestimated that it is considered a multifactorial movement. Figure 1 illustrates some of the factors that determine the qualitatively correct execution of any movement.

First and foremost are the **anthropometric characteristics**, namely our own size, that naturally cannot but affect what we do. For example: a short person is at a disadvantage when playing basketball, because height is not a trainable characteristic and it affects many aspects of a movement. Having said that, one may argue that this is a reductive vision because, in reality, all the shapes of our body, not only height, are decisive factors: in addition to the total length, there is also the "shape" of the individual elements that determines the length of the levers, therefore the ability to move. In other words, if the insertion of a muscle is more or less displaced with respect to the centre of rotation, the lever will be more or less disadvantageous or, if the femoral neck is angled in a certain way, or the pelvis has a certain conformation, it will be possible to flex the femur on the pelvis to a greater or lesser extent, and consequently squat more or less.

Next comes **joint mobility**: the ability of a joint to move the articular segments with a greater or lesser angular excursion depends on the ligamentous apparatus, the tendons and the connective tissue bands surrounding the joint. For example, the lack of ankle dorsiflexion constitutes an extremely critical element for the execution of a squat.

In addition, the ability to generate **muscular strength** and to stabilise a joint. In brief: joint stability is the ability - while performing a given movement - to "lock" a joint in a certain position and not move it.

Lastly, the **mental representation** of oneself during the movement, deriving from proprioceptive signals, such as, for example, the information on joint opening, muscle and tendon tension, and from exteroceptive signals such as the head position, vision, etc. All these inputs result in a perception of movement and combine to create the executive motor pattern.

The image in Figure 1 shows that the final result derives from a series of elements in which it is difficult to determine which is the most critical.

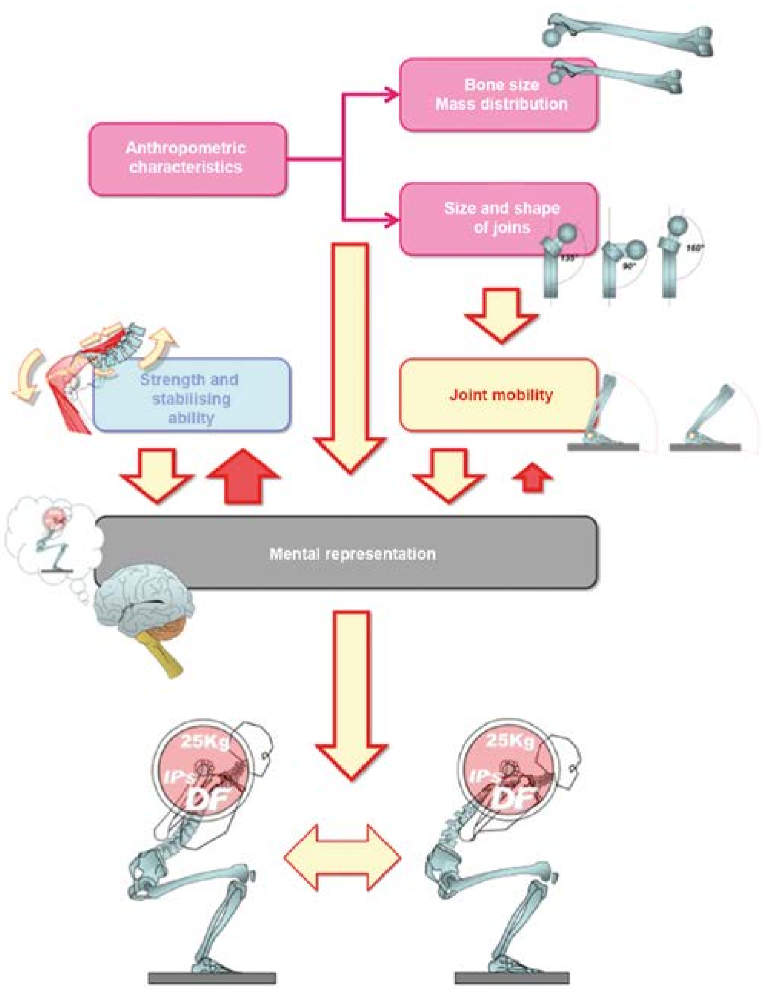

FIGURE NO. 1
THE POSSIBILITY OF MAKING A MOVEMENT

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What is certain, however, is that a movement should be analyzed in its entirety, including how the individual elements contribute to the realisation of the whole.
In literature, there is a multitude of test protocols on the squat movement that highlight not only the individual's ability to perform the movement effectively and safely, but also to identify critical elements (1), (2) (3), (4). It is precisely because movement depends on some characteristics which are fixed and on others that are highly adaptable, that these tests can be used not only for an initial assessment at the start of the movement training programme, but also during the programme, in order to monitor improvements and any other points worthy of attention. In this article, we will attempt to explain how anthropometric measurements may influence movement, creating, in fact, facilitating or limiting conditions for the success of the same. We will present some concepts that are considered difficult, often rightly so, and also unnecessary, often wrongly so: such as kinetic chains and the centre of mass.
Understanding these two concepts will allow us to critically discuss two of the many "myths" of the squat: the "*child squat*" and the "knees behind the toes squat."

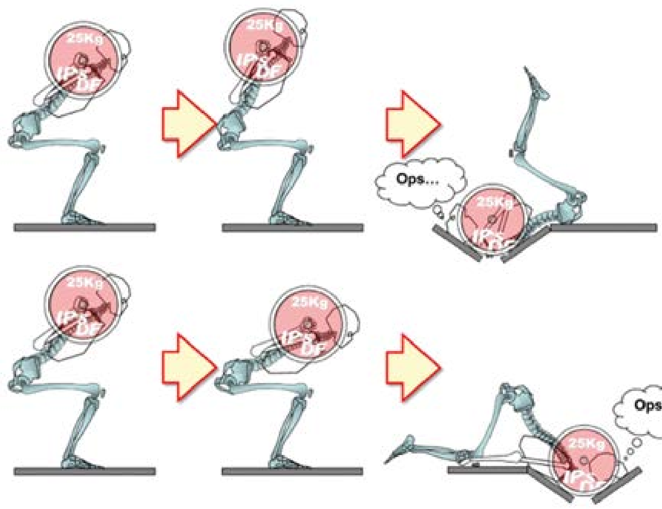

FIGURE NO.2
A CLOSED KINETIC CHAIN

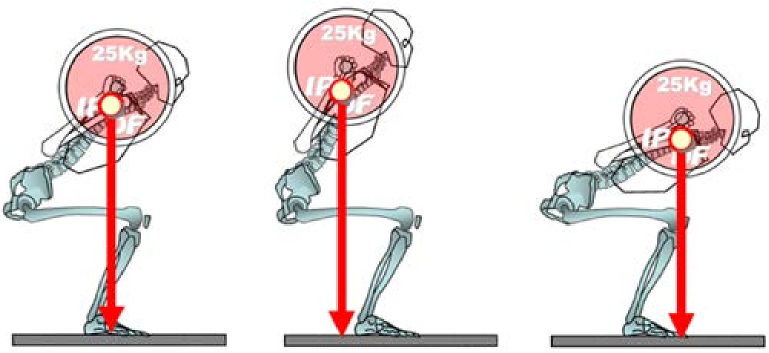

FIGURE NO.3
THE CENTRE OF MASS

KINETIC CHAINS AND THE "COM" CONCEPT

A kinetic chain is a set of segments in which the end of each one is connected to the end of another via a joint. In biomechanics, the simplest kinetic chains are made up of the limbs and the trunk. A kinetic chain is said to open if at least one end of it is free. Think of a gymnast in flight, when performing a floor exercise: in this case, the kinetic chain of the upper limbs, trunk and lower limbs is fully open since no extreme is resting on the ground. Or, imagine a baseball player throwing a ball. The kinetic chain of the lower limbs, trunk and throwing arm has one extreme, the foot, on the ground and the other free to move in any direction. A kinetic chain is defined as closed when its two extremes are bound, that is, are not able to move freely. Imagine a person who performs the leg press at 45°: the trunk rests on the back support, the feet rest on the platform that runs on the tracks, so the foot cannot move freely.
The squat is called a closed kinetic chain exercise, a definition that is often repeated, but, we regret to say, is accepted without a real understanding of the movement: the feet are on the ground, bound by the floor and by the friction with it, but the trunk, that is, the terminal segment, can actually move where it wants. Why, then, is this chain considered closed? We will try to explain it in the following lines.
Figure 2 schematically illustrates what would happen if the trunk were to move freely during a par-

allel squat: even when there are no locks or tracks preventing this ... no one would try something like that because the barbell would fall.

Figure 3 – the centre of mass

The sensation is as if the entire mass of the body and the barbell was concentrated on a point that "presses" on the ground. By moving the trunk, and therefore also the barbell, forward and backward, this pressure moves, making the individual "feel" like he is losing his balance. The stability of movement is when this pressure is approximately at the centre of the foot.

This hypothetical point on which the entire mass of the athlete-barbell system is concentrated is called the COM, the centre of mass, COM. Figure 3 shows the COM with its projection on the ground. The pressure felt under one's feet when performing a squat is not given by the projection on the ground of the COM, but rather from what is called the centre of pressure, the COP. COP and COM are two completely different, but related concepts (for example there is a single COM for the athlete+barbell, but two COPs, one for each foot), however, as this article is not intended to be an in-depth analysis, here we will discuss only the COM.

The fundamental point is that, if the ground projection of the COM is moved too far forward or backward from the centre of the foot, the individual would fall: therefore, there is a restriction, albeit not as rigid as the platform of a leg press at 45°. For this reason the squat is a closed kinetic chain exercise: the barbell cannot go wherever it wants to ...

The characteristic of a closed kinetic chain is that the movement of one segment affects that of all the others. On the left in Figure 4, is the position of a parallel squat seen on the sagittal plane: macroscopically, the kinetic chain is composed of the trunk, the femur and the shin; it is assumed that the barbell is immobile, the trunk can rotate around the convex circumference centred on the mid-point of the barbell, and the shin rotates around the concave circle centred on the ankle.

To the right, the variation of the position of the trunk, from very inclined to erect: the pelvis shifts the femur forward, which in turn moves the shin, which rotates around the ankle. Therefore, it is not possible to move the trunk without moving the other elements, and vice versa. This means that a variation of any point of the chain causes repercussions at other points.

The consequence of all this is the impossibility to observe the squat movement focusing only on details such as the knees, hips, the position of the barbell and so on, without observing the movement as a whole.

THE "COM" OF THE SQUAT

The concept of COM is crucial to understanding many features of the squat movement, so it is essential to know how it is formed. Imagine (Figure 5) wanting to balance a femur on a fulcrum.

On the left, we can see the position that does not allow the femur to rotate, so it is as if the entire mass of the femur was concentrated in

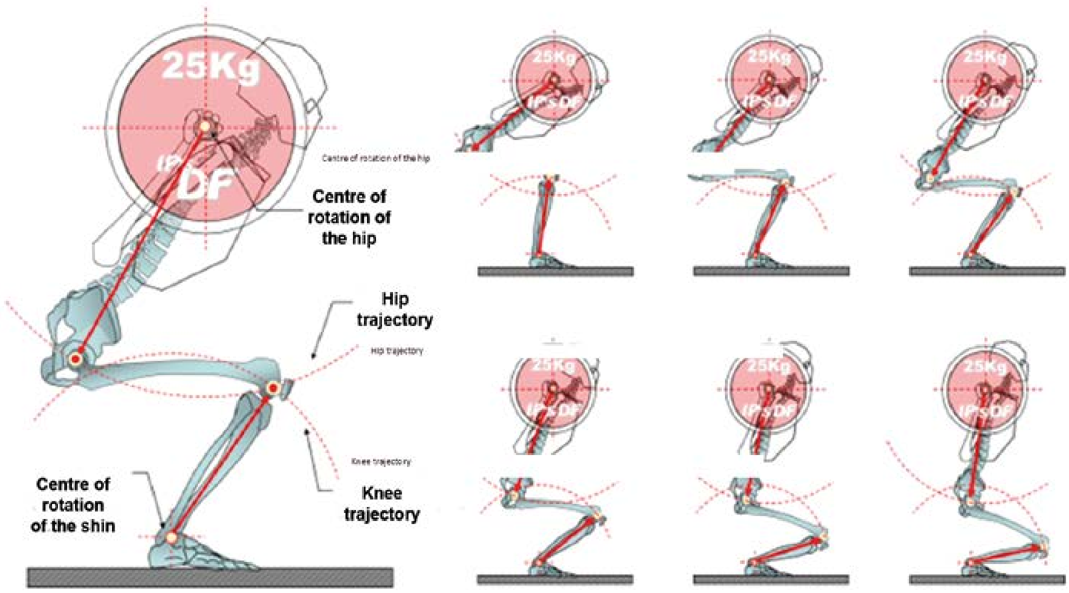

FIGURE NO. 4
IN A CLOSED KINETIC CHAIN, THE MOVEMENT OF ONE SEGMENT AFFECTS THAT OF ALL THE OTHERS

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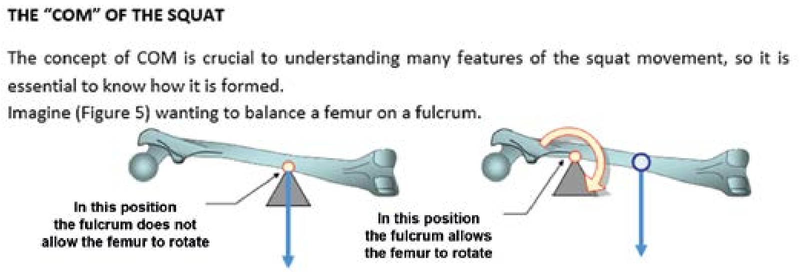

FIGURE NO. 5
THE COM
OF THE FEMUR

that point. In fact, by positioning the fulcrum at another point, as we see on the right, the femur would rotate and fall. That first point, therefore, is the COM of the femur. The position of the COM depends on the distribution of the masses, therefore, it tends to move towards the parts with greater mass.

The position of the COM depends on the geometry of the femur and on how the masses are distributed. The distribution of the masses takes place on the basis of femoral geometry: in Figure 6, there are three femurs of different shape and so three different positions of the COM of the same, closer to the parts with greater mass.

The COM concept is very useful because it allows to treat the femur as if it were a weightless rod in which the entire mass is placed in a single point of the femur itself. Each body system with a mass has a COM, which is a three-dimensional point, not a two-dimensional one as these examples show.

In biomechanics, numerous studies have classified the COM of all the "parts" of the human body, according to processes that use live individuals or cadavers, as in (1) Figure 7 and Figure 8.

As there are tables that allow to estimate the COM position for each body part, the COM total of a subject can be calculated during any movement.

On the left in Figure 9, an individual performs a squat with a natural load: on the COM of each body part is possible to "hang" a mass equivalent to that of the part itself: the individual basically becomes a structure without weight, with the masses attached at certain points. On the right, the total COM, which represents a middle point in which all the masses of the individual parts can be concentrated. Important: the COM is an unreal, abstract point, therefore it can position itself

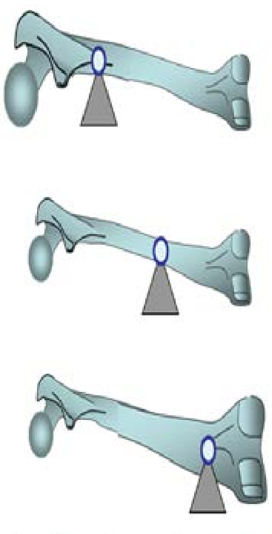

FIGURE NO. 6
DISTRIBUTION OF
DIFFERENT MASSES,
DIFFERENT COM
POSITIONS.

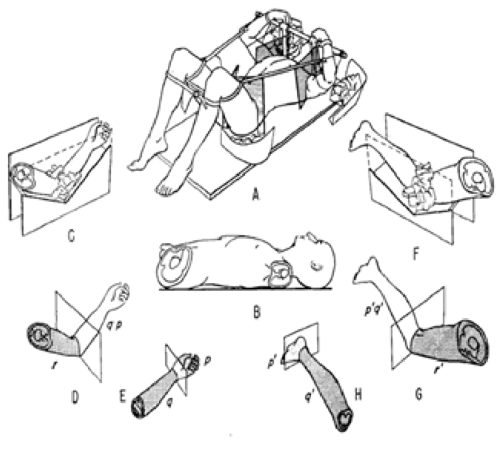

FIGURE NO. 7
THE CALCULATION OF COM (1),
FROM "PROPERTIES OF BODY
SEGMENTS
BASED ON SIZE AND WEIGHT" BY
DEMPSTER AND GAUGHRAN

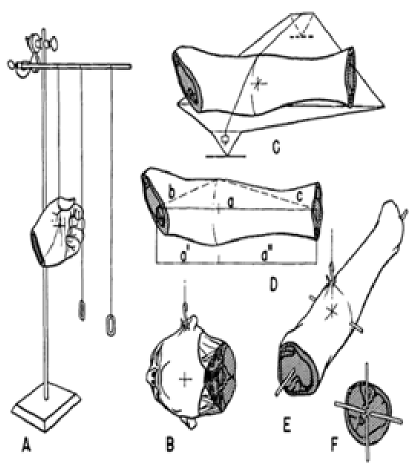

FIGURE NO. 8
THE CALCULATION OF COM (1),
FROM "PROPERTIES OF BODY
SEGMENTS
BASED ON SIZE AND WEIGHT" BY
DEMPSTER AND GAUGHRAN

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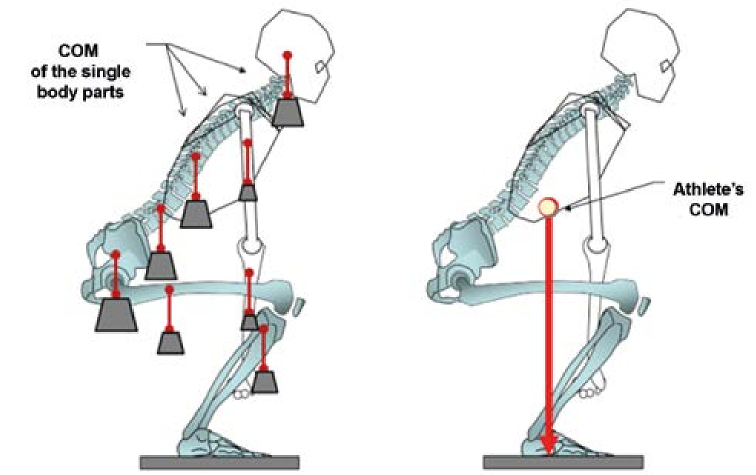

FIGURE No. 09
COM OF AN INDIVIDUAL

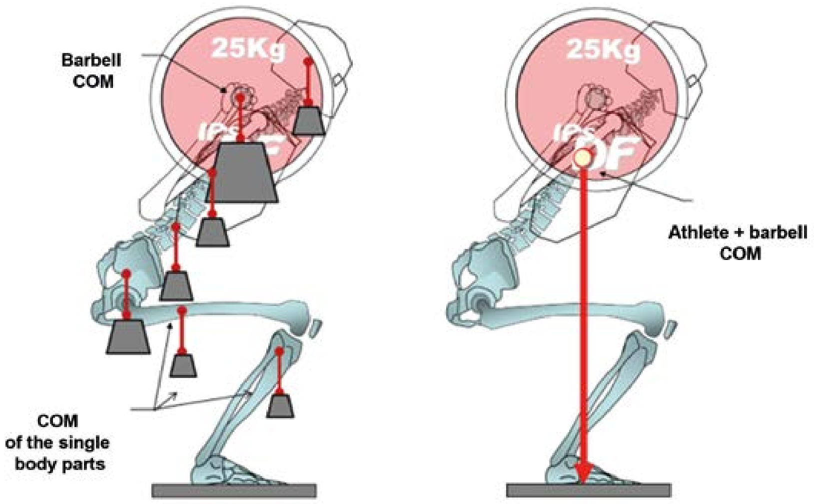

FIGURE No. 10
COM OF AN INDIVIDUAL WITH THE BARBELL

FIGURE No. 11
THE IDEAL SQUATTER?

during movement at a point even outside the athlete's body.

In Figure 10, however, the individual has a barbell on his shoulders that is equal to his actual weight. The COM of the barbell is at the centre of the barbell itself, on the sagittal plane, because the weights are symmetrical with respect to this point, and we assume that the entire mass of the plates is concentrated in the centre. The COM can be recalculated for the athlete plus the barbell, the result is on the right: note how the COM is moved higher and further to the right than in the case of just the athlete. In fact, the COM, depending on the distribution of the masses, positions itself towards the areas with greater mass and the more the barbell is loaded, the more the COM will move towards the centre of the barbell.

THE "CHILD SQUAT" UP TO NOW

There is an actual school of thought that considers a child's ability to squat, an example of how the squat should be performed (Figure 11), and how this ability is lost as adults. In fact, the squat movement comes naturally to a small child thanks to his body shapes that place his COM in an extremely convenient position.

In Figure 12, the heights of the individuals have been equalised, normalised in order to highlight the different proportions of the various body parts during the stages of growth. The weight of a baby's head is about 25% of the total weight, in adults it drops to 5-6% and so we can simplify this by saying that young children are all head and trunk, with short arms and legs.

Figure 13 illustrates: on the left, the COM of a 1.75 m adult weighing 80 kg, in a parallel squat position; on the right, the COM of an individual with the same height and weight, but with the proportions of

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a child. In the comparative simulation, in A there has simply been a change in the relationship between the legs and trunk, shortening the former and lengthening the latter: to maintain the same position of the centre of mass, a child can stand much more erect. This is because it has shorter legs and so, with the same inclination of the shin with respect to the adult, the pelvis moves back less, so as to enable him to keep his back straight. By contrast, in B there is a shift of the body masses towards the trunk and the head: this moves the entire COM forward, so that in order to keep it constantly at the same horizontal distance from the ankle, the child can stand even more erect.

A child, therefore, is the perfect "squatter", but his so-called "natural gift" for this movement derives from his physical build, as he grows he does not "unlearn" anything, his anthropometric distribution simply changes and that kind of movement becomes more complicated. There is nothing to copy from a child because an adult is physically not built like a child. Conversely, a child is not built to run for the same reasons: aside from the immaturity of the neuromuscular system, a very high COM puts him at a disadvantage, making him sway like an adult trying to run with a weight of 40 kg on his head. The photos shows Andrzej Stanaszek, a highly skilled powerlifter (300.5 kg squat for 52 kg body weight). One of the reasons that this athlete is so strong (and "squats" perfectly vertical) is that, being a dwarf, he has the proportions of a child.

The position of the COM above the balancing quadrilateral is therefore affected by the distribution of body masses; understanding this concept is therefore an effective key to understanding the movement itself. For example (2), a number of normal weight and overweight people were asked to perform the squat:

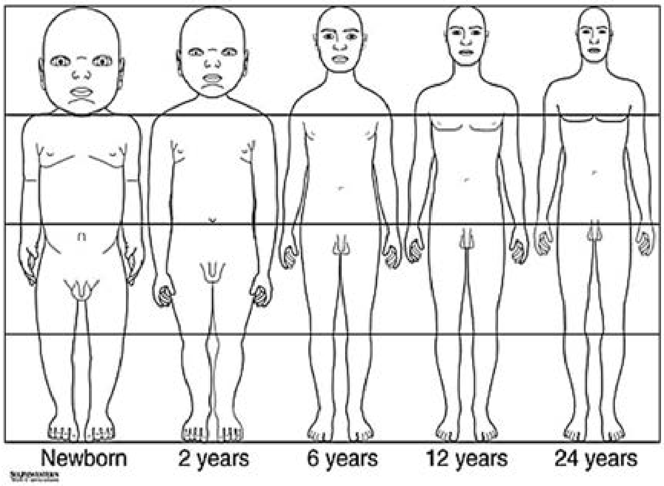


FIGURE NO. 12
BODY PROPORTIONS DURING GROWTH

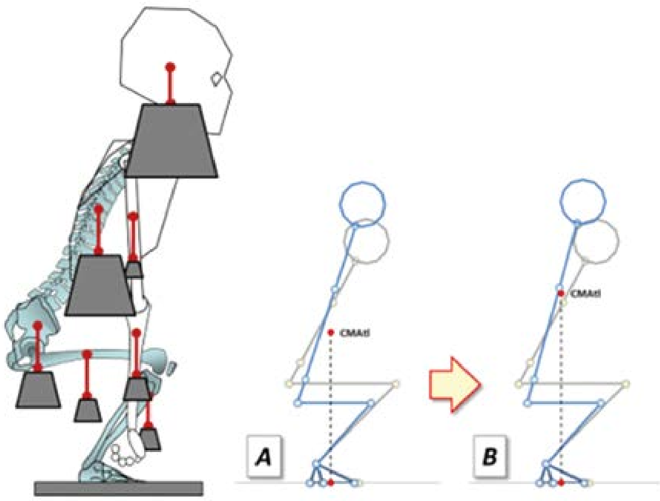
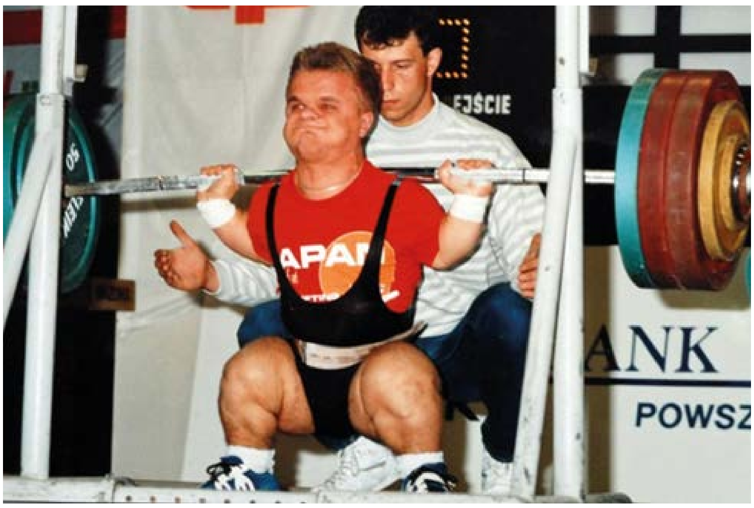


FIGURE NO. 13
ON THE LEFT, THE COM OF AN ADULT, ON THE RIGHT THE COM OF A CHILD



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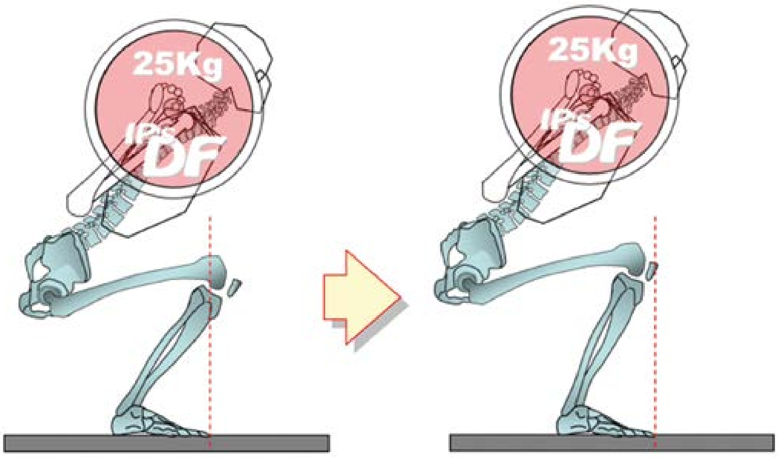


Figure No. 14
On the left, an incorrect squat, on the right a correct squat?

Figure No. 15
Knees extending beyond the toes

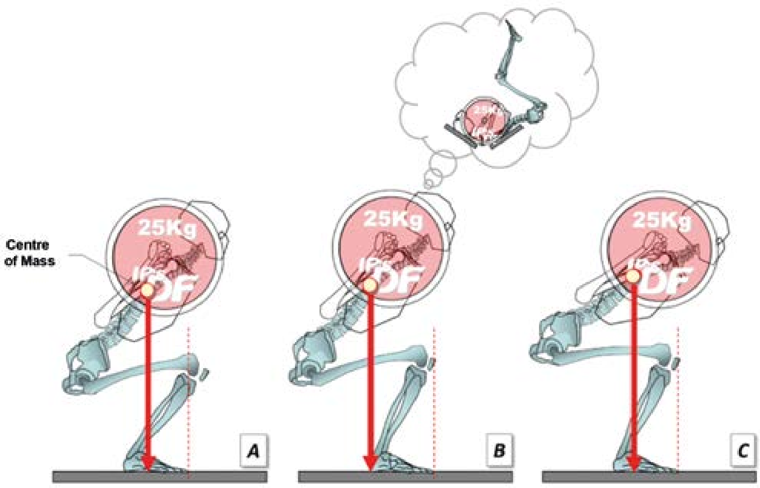


Figure No. 16
Move the knees, move the back

the former were able to flex the knee more than the latter. An overweight person tends to have high body mass in the central and lower part of the body, so - by moving the pelvis backwards in the drop-down - the COM moves back to the supporting quadrilateral at a lower degree of knee flexion with respect to a person of normal weight.

Positioning the arms completely parallel to the ground moves the COM further forward, allowing greater bending of the knees. Therefore, in this case, placing the mass in front of the trunk is advantageous: the positioning of the COM explains why individuals who literally “fall back” during the descent, can squat. all other factors being equal, if they holding a barbell, a kettle bell or any weight to the chest.

THE SQUAT WITH THE “KNEES BEHIND THE TOES”

One of the “rules” to follow for a correct movement of squat is that the knees should never extend beyond the toes.

Figure 14 illustrates the problem: by tracing an imaginary perpendicular to the ground and passing by the toes, the squat on the left would be incorrect because the knees go beyond this line, while the squat on the right would be correct, and therefore a reference. The explanation is that in the image on the left there is an increase in the forces acting on the knee, with respect to what happens in the image of the right: greater forces on the knees, higher chances of injury.

Faced with such a categorical position, it is necessary to maintain a rational approach: the position should be assessed and not accepted without criticism.

Firstly, we need to observe what happens in practice. If the knees extending beyond the toes was really harmful to the knees, Dimitry Klokov and Lydia Valentin, as shown in Figure 15, would be perform-

ing a completely wrong move.
The point is that in the Olympic lifts the knees are more or less in this position. And not only that, if we observe 100 different squats, not only in Weightlifting, but also in Powerlifting, or performed by people at the gym, it may be that at the lowest point, the knees are aligned with the toes, but at a certain point of the descent they actually extend beyond them.
There are no statistics that indicate the danger or risk of injury to the knees due to their position, which does not mean that the problem cannot exist, however, it is interesting to at least question the "rule".
Let's analyse what occurs in Figure 16:

- In A, the position is considered incorrect, but it provides stability to the individual performing the squat, with the COM over the centre of the feet.
- In B, the individual is asked to move the knees back, but this causes the whole trunk to move because of the kinetic chain. Moving the trunk back causes an equivalent displacement of the COM toward the heels, leading to a feeling of instability.
- In C, the individual recovers balance by tilting the back forward, so as to reposition the COM above the centre of the feet.

In other words, by simply resorting to basic physics, the "correction" of the knees undoubtedly worsens the movement as a whole, and the reason is to be found in the COM displacement.
Therefore, one wonders how did this "rule" of "knees behind the feet" actually come about: it is possible to consider the study of Chandler (1991) (7) as a good starting point. This research is the official position of the NSCA on squats for athletic training, and many studies have been confronted with this paper, to either confirm or discredit it. We encourage the reader to find the original document, so as to read it in its entirety and not limit oneself to an interpretation of the passage that follows. This study reported that: *"forward lean of the knee increases shear forces on the knee. Keeping the shin perpendicular may increase shear forces on the back as a result of forward trunk inclination. Although there are exceptions, the shin generally should remain as vertical as possible to reduce shear forces at the knee. Maximal forward movement of the knees should place them no more than slightly in front of the toes"*. This guideline derives from a series of studies by McLaughlin (1977, 1978), the first to have formalised the analysis of the squat, dividing the movement into phases. In an initial study in 1977 (8), in fact, it is shown how lifters at national level tend to have a lower forward movement of the knees and lesser inclination of the trunk.
A reduced forward movement of the knees, as analysed once again by McLaughlin (1978) (McLaughlin, Kinetics of the parallel squat., 1978) with one of the first biomechanical models of the squat, creates, all else being equal, lesser force on the knees themselves, as is apparent from the above conclusion.
As always occurs in the academic world, every position is studied and analysed to confirm or discredit it. In 2003, Fry and other researchers (10) carried out very interesting work: to prevent the tips of the knees from extending beyond the toes, the researchers used a "barrier" (a sort of "wall") placed in front of the people performing the squat. Figure 16 is very explicit, because it demonstrates exactly what happens: the individual's knees are behind the toes, but there is a greater inclination of the back.
The authors' conclusions are: *"Barbell squat exercise guidelines, in-*

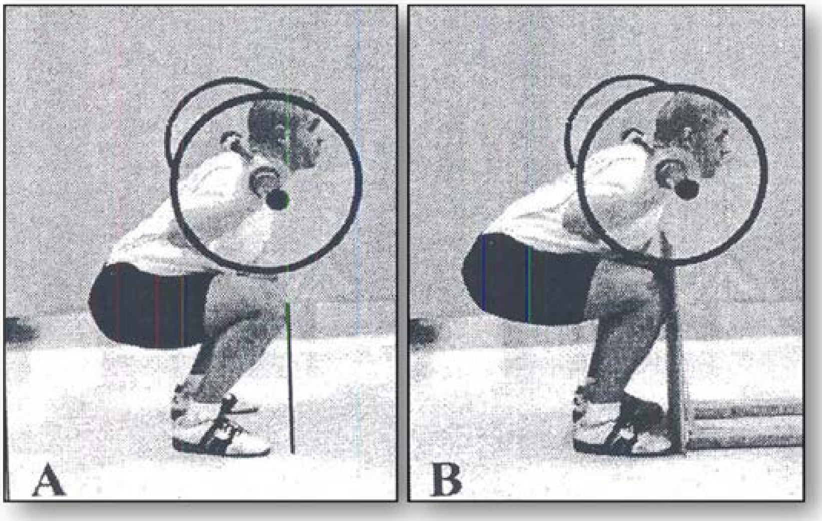


Figure No. 17
Knees aligned with toes

cluding those published by the National Strength and Conditioning Association, cite the need to keep the knees from moving forward past the toes or to keep the shin as vertical as possible, when performing the exercise. However, in order to optimize the forces at all involved joints, it may be advantageous to permit the knees to move slightly past the toes when in a parallel squat position. This suggestion assumes that the individual performing the squat does not possess any pathological conditions of the involved joints such as chondromalacia, patellar tracking disorders, anterior or posterior cruciate ligament injuries, injuries of the meniscus, or related conditions".

In fact, this study does not provide any explanation for this behaviour, it only shows what happens. The limits of the study itself are correctly pointed out: the model is 2D and the centre of mass (COM) is not calculated in a detailed manner.

Further studies followed over time, such as those of Lorenzetti (11) and List (12): in the research, respectively from 2012 and 2013, there is a full 3D biomechanical model, the change in the spinal curvature is analysed, and above all, the real problem of the previous study was overcome. In these two studies, the protocol does not provide for the execution of the squat with a "wall" in front of the knees. In this case either verbal instructions during performance (e.g. "Keep your knees back") or there is a visual reference (as in these two studies, Figure 17), which make the situation more realistic. An extract from the study by List (12): "*the restriction in the movement of the shins in a restricted squat shows an increase in the trunk's ROM (Range of Motion), especially between the lumbar and thoracic segments of the spine, but there is no increase of ROM in the hips. The increase in the thoracic curvature in a restricted squat represents flexion of the spine itself. Therefore, a restriction in the shins' movement results in an increase in the trunk's movement.*

To prevent a backward fall, the restriction in shank motion needs to be compensated for by increased motion of the hips or the trunk to maintain stability, with the centre of mass vertically aligned above the base". Further conclusions from the study by List (12): "*Prac-*

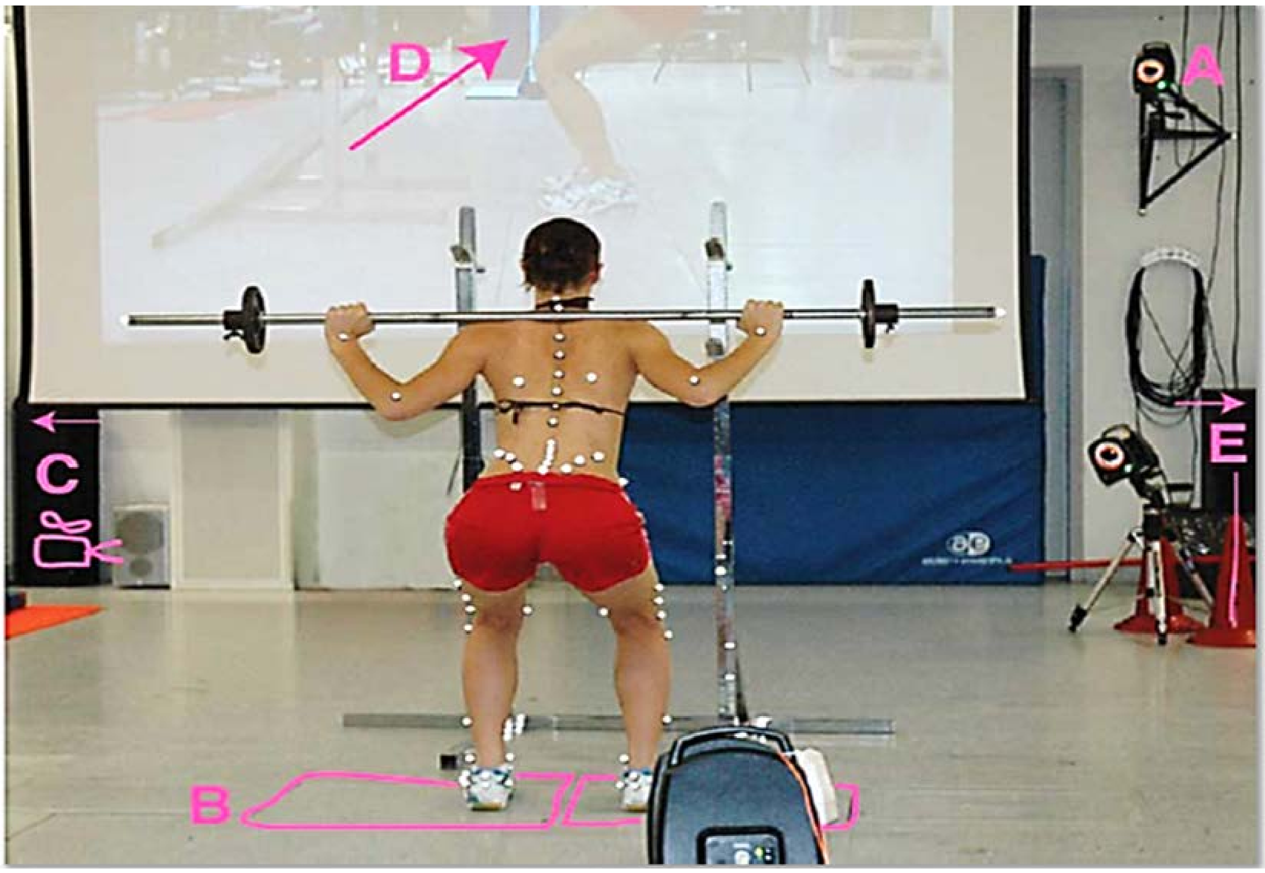
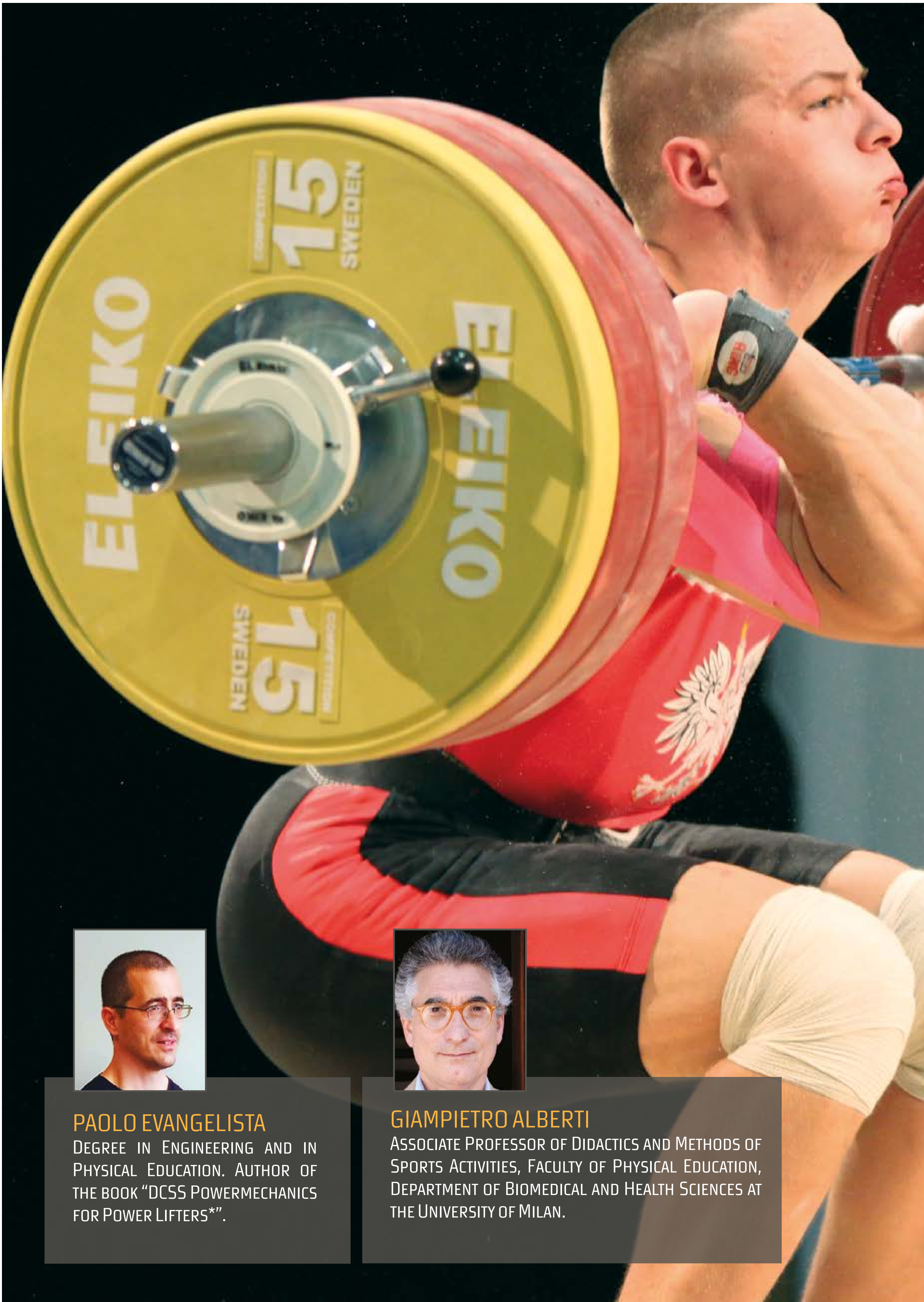


Figure No. 18
THE SQUAT PERFORMED WITH VISUAL REFERENCE FOR KNEE POSITION

titioners should not be overly strict with athletes/clients in coaching against anterior knee displacement during performance of the squat.
A certain amount of anterior displacement at the knee during unrestricted squatting may prevent undue stress on the lumbar spine and potential for back discomfort. Thus, when training leg muscles, the unrestricted squat may be the best choice". Conclusions from Lorenzetti's work (11): *"Limiting the position of the knees requires both a displacement of the centre of pressure (COP) towards the heels, and a compensatory mechanism in the upper body. A displacement of the COP far from the centre of the support area reduces stability and this is particularly unfavourable when the individual is lifting relatively heavy weights. Maintaining a stable position of the COP on the foot support area is crucial to the athlete's safety. A forward displacement of the trunk is required to maintain balance and simultaneously vertically align the shanks."*
These last two studies, in fact, confirm and expand upon the result of the first, stating the fact that a forward displacement of the knees is necessary for a proper squat, otherwise the back flexes forward and may even loses its curvature. The reference samples of the studies are individuals with considerable experience in performing the squat, the same people that you, the reader, will often find yourself coaching: individuals that "work out" in the gym, athletes of sports that are not related to weightlifting: therefore, these results are certainly interesting. An additional study by (McKean, 2012) describes the complex movement of the knees during the squat, both in an anteroposterior and mediolateral direction during the flexing phase, and the extension of the lower limbs. The study concludes: *"(...) the time at which the knees moved forward of the toes was always before the subjects reached halfway of the descent(...). Maximum forward position also occurred before the deepest part of the squat and the authors suggest that this is required to allow the hips to reach the deepest aspect of the squat movement. Rather than set guidelines for forward knee movement during squatting the authors suggest viewing the forward knee movement as a precursor for synchronisation of the hip and knee angles."* To summarise, the knees behind the toes "rule" has been scaled down: the knee position is the result of the mutual movement of the hips and knees: and that is what should be observed, precisely the movement as a whole: a considerable forward displacement of the knees can therefore be both an indication of a wrong move, or totally functional to the mechanics of the same. The skill of the expert lies in being able to understand when it should be corrected, taking into consideration the entire movement. The kinetic chain and COM concepts allow us to understand the overall restrictions of the movement, and therefore should be assimilated and embraced by the kinesiologist.



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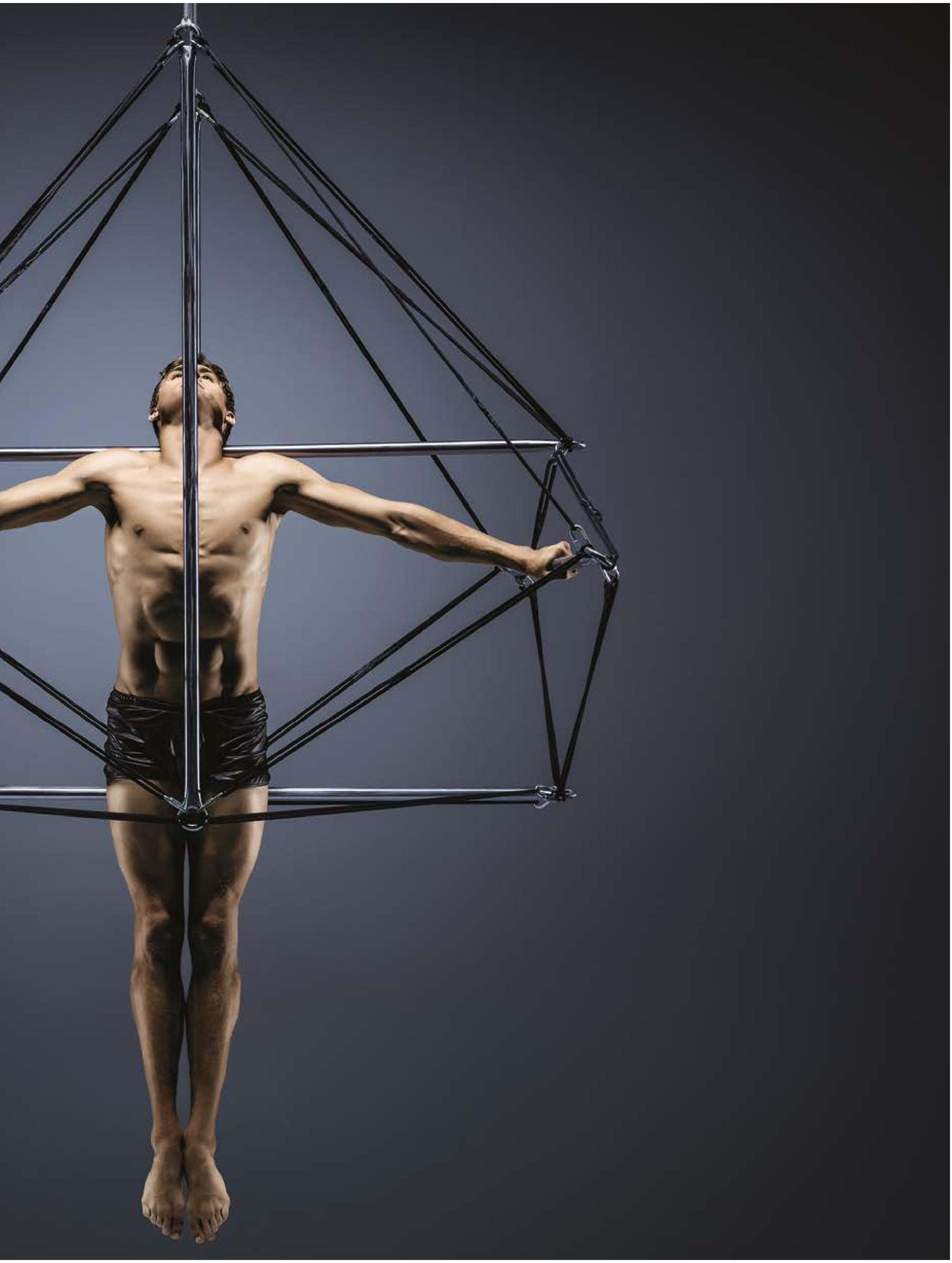
ANTICIPATING THE TIMES. FROM THE THEORY OF IDEAS TO EXERCISING MOVEMENTS

BY ALBERTO ANDORLINI



0.THE PLAN

Another attempt. What we are about to start. In our slow and tiring flight (so abstract that is seems inconclusive), I have not imposed a conventional code that can guide the reader from the dark depths of the basic concepts, to the bright sunlight of the exercise. There are the guides and manuals for this. No, the idea behind the presentation, albeit written, was a freely "articulated" reflection or, better still, a "helical" reflection. Not a circle that could and should close, but a "spring" that continues to expand, stretching out, broadening themes and amplifying issues.

It is true that the two extremes of the helix have never touched; from time to time, step by step, we have brought them close, then moved them apart, depending on the need to compress the sense of the discussion, or expand its the meaning.

This chapter, "Anticipating the times", takes another step. It establishes another passage. For once again, we rewind and expand the "spring", and on that mutating coil we entwine our reasoning. Those who have had the patience to follow the contortions of a thought that wraps around itself; those who have transformed the words a writer into unequivocal feelings of a doer, will have realised that we spoke of "Training" without involving the standard terms and/or conventional references. We talked about a Body that moves 24 hours a day, that performs a pirouette, that carries an oval ball over a line, that jumps long, high and sometimes low; a body which, in moving, exerts a function; and that, by working, changes its Shape and the shape of the world around it. Nothing more. But also, nothing, absolutely nothing, less.

IN BRIEF.

The more observant (or perhaps only the most patient) of readers, will have noticed that we passed "Beyond Training" and "A new Awareness", two titles for two cycles, each consisting of five articles.

Today we will address "Anticipating the times", the third and last title for a thought that has come to fruition along the way. With the first two cycles, I tried to define the structure of an ideal model. I know that talking about "method" may sound excessive; let's just say that together we have faced a methodological assumption that I consider realistically feasible.

I REMEMBER.

The ten articles, enclosed in the two cycles, gave birth to eight statements, eight suggestions, eight ruminations between the speculative and theoretical.

Eight steps that have accompanied us from a reworking of an A-Z for enthusiasts of Body, Movement and Equipment to the drafting of a minimalist vocabulary, dedicated to a few key words: Position, Movement, Action, Skill, Transition, Concatenation and Flow.

I RE-THINK.

Our reflection then led us to an extended analysis of the training model; to the observation of how each movement can be traced to a common structure and primary language; and the formulation of the hypothesis according to which methods, techniques, arts, disciplines or sports can be brought closer together or overlap each other, on the basis of a similar structure. The final step hinted how, in the field of methodology, it is possible to chain rather than separate, to connect rather than distinguish. The steps were too few and too abstract, and perhaps the conclusions were too concise, to be able to claim to have concluded a trip. However, at this point, whether the steps taken were long and substantial or - on the contrary - inconsistent and short, all that is left is for us to continue thinking; and think that it is indeed possible to "train movement" and to "move training", moving the boundaries imposed not by the body's mobility but by the immobility of thought.

LET'S GO BEYOND.

We will attempt to move from the theory of ideas, to the verification of the concepts. And to do this, we will try to index as much as we know about Exercising Movement. To use the standard analogy, we will take a step.... back. First we will address Study, then Exercise. We will deal with re-establishing a connection with who, as an unwitting precursor, has laid the foundations of authentic and contemporary training; and we will try to analyze those exercises that Functional Theory filtered, labelled and made its own.

Let's forget what has been said so far. Alas! Let's forget the defragmentation of techniques and disciplines, the architecture of the body, the mechanics of movement, the five levels of Exercise, the somatografiche coordinates, the familiarity of the equipment and instruments, the grammar of the moving body (Position, Movement, Action, Transition, Concatenation, Flow) and everything that qualifies Exercise as dys-functional, non-functional, pre-functional and functional. Let's go back to verify the sustainability of what was expressed in the previous articles.

BEFORE FUNCTIONAL TRAINING.

Let's fluctuate between the considerations relating to the dissemination of the training model known as "Functional Training", and the suggestions induced by everything that has been said, described and experimented "before F.T.". We will attempt to extend the sources of Functional Training, and to widen the retrospective base, without running the risk - I hope - playing second fiddle to idle fashion and trends. I hope to facilitate the reading of the following pages that follow, commenting in advance on paragraphs that make up the basic structure.

1. THE STATE OF PLAY

Two brief quotations will trace the lines within which the topics will be discussed.

If it is true that our society is sick, what remedial action we can take to prevent the deformation of the process we are most familiar with, in other words, the training process? Or rather, how can we develop the innate potential in a practice, training that is, that may overlap, interfere and interact with any field of human activity? Which buttons do we have to touch to talk about proactive training models and not of fragmented and sectoral structures? How can we uncover knowledge which was never fully assimilated, without falling into the trap of the banal, marketable proposal? Should our proposal aim at the specialisation of a single sector of human activity or at the optimisation of all components of social life?

2. FROM USEFUL UPDATES.... TO OLD DISCUSSIONS

Retracing the steps that have mapped out the current "training scene", you get the strange feeling of discovering everything for the first time. Countless words have been written, discussed or even thought of over time. Words to support sound ideas were laid one over one another, building a house of cards. Often, the anxiety to quickly change our approach to teaching movement, and to change just as quickly our movement attitudes and habits has led us to read those words superficially, passing over truly revolutionary concepts and principles. We get the impression that the same fate befell enlightening and comprehensive pages, read and perhaps analysed, but then left to rest at the back of a drawer. There is a piece on this topic, taken from a much broader discussion. The extract contains the words of Vern Gambetta and Gary Gray, two authors, two operators, who exposed their ideas, in their own field, giving a sense to the activity ... to come. The extract shows us how to work so that a "real" body is able to make a "real" movement. The contents expressed would be sufficient to animate the work of a lifetime; and instead, they run the risk of being downgraded, from useful updates to abused reasonings.

3. STARTING FROM SCRATCH.

So, let us not be dazzled by the quest for new ideas at all costs. More often than not, things passed off as new, can be regarded as irrelevant diversions; at the most steps to the side, but never steps forward. Starting from scratch means recovering the true meaning of that experiment which introduced new models of motor intervention. A few words to introduce the next step:

4. THE PIONEERS

The paragraph is devoted to the lessons given by thirteen leaders in the field of the Movement. Thirteen precursors, twelve explorers of the functional path, each dedicated to study, research, experimentation, teaching, practice "in the field." Each one, the author of a system, which draws inspiration from previous systems, in a sort of chain that generates mixtures, interactions and mergers between different cultural and scientific elements.

5. VIRTUES AND VICES

The unquestionable work of what I call the "Pioneers of the Movement" inadvertently supported the spread of the Functional Theory. On the other hand, to say that the Training we have labelled as "Functional" was born from such previous acquisitions, is rash, at the very least. The incontestable fact remains that these statements have formed the ideological, philosophical and scientific skeleton of an approach that attempted to restore as much as possible, the natural relationship between Body and Movement. In this paragraph, I discuss the virtues and vices of a theory that, in most cases, has remained so.

6. THE GOALS . OR WHAT IS LEFT OF THEM

From a terminological analysis - more or less the same as what presentations, discussions and exchanges have made us accustomed to - to a simple listing of what are or were the main goals of Functional Training. In Functional Training, as not always happens in other fields and for other techniques, the goals give shape to methodological principles; the principles set out the guidelines in the operating field; the guidelines lead to the choice of equipment, methods and parameters; equipment, methods and parameters dictate the selection of content. The exercise, therefore, is only the end result of a process that arises from the definition of a function to be trained. What the main function is and what the derived functions are, is the key to set a targeted and beneficial course.

7. THE EXERCISES. POSITIONS THAT BECOME MOVEMENTS THAT BECOME ACTIONS, THAT – IN SEQUENCES – CAN OR GENERATE TRANSITIONS, OR CREATE CONCATENATIONS, THAT CAN FEED FLOWS.

A long title, for a paragraph that might become infinite. In the title, the desire to connect this last article, "Anticipating the times", with what has been said in the previous cycles ("Beyond Training" and "A new awareness of training"). In this paragraph, I propose the categorisation of exercises according to functional classification. Even in this case, what was considered an attempt at the limit of creativity until a few years ago, has been absorbed as conventional and accepted as such. In photographing and describing the exercises, I wondered what actual value could the framework of the same exercises have, based on a different mapping (e.g. the one proposed in my previous articles, referring to somatografiche coordinates); and how, I wondered, such mapping can contribute to an eclectic vision of training; and, if a different grammatical approach (Positions, Movements, Actions as letters, words and verbs) can guide the conjunction of several motor areas (disciplines, arts, techniques, methods, sports), according to a common syntactic construction (Transitions, Concatenations , Flows). The answers are up to you.

1.THE STATE OF PLAY

"Our society is sick, from teenagers to sedentary adults, to athletes who take shortcuts. The reactive medical model is completely ineffective, and it has become obvious that the solution lies in **proactive options** of mental attitudes, nutrition, movement and recovery. Our performance industry, providing efficient, customised and scientific training models is the key to healthy and happy lives. The only way to do this is to do it together, with open minds, studying, researching, sharing and elevating others in the process. "

Mark Verstegen
President/Founder Athletes' Performance.
Creator of the Core Performance System

"A human being should be able to change a diaper, plan an invasion, butcher a hog, conn a ship, design a building, write a sonnet, balance accounts, build a wall, set a bone, comfort the dying , take orders, give orders, cooperate, act alone, solve equations, analyze a new problem, pitch manure, program a computer, cook a tasty meal, fight efficiently, die gallantly. Specialization is for insects. "

Robert Anson Heinlein
American author of Science Fiction

2. FROM USEFUL UPDATING TO ...OLD DISCUSSIONS

The following is an extract from "Following a Functional Path" by Vern Gambetta and Gary Gray, an excerpt from "The Gambetta Method", published in 1998. My personal notes and remarks are in italics.

"Anatomy books describe muscle action very precisely, but they do not refer to the kinetic chain that such actions express, nor do they discuss the motor purpose and what this involves in terms of mobility, stability, proprioception and neuromuscular control. Basically, the anatomy book version of movement and the real-life version are very different. For this reason, Functional Training refers to the concept of the "Kinetic Chain". The Kinetic Chain is characterized by deceleration at one joint in order to conserve the movement and absorb the thrust, and by necessary acceleration at the next joint, so as to transmit the movement along the chain until it directs the effect of resting on the ground to the effector organs. The kinetic chain concept supports and strengthens the hypothesis that the muscles, joints, and proprioceptors all work synergistically—no joint or body part works in isolation; therefore it is important to train movements not muscles. According to Johannes Noth in his chapter "Cortical and Peripheral Control." Which appeared in the book Strength and Power in Sport, edited by Komi Pavo, "the motor cortex is organized in such a way as to optimize the selection of muscle synergies and not for the selection of a single muscle. Thus the motor cortex thinks in terms of movements and not muscles." Therefore, training individual muscles isolates and breaks the kinetic chain. Vice versa, training movements integrates and improves the function of the kinetic chain.

In all motion, the body, or a segment of the body, will decelerate or reduce force before it accelerates to produce force resulting in the subsequent movement. In other words, performance is a constant interplay of force reduction and resulting force production occurring against a background of stabilisation. In order for this to occur, the body takes advantage of gravity, GRF, and momentum.

The explanation of functional training may be unfamiliar, or at least unconventional; its implementation, however, does not require a radical change or a change of direction; it simply invites you to assess the current and recurring ideas in terms of training, from a different perspective. Here are some clarifications in this regard:

1. The purest form of training for any activity is the actual activity itself; therefore, it is imperative that functional training include activities that are complementary to the sport being trained. These should occur in multiple environments and include components of the actual function. The more functional the environments are in training, the more versatile the athlete will be in handling the forces and stresses incurred by the actual sport activity.

2. Programmes need to introduce controlled amounts of instability, which trains the reactive control of the athlete.

3. The body's relationship to gravity must always be considered. Gravity produces torque around all of the joints of the body. Gravity determines the body's posture. Standing and walking require that we overcome or, at the very least, neutralise the effects of gravity. Gravity conditions the synergic intervention of joints and muscles in dictating the rhythm of the tri-plane movements and the synchronous and simultaneous involvement of the limbs and trunk. Therefore, the exercises should involve and integrate all three planes of joint development and all the joints at the same time.

4. Gravity is the basis of all resistance training; once the body has adapted to the control of its own load (made up of either the entire body, or a part of the body, or of an aggravating environmental situation: ascent/descent, touching/slipping, resting/uplift/landing), only then will it be possible to add an extrinsic disturbing element (with the sole purpose of teaching the body to react to the forces from the outside). A practical example of this concept is to stress core before extremity strength and to use the body weight for resistance before adding external resistance. The initial load should be added eccentrically to teach the athlete 1. how to take advantage of the force reduction and 2. to create a more powerful and effective concentric action.

5. The movement that can train an athlete to run, jump, or throw, is the same movement that can rehabilitate that same athlete from an injury. The principles of functional training apply to rehab the same way they apply to conditioning. The body does not work any differently in rehabilitating than in training.

6. In function there is no such thing as pure open and pure closed chain. All movement involves a coordinated opening and closing of the chain; the issue is not whether the movement is open or closed chain but whether it is a functional or a non-functional movement.

7. The goal of training and rehab is to improve condition; however, it is precisely the activity that causes optimises performance that can also cause an injury. Should an injury occur, how can we make the 'causative activity' contribute positively to that athlete's development or rehabilitation. Essentially, we must realize that the causative activity is really what will make that athlete better in training and will be the cure if there is an injury. In both scenarios the body must successfully deal with the loads and motions that are produced. The effective management of the apparent dichotomy is based on a sound fundamental understanding of the body's function (biomechanics) and the function of the movement. The better we understand this, the less risk if injury there is, and at the same time, there is more chance to intervene.

8. The body knows its weak points. The cliché that the chain is only as strong as its weakest link can be applied to the concept of body movement. The body either breaks down at the weak link or transfers the force elsewhere in the body. When that force is transferred elsewhere, that body part is ready for the increased forces or has a breakdown. In sport, when one player gets tired the coach will substitute another fresh player. The body works in a similar manner. This can be good or bad depending on the quality of the substitute and the demand placed on the substitute.

9. Traditionally, the selection and use of methodology (means, instruments and content)has been the focus in rehab and conditioning. In functional training, it is more important to understand the performance paradigm and the conceptual basis of functional training—and then be able to apply these ideas to your situation. It is also important to consider a spectrum of training or rehab activities that challenge the system to improve. Motion, stability, speed, flexibility, and strength are all facilitated concurrently; they are not developed separately and then combined. Therefore, it is important to have a variety of activities that constantly force the body to raise the level of adaptation and adaptability.

10. The choices of specific methodology are vast. The scope of this article does not allow us to go into detail on all the various methods; suffice to know that functional training includes the use of equipment that facilitates neuromuscular activity. Neutralisation of gravity, the expression of movement, a deep perception of the movement and adaptability to real situations, are all usable means when located in the context of a systematic integrated approach. We should remember that the body is a tool, movement is the means and the body in movement is the only purpose. All additional means and tools are only accessories; without a plan and a trained user the tools can be virtually useless. To be most effective all methodology must meet the criteria of the "Three Ps" and the "Three Es":
    - Is it Practical? Can it be accomplished given the level of development of the athlete and the
    - facilities and equipment available?
    - Is it Personal? Does it meet the needs of the individual athlete both in terms of abilities and skills?
    - proficiency and physical development?
    - Is it Proactive? Is there a plan? Does it anticipate the possible roadblocks to progress and
    - provide a method to overcome these obstacles?
    - Is it esthetic? Does the movement requested produce a balanced and fluid effect?
    - Is it effective? Is the movement produced effective? Does it reach the set goal?

11. The body will move as we wish it to only if we listen to it and use it as it was designed and constructed. This is the key to functional training. We must allow the body to act naturally1.

3. STARTING FROM SCRATCH

If back then (in 1998!) I had been careful, I would not be here now, questioning myself on the plasticity of training and discussing with you the usefulness or otherwise of reworking a thought. Would we have saved time? I do not know. After all, our discourse, stems from our carelessness. After all, the previous articles do not express anything more than a progressive rediscovery of some of "historical" arguments, which were never fully developed.

STARTING FROM SCRATCH, or rather, from a manual of Functional Training. Not to slavishly support the latest fad - precisely functional training - but rather to engage in a debate that has captured the interest of thinkers and performers of movement. It will obviously be a fake manual; an ad hoc excerpt; a compendium of quick, easy and compressed reference, able to indicate, albeit partially, where the training world is heading. Basically, we will make another attempt to see if the "past" hypothesis, are acceptable or not; if there is a need to move away from consolidated concepts and principles, to direct ideas and actions towards a more responsive reaction to current needs. We will critically address what has already been widely disseminated, understood and reinterpreted. And from all these things that have already occurred, we will extract what can help us to train movement and move training. With the underlying intent of anticipating the times.

4.PIONEERS

The wellness industry has turned gymnastics into a useless "modernism", diverting the use of movements from the real function to a sterile superficial form. Most of us have followed the "widespread" operational wave, using a selective approach, based on a particular structural analysis, so immediate and powerful that it fed and perpetuated imbalances, amnesia and muscle asynchronies. These same imbalances, amnesia and asynchronies, were each generated by the static, repetitive and one-sided use of motor potential. In other words, we "closed in", reducing our ability to resist gravity and the destabilising variables that "being on earth" imposes on us. The result? Hyperactivity flexors, adductors and internal rotators of the hip; hand and foot pronators; internal rotation of the shoulders; jaw depressors; and shoulder girdle depressors; all in oppostion to the inhibition of extensors, abductors and external rotators of the hip; hand and foot supinators; external rotators of the shoulder; jaw elevators; and shoulder girdle depressors.

ATTRACTED BY NOVELTIES, we have forgotten that the selective approach, in fragmenting and compartmentalising, can 1) reduce the complexity of an intervention in itself indivisible; 2) cancel the driving synergistic actions of agonists and antagonists; 3) reset the proprioceptive afferents; 4) neglect the neutralising and stabilising ability of individual muscles and muscle groups; 5) alter the timing of muscle activation; and 6) interrupt the sequential activation of the kinetic chain.

AHEAD OF THE TIMES. The work of some of scholars, researchers and practitioners has been somewhat predictive. By anticipating the times, these pioneers of movement have built a structure of thought and an operating patrimony, able to support the evidence of their insights. Thanks to them, and to their work, we have the possibility of drawing closer to the essence of movement, establishing a rational continuum which links cognition processes to motor operations. In chronological order:

1. **Joseph Pilates**
2. **Moshe Feldenkrais**
3. **Herman Kabat**
4. **Vladimir Janda**
5. **Berta e Karel Bobath**
6. **Maggie Knott and Dorothy Voss**
7. **Karel Lewit**
8. **Pavel Kolar**
9. **Gary Gray**
10. **Michael Boyle**
11. **Gray Cook**
12. **Stuart McGill**
13. **Stephen M. Levin**[1]

I will focus on the main considerations of each figure. The same considerations which form the basis for a careful operative approach to function. It will be a way of opening a window on the world of research and understanding how functional exercise is born, transforms and generates variations on the theme, not by chance, or fed by a random "fashion", but because it is the result of careful and meticulous work; work that promotes Movement, scientifically supporting the applicability and enhancing the preventive, rehabilitation and performing potential together. Every indication in the profile of the individual scholars reminds us that there is a communion of elements ... common to all movements.

1. Among the most represented and quoted operators on the Internet, in line with functional ideas: Bill Hartman, Charlie Weingroff, Eric Cobb, Craig Liebenson, Keats Snideman, Leon Chaitow, Mike Verstegen, Mike Robertson, Steve Myrland, Greg Roskopf, Paul Chek, Greg Rose, Erik Dalton.

JOSEPH HUBERTUS PILATES

1. JOSEPH HUBERTUS PILATES

(Monchengladbach 1880, New York 1967). Author of two books ("*Return to Life through Contrology*" and "*Your Health: A Corrective System of Exercising That Revolutionizes the Entire Field of Physical Education*") and creator of the training system that bears his name. Inspired by ancient oriental disciplines such as Yoga (India) and Do-In (Japan), J. Pilates devised an innovative exercise system, which he called *Contrology*, referring to mind control over muscles. The method that is taught today, although based on the principles developed in the early 1900s, is constantly enriched with new medical and rehabilitative knowledge. The key point of the method is the toning and strengthening of the Power House, the functional unit now defined as Core.

The fundamental basics of the technique identifies in the balance of the pelvic floor and breathing the key with which we restore the entire body structure. The Pilates technique includes sensitisation, mobilisation and stabilisation of all the girdles, thanks to a set of exercises that can be performed either as matwork, and with the help of tools, *Reformer, Cadillac, Tower, Barrell, Chair, Circle*).

There are six basics principles of the method:

1. Control over *Breathing*; guided by the teacher, as in Yoga;
2. *Centering*, the core is the synonym of the Power House, considered the centre of force and the functional intersection;
3. Exercising *Precision*; maximum attention to the proper form of each movement;
4. Exercising *Concentration*, constantly focussing the mind on each movement;
5. Exercising *Control* over every part of the body;
6. Exercising *Flow*, a smooth synthesis of all the previous principles.

The application of the principles, constantly updated in the light of current knowledge, allows the individual to develop a specific programme for each posture, preferring to focus on the realignment of the body, harmony and movement awareness.

2. DR. MOSHE FELDENKRAIS

(1904-1983)(doctorate in physics at the Sorbonne) was an engineer, physicist, inventor, martial arts instructor and student of human development. In developing his work Moshe Feldenkrais studied, among other things, anatomy, physiology, child development, physical activity, evolution, psychology, as well as a number of Eastern awareness practices and other somatic approaches. Precisely because of the vastness, vibrancy and accuracy of his training, Feldenkrais' work has been applied in diverse fields, including neurology, psychology, performing arts, sport and rehabil-

DR. MOSHE FELDENKRAIS

itation. His interest in Ju Jitsu led to him meeting Professor Kano, who developed the discipline of Judo. In 1934, he founded the Ju Jitsu Club in Paris and was among the first Europeans to earn a black belt in Judo. And it was precisely the experience of applying judo to learning movement, combined with an in-depth knowledge of the **mechanics** of the human body and the study of anatomy and neurophysiology, at the origin of his famous *"Awareness through movement - ATM"* lessons.
Other significant experiences came from an interest in the work of **F. Mathias Alexander**, the first to show how body posture is not fixed, but can be permanently modified and improved through a set of specific practices. In 1949, he published " Body and mature behavior," a text in which his work is exhibited in an organic way. In 1975, Feldenkrais decided to call his system of individual **"Functional Integration"**, in the wake of **Ida Rolf**'s *Structural Integration* which was at that time becoming popular in the United States. The Feldenkrais Method is a corpus of movement configurations that allows the individual to become aware of a limitation, a lack, a cancellation, an under-use, an atrophy or a non-aware habit; and to replace or fill it or complete it with a more effective and satisfying experience. Stimulating the brain to recognise and to reorganise the differences, the method leads to an experience consistent with respect to gravity, and then integrates the results into a gradually less expensive functional self-image in terms of the use of resources and more complete of **possibilities**. The network of differences is enhanced by interconnections, it is more organised, more plastic, more effective for survival. The broader the contexts and the more varied the experiences in those contexts, the higher is the stimulus for the brain to ask new questions, to explore **new possibilities**, to create new answers.
The proposed neurological strategy primarily consists in increasing the variety of testable paths, connecting them together in a more or less certain and direct way, according to a linear progression that goes:

- from simple to complex
- from general to specific
- from detailed to the whole
- from left to right
- from below to above

This results in a model of distinctions that can be further enriched, according to other possible strategies, in a game of virtually endless modalities:

- I try randomly
- I try based on past experience
- I try everything that works
- I consciously do what I already know I cannot do
- I try everything that does not work
- I use inconsistency
- I use "pitfalls"

and so on ad infinitum[2].

3. HERMAN KABAT

(MD, PhD; 1913 - 1995). Neurophysiologist and researcher in neuroscience, known as the creator of the " Proprioceptive Facilitation" method. The method, which picks up from the studies of physiologist Charles Sherrington, was elaborated in the 1930s, in collaboration with physiotherapist Margaret ("Maggie") Knott and is used in the treatment of patients with neurological disorders. Herman Kabat created a system of care based on manual treatment, able capable of assessing the patient's movement and stimulating, at the same time, the activation and use of motor

HERMAN KABAT

strategies aimed at restoring the most effective kinetic connections.
The method thus becomes not just a therapeutic approach, but a means by which to evaluate and simultaneously treat certain types of neuromuscular dysfunction. The knowledge gained through experiments is transferred and fixed during rehabilitation. Kabat insisted on the concepts of "facilitation" and "inhibition", keywords in the history of both scientific research and clinical practice.
The Proprioceptive Neuromuscular Facilitation2 technique can be defined as a set of methods to evoke or accelerate the responses of the neuromuscular mechanism, through the stimulation of proprioceptors. The movements are performed under the continuous manual and verbal control of the therapist, following very specific patterns. They have a diagonal and spiral direction and involve the muscles that work in a global pattern. The movement has a spiral development, in so far as the muscle itself, as a fibro-elastic structure, has a winding-unrolling sequence during the range of motion (think of the woodcutter who raises his arm backwards before hitting a trunk, or a tennis player getting ready to serve).
"Spirality" has ancient origins: the movements made in ancient oriental dances or the evolutionary development of many life forms such as shells, are an example. The patterns selected by Kabat have the ability to place the muscle groups in a state of maximum elongation, and to make them contract in accordance with the optimal performance of power. The term "facilitation" implies several things: one is the rapid stretching of the muscle, which produces - as a result of elongation - immediate shortening and greater facilitation in the recruitment of motor units; another element is that the weaker joints fulcrums are emphasised by the stronger ones. How? In the embryo, the germ layer of the spine, called the notochord, has two bulges: one cervical and one lumbar; they will become the future plexus, vessels and muscles of the upper and lower limbs. This phenomenon makes us think that every part of the body is closely connected to the adjacent one; such as: hand - shoulder girdle, but also the trunk and limbs. The ability to use stronger parts or whole parts opens up a series of possibilities of combined patterns and involvement - for example - of a hip flexion through the flexion of the head against resistance. The movement sequence that takes place through a precise pattern requires resistance an expertly modulated by the therapist, in order to channel the radiation that emerges. The irradiation described by Sherrington has the ability to facilitate movements other than those initially executed. Kabat tried to formulate his 16 basic patterns for the upper limb and 12 for the lower limb, by making the most of the proximity of the muscles stimulated by irradiation.

For example, if we make resistance against the top part of the upper limb (flexion plus abduction) by rotating it outwards, it will cause the hand to open; if we do the exact opposite movement, the hand will close, and so on. The therapist will have to choose the most appropriate between the 700 possible variation, remembering the seven commandments of the therapeutic exercise in PNF:

- the pattern,
- the position of the therapist's hands,
- maximum resistance,
- verbal commands,
- visual coordination (the patient must visually follow the movement),
- traction or the approximation (if the movement is more tonic or more phasic),
- rapid stretching.

In spinal cord injuries, it has preferable to use those more global movements aimed at the acquisition of individual phylogenetic stages:

- rolling,
- sitting up,
- on all fours,
- upright.

The centre of gravity is gradually

raised, and the support base decreases, similar to that of a pyramid. In a game of fixed points and impulses, even patients with spinal cord injuries can reach sufficient autonomy, taking advantage of the remaining supra-lesional muscles. In peripheral lesions (plexus or cauda injury), this method performs valuable neuronal "bombarding". In these lesions, the excitability threshold is very high, and requires a great incentive to produce a minimal response. PNF is used to bombard the final common pathway with afferent input, so as to facilitate both the passage of a successive stimulus (temporal summation) and more stimuli simultaneously (spatial summation).2

MARGARET KNOTT - DOROTHY VOSS

BERTA and KAREL BOBATH

4. MARGARET KNOTT and DOROTHY VOSS.

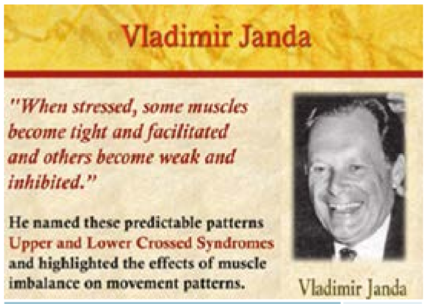
What we know today as the "Proprioceptive Neuromuscular Facilitation" (PNF) method is the systematic evolution of the work started by Dr. Herman Kabat. In 1945, Margaret Knott joined Dr. Kabat, in the role of physiotherapist, and expanded the activities related to the teaching and dissemination of the method. In 1954, it is she who added the word "neuromuscular" to the method name. In 1952, collaboration with Dorothy Voss began, leading to the publication, in 1956, of the text *"Proprioceptive neuromuscular facilitation: patterns and techniques"*.

5. BERTA (physiotherapist) (1908-1991) and KAREL (1907-1991) (psychiatrist/neurophysiologist) BOBATH.

More than 50 years have passed since Berta and Karel Bobath proposed what was then regarded as a revolutionary new approach to the treatment of central nervous system (CNS) lesions. The Bobaths elaborated a therapeutic method capable of acting on neuropathies through the inhibition of those postural reflexes which tend to adversely affect coordination and muscle tone. The Bobath technique includes a series of positions capable of inhibiting the reflections that construct abnormal postural positions; facilitating the construction of those reflections that produce normal and positive postural patterns; intervening on the increase of the tone of muscles that determine positive patterns. This method was designed to obtain the attenuation of spasticity, characteristic of cerebral diseases, but was extended to all neurological muscle deficits. The Bobath concept moves away from some fundamental considerations. A selective movement, which isolates and also involves a single joint, is always accompanied by a reflex activity that balances and absorbs unwanted forces, distributing them across the articular "network". The Bobath concept sees the selective movement as an essential component of complex motor sequences, consisting of coordinated movements, aimed at achieving a purpose. The effective movement depends on the ability to limit and combine segmental movements, involving them in the desired functional activity, with a variability subjected to a wide range of environmental conditions. For the multi-joint movement to be performed in a precise way, the CNS must control the effects of interactive torques, arising from the movements produced by other joints. Such activities, when engaged in a functional way, provide adequate postural stability throughout the multi-segmenatal kinetic chain. Such assertions underline the importance of synergistic muscle activity, expressed at a distance by the specific activation area and the need to reconsider the association between the global dysfunction and deficiency of a single segment. Adequate postural control, along with the possibility of "moving" selectively, facilitates the production of coordinated motor sequences, known as movement patterns. Patterns, which can be described in relation to the spatial and temporal components and which include walking, reaching, grabbing and all postural transitions, such as sitting down and standing up and passing, with all possible "useful" variations, from lying down to sitting up, to standing up. Postural transitions, although similar between individuals, become sequences of dynamic movement, changing and variable in relation to the individual, the environment and the purpose.

6. DR. VLADIMIR JANDA

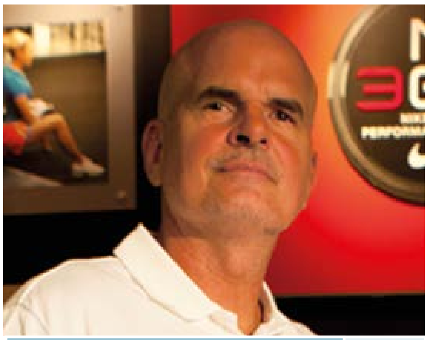
(MD, DSc ; neurologist, physiotherapist; 1928-2002). The idea that a system (which appears if not absolutely unalterable, at least relatively stable) can progressively lose its functional equilibrium was described by Vladimir Janda, as a result of observations made of patients suffering from cerebral palsy and strokes. Janda demonstrated how muscle imbalances can be better understood if approached and compared to pathological neuromuscular conditions (In brain paralysis the hyperactive muscles are affected by spasticity, conversely, in the case of a stroke, the inhibited muscles are affected by paralysis).
Janda also showed (with six relatively simple screening tests) how faulty movement patterns resulted from predictable muscle imbalances and how these caused repetitive strain injuries, and joint dysfunction.
Janda describes two regional syndromes - Upper & Lower Crossed Syndromes and more global Layer Syndrome). The latter, is very similar in appearance to the "Joint by Joint" approach recently published by Michael Boyle and Gray Cook.
In addition to what has already been reported, we should remember the development of a model for the evaluation of hip abduction. The test involves the gluteus medius as the agonist; the tensor fasciae latae, piriformis and quadratus lumborum as synergistic; the adductor muscles as antagonists. The gluteus medius works as a stabiliser of the femur and pelvis in the frontal plane. According to Janda's observations, a deficient or defective mechanism of abduction can cause patellofemoral syndrome and iliotibial band syndromw, both due to hyperactivity of the TFL (tensor fasciae latae); the reason for the latter being the



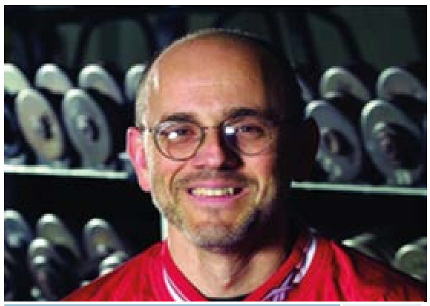
DR. VLADIMIR JANDA

DR. KAREL LEWIT

DR. PAVEL KOLAR



GARY GRAY



MICHAEL BOYLE

excessive lateral tracking of the patella during knee extension. An "impoverishment" of the function of the gluteus medius and lower back also produces Trendelenberg posture, an imbalance of the pelvis, a lack of lumbar-pelvic stability during single leg stance.

7. DR. KAREL LEWIT

(MD, DSc) (Czech Republic), neurologist. Lewit, despite having crossed the threshold of 90 years, is still devoted to teaching, practice and research. Amongst many contributions over a 50-year career, we recall the description of the protracted posture syndrome (Forward Drawn Posture). This syndrome, characterised by over-activity in the hip flexors, is the result of "prolonged sitting." This attitude develops a closed or flexed posture. The gluteus maximus is inhibited and compensatory tightness develops in the hamstrings. Treatment is aimed at two primary targets: fascial release of the posterior chain (erector spinae, gluteus maximus and hamstrings) and mobilisation of the fibular head. Normally, posture improves immediately after treating just of these key links.

8. DR. PAVEL KOLAR

(Czech Republic). Dr. Kolar is a physical therapist specialising in paediatrics, sports medicine and neurological rehabilitation. A former world class gymnast and protégé of Vaclav Vojta (*the physician who developed the method of the same name, for the treatment of Cerebral Palsy*), Kolar has emphasised that developmental kinesiology is closely interfaced with the central nervous system and how the acquisition and the reworking of simple movements can be used to reboot complex motor patterns and to correct compensatory imbalances associated with repetitive stress. In particular, Kolar focuses his research on the neurological development that leads to the full acquisition of upright posture, from birth to the age of 4. Along the same line of thought is the affirmation that postural alteration resulting in lifestyles that do not conform to the natural motor development, would be able to develop a "dead zone" from both a mechanical and perceptive point of view, in the spinal tract between T4 and T8.

Consequently, for Kolar, the first goal of therapy is to normalise upright posture.
Strategies to verticalise posture include *"reflex locomotion procedures"*; distension of the abdominal wall; rib mobilisation; facilitation of key stabilisation areas referred to as punctum fixum (lower anterior ribs, lower border of the scapulae, etc.); The exercises designed to develop enhanced co-muscle activation around key joints (e.g. C0-C1, T/L & Lumbo-sacral).

9. GARY GRAY

PT (Michigan, U.S.A.). Gray is an American therapist, who has significantly developed the principles of kinetic chain paradigm. Gray supports both the use non-functional floor exercises, as a primary way of restoring function, and the use of functional exercises in a standing position, as the subsequent dynamic proposal. He developed the concept of how the "upper quarter" can interact with the contralateral "lower quarter" developing a mutual "diagonal" feature; and how manoeuvers and movements applied to a quarter produce "cross" adjustments and adaptations. His coined term "mostability" supports the importance of stability and mobility in the new kinetic paradigm. He also introduction a applied methodology - "Tweakology" - that interconnects the properties and the drivers that define the exercise. Gray states *"if you want to train the transversus abdominis, train in the transverse plane"*; a statement that has opened the door to 3D and rotational exercise.

10. MICHAEL BOYLE

is a leading name in the strength and conditioning world (*Strength and Conditioning, Performance Enhancement and general fitness*). Author of *"Functional Training for Sports"* (2003) and *"Advances in Functional Training"* (2011). He divides his time between training, studying, writing and teaching. One of his most important contributions has been his emphasis on the mutual relationship between hip extension and knee extension; the diffusion of anti-flexion exercises supported by Dr. Mc Gill; and the dissemination of the Joint by Joint Approach, an expansion on the well known Layer Syndrome of Dr. Janda. He always invites people to think in terms of movements instead of individual muscles.

11. GRAY COOK

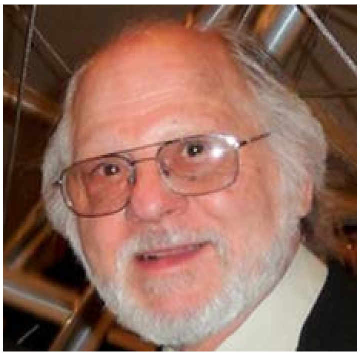
PT, co-founder (with Greg Rose, DC, and Lee Burton, PT), of Functional Movement Screening (FMS) and Selective Functional Movement Assessment (SFMA); evaluation models to detect, analyse and classify fundamental and functional movements. A screening exam based on the observation of these motor patterns, FMS and FSMA classify movements based on any dysfunctions, excluding from the assessment the weight of isolated muscular impairments. The evaluation systems have the advantage, compared to similar tests proposed by Dr. Janda, of being numerically scored.

12. STUART MCGILL

Professor at the University of Waterloo, a biomechanical spine expert. Author of the texts: "*Low Back Disorders*", "*Ultimate Back Fitness and Performance*", "*The Ultimate Back. Assessment and Therapeutic Exercise*", "*The Ultimate Back. Enhancing Performance*". Laboratory research directed by McGill has three objectives: understanding how the low back works; studying the causes of the problems relating to the low back; searching, investigating and making assumptions that may influence the preventative, rehabilitative and performance proposals. He has shown the dangers of repetitive actions, and called for a special attention to the well-known, but abused exercises. He created the "Big 3", low back core exercises to deal with back problems.

13. STEPHEN M. LEVIN

Orthopaedic Surgeon. Levin coined the term "biotensegrity", adding the prefix bio to an already known term, Tensegrity. The term tensegrity describes the biomechanical organisation of all life forms, from viruses to humans. Studies conducted on the human spine led Levin to find what he himself has identified as defects of the prevailing biomechanical model. Levin started these studies from a purely surgical perspective. In the mid-70s, he began to study the mechanics of the spine. At that time, the field of biomechanics respected the Newtonian approach. As a result of studies by Borelli (1680), the biological structure was described as a set of rigid material resting on a solid foundation. Human beings, however, and all the biological structures are omnidirectional, dependant on gravity but they are mobile and - above all - made from "soft" materials such as foams, colloids and emulsions. The laws of mechanics, if applied to the resulting structure, can lead to different conclusions. Levin has sought and found in the principles of tensegrity architecture, a model compatible with his intuition, in stark contrast to the dominant Newtonian approach. Levin states that it was the vision of the Needle Tower that inspired his study. The sculpture by Kenneth Snelson, with its compression struts, floating in a global supply network, enabled him to understand how, in the relative simplicity of the design, it contained the key principles of an alternative model to the one commonly accepted, essentially made up of fulcrums and levers. Levin contacted Snelson and began his long career in the research and publication on the subject. He has created models of the human spine and other organs, using the laws of tensegrity (cf. the life and work of Buckminster Fuller). In this system of total body re-modelling, the spine and limbs are not a set of assembled rigid elements. They are, rather, semi-rigid, viscoelastic, non-linear bone segments, connected by non-linear, viscoelastic connectors (i.e. cartilage, joint capsule and ligaments) to a viscoelastic, non-linear, integrated motor system (muscles, tendons and connective tissue). Levin has developed a hierarchical model of the body that incorporates mechanics and physiology, from the sub-cellular to the structured organism; a model based on a Tensegrity icosahedron. Levin has extended the model to all living organisms, from viruses to vertebrates, their systems and sub-systems. The model has now spread around the world,



STARTING FROM THE LEFT:

GRAY COOK
STUART MCGILL
STEPHEN M. LEVIN

embedded in many of the disciplines of physical and manual therapy.

EXTRAPOLATE & TRANSFER

From the teachings of each of these "pioneers", we can acquire significant elements, correlated to the development of a theory, which is not born, ipso facto, but which, formed by the dissemination of an overall thought, has been gradually enriched with various contributions. A theory that has intervened to define the current direction in the field of training, restoring the correct relationship between real movement and the ideal exercise, between artificial exercise and natural movement.

A THEORY MADE UP OF THEORIES:

some elaborated in the field of motor control *(Gesell & Mc Graw, 1940; Bernstein, 1967; Gibson, 1966; Schmidt, 1975; Kelso, 1984)*; others derived from clinical practice *(Neuro-Developmental Treatment, NDT approach by Karl and Berta Bobath; Brunnstrom Approach by Signe Brunnstrom; Neuro-Physiological Approach by Margaret Rood, Sensory Integration, S.I. Theory by Jean Ayres; Proprioceptive Neuromuscular Facilitation P.N.F System by Kabat, Knott and Voss)*; some developed in the field of training science, or derived from the study of the anatomy (the muscle chains studied by F. Mezieres and the myofascial meridians researched by T.W. Myers); the last, finally, linked to the study of motor learning processes *(Task Oriented Approach, Shumway-Cook & Woolacott, 2001)*.

If the keys to training are integration (training the interdependence of muscle actions and not their independence), neuromuscular control (feed back - feed forward), opposition to gravity (one/two leg stance), control over one's own body weight, multidimensionality, the reactive forces exerted on and by the ground, torques (momentum), the acceleration and deceleration of segments located on the same kinetic line, the generation and absorption of forces, the mind/body relationship, then, through the in-depth work of those pioneers, we can verify (or at least consider) how every principle and every concept expressible in theoretical terms, has already been investigated and exposed by those who knew how to skilfully expand the search horizon. What emerges from the work of each of them? I shall attempt to answer briefly, leaving room for further - your - personal insights.

- From **J.H. Pilates**, the centrality of the Core, as a source of proximal stability and distal mobility; respiratory education; peripheral control; the use of "integral" small equipment and machines.
- From **M. Feldenkrais**, experimenting new experiential routes beyond the restrictions imposed by gravity; exploring new possibilities in motor sequences organised around a specific human function (walking, bending, stretching out, sitting down, etc.); the adaptation to new contextual situations; the relationship with the ground (grounding); the expansion of the three-dimensional motor paradigm; the continued involvement of thought, perception, imagination; the search for a precise, effective, economic and efficient action (getting the maximum benefit possible from minimum effort).
- From **H. Kabat, M. Knott and D. Voss**, the use of multi-joint multi-plane diagonal and rotational movement patterns, referring to upper and lower limbs, trunk and neck; attention to "spiral" movement; using global preparatory patterns aimed at the acquisition of individual phylogenetic stages: rolling, reaching a sitting position, quadrupedal position, upright position; the gradual raising of the centre of gravity and the gradual reduction of support points.
- From **B. and K. Bobath**, the integration of selective movements in composite and complex movement patterns: from the reduction of the support base in multi-joint movements, quadrupedal positions, to verticalising adjustments, to postural transitions; the use of the Swiss ball.
- From **V. Janda**, the description of Upper & Lower Crossed Syndromes and global Layer Syndrome; the focus on stabilising mechanisms and activating "forgotten" or inhibited muscles; the use of the monopodalic position and locomotives patterns in therapy; the use of unstable surfaces; attention to the integrated work of the muscles crossing the critical junction between the gluteus and the latis-

simus dorsi of the opposite side (thoracolumbar fascia).

- From **K. Lewit**, neuroplasticity, sensorimotor amnesia, the relationship between overactivity and muscle inhibition resulting from habits that do not conform to natural motor development;
- From **P. Kolar**, the locomotor pattern, the reflexes of rotation and sliding, to facilitating and co-activating exercises aimed at "fixed points" or key areas of stabilisation.
- From **G. Gray**, the relationship between upper and lower quarters as a synthesis of the contralateral intersecting relationship; the emphasis on Stability and Mobility as cornerstones of performance; the proposed rotational and three-dimensional exercises; the introduction of diagonal patterns of trunk flexion with rotation (chop) and trunk extension with rotation (lift); the fusion of elements of conventional training concerning force, with concepts of the rehabilitation world.
- From **M. Boyle**, the dissemination of the Joint by Joint Approach.
- From **G. Cook**, the creation of Functional Movement Screening (FMS), and Selective Functional Movement Assessment (SFMA).
- From **S. McGill**, the "Big Three" as an element of postural synthesis, focused on core stabilisation.
- From **Stephen M. Levin**, the myofascial chains and the approach of the musculoskeletal system to a plastic model of biological tensegrity.
- From the models regarding the study of motor control and learning[2], the therapist's need to find a task or to propose a problem which the nervous system has to solve (problem solving) to make a movement; the patient on the other hand, needs to search and "actively" use the perceptual information gathered in a real and stimulating environment, in order to coordinate the movements towards the desired goal.

2. Sherrington and the Theory of Reflexes from the early 1900s; Jackson and the Hierarchy Theory, also from the early 1900s ; J. Gibson and the Ecological Theory from 1966; N. Bernstein and the Theory of Systems or Cybernetics from 1967; the recent Theory of Parallel Distributed Processing, by various authors.

ALBERTO ANDORLINI

After extensive experience as a Physical Education Teacher, today he is a Sports Trainer and Rehabilitator. His activity has long been connected to his interest in the evolution of movement and the development of performance.

He has worked for Fiorentina F.C., Siena F.C., Al Arabi Sports Club, Chelsea F.C., he was the Physical Therapist and Sports Trainer for the Italian Women's Football Team. He is currently the Rehabilitator at Palermo Sports Club. He collaborates with the Florence Training Lab and lectures in Sports Science and Techniques and Preventative and Adaptive Motor Sciences at the University of Florence.

SCIENTIFIC BASIS FOR POWER TRAINING

BY JAY R. HOFFMAN

In general individuals who are not experienced in resistance training will experience large increases in strength during the beginning stages of a training program. As strength levels are improved the individual may also experience improvements in various power components of athletic performance, such as jump height and speed. This is primarily the result of the athlete being able to generate a greater amount of force. As the athlete becomes stronger and more experienced, the rate of strength development decreases and eventually reaches a plateau (Hoffman et al., 2014). At this point, not only are strength improvements harder to achieve, but improving maximal strength may not provide the same stimulus to enhance power performance as it did during the earlier stages of training.

An important factor for maximizing power production is exerting as much force as possible in a short period of time. Training for maximal strength through heavy resistance training may be effective for enhancing power in the inexperienced athlete, but may not provide the same stimulus in the experienced, resistance trained athlete. For these athletes, if plyometric exercises or a combination of plyometric and resistance training (using a light resistance such as might be used with ballistic training) is added to the training program, the athlete's ability to increase their rate of force development may be enhanced. However, it is also important to understand that it is not a question of performing one mode of training versus the other, but it is a function of adding to the existing training program. In order to maintain strength performance the athlete needs to continue to provide the stimulus that maintains maximal strength performance. However, the inclusion of specific exercises that focuses on high velocity movements will maximize power performance as well. This has also has been demonstrated by several investigations that have shown that the inclusion of ballistic exercises (e.g. squat jump) can enhance power production in resistance-trained athletes when combined with their regular traditional resistance training programs (Hoffman et al., 2005; Newton et al. 1999). The use of ballistic training appears to generate a new window of adaptation stimulating performance gains in elite athletes with considerable training experience.

As discussed, power performance will increase the rate of force development. The rate of force development is defined as how quick maximal force is reached (**see Figure 1**). Although maximal force remains important, how quickly the athlete can get there which is critical for success. Optimally, athletes and coaches desire to increase maximal force and the rate of force development. Specific training programs or manipulating acute program variables within the resistance training program can emphasize either and/or both training goals. Most power movements in sports involve a countermovement in which the muscles are first stretched and then shortened rapidly. An example is the bending of one's knees prior to performing a vertical jump. This movement is referred to as a stretch-shortening cycle. The difference in jump height and power expression between a squat jump and a countermovement jump (in which the athlete lowers him or herself to a squat position and pauses before performing the jump) is related to the greater force output at the start of the upward (concentric) movement. The countermovement jump allows for greater forces to be exerted against the ground and enhances acceleration of the body as it leaves the ground (Newton et al.

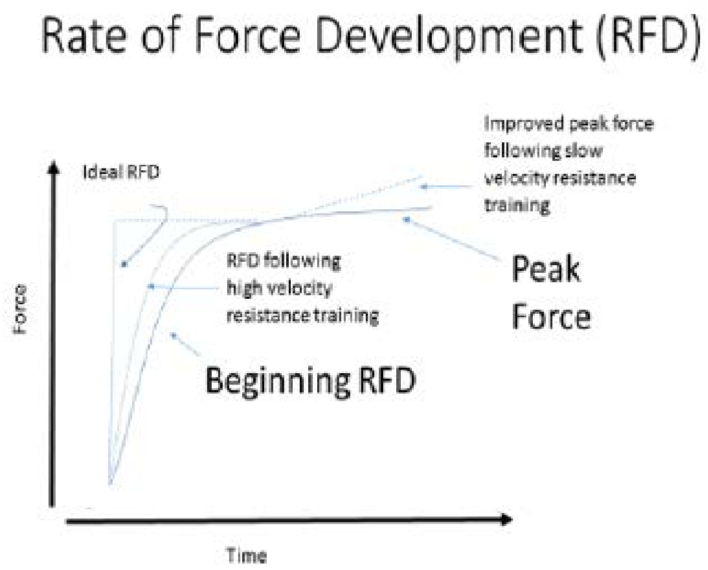


FIGURE NO. 1 RATE OF FORCE DEVELOPMENT (RFD)

2012). Other methods attributed to the differences in power output between the two types of jumps are recovery of stored elastic energy, activation of the stretch reflex and muscle-tendon interactions (Hoffman, 2014).

RELATIONSHIP BETWEEN FORCE, VELOCITY, AND POWER

Training Methods for Power Development Traditional resistance training programs are effective in improving strength in the high force, slow velocity movements. However, these strength improvements are not reflected in the same magnitude during higher velocity movements. Exercises using reduced loads performed at a greater velocity will result in greater force outputs at the higher velocity ranges and improve the rate of force development (Newton et al. 2012). It is the combination of both high force, low velocity and low force, high velocity that should be integrated into the athletes training program. If the trained athlete would focus on only one aspect of the training model, a potential decrease in either the force or velocity component may occur without the appropriate stimulus.

One of the major issues that has been identified with traditional resistance training exercises is the deceleration of the bar towards the end of the concentric phase of a lift. Deceleration has been reported to occur for nearly 25% of the time spent in the concentric phase, but may increase to 52% as the load is reduced (—80% of 1-RM) (Elliot et al. 1989). Thus, even when using lighter resistance the athlete needs to spend more time decelerating the bar. However, if the athlete was able to accelerate the bar through the full-range of motion by actually throwing the bar as in a bench press throw or jumping with the weight as in a squat jump, the potential for power development may even be greater. This type of movement is referred to as ballistic resistance training. As an athlete moves a bar through its full range of motion during a lift, the greater velocity of movement in a movement that allows for continuous acceleration would be advantageous in stimulating power development compared to a traditional exercise, in which the bar is decelerated towards the end of the range of motion. Newton and colleagues (1996) comparing the bench press throw to the traditional bench press movement reported that muscle activation was 19% - 44% higher in the throw versus the press movements, and that deceleration occurred for

40% of the concentric movement during the press.

It is acknowledged that the bench press throw may not be a practical exercise, considering that attempting to catch the bar is not recommended once it leaves the hands, there are several other types of exercises that may be very effective. For instance, squat jumps, medicine ball throws, and plyometric drills are all resistance movements that do not require deceleration during the concentric phase of the exercise. There have also been technological advances that have used hydraulics to allow athletes to use a bench press throw as a legitimate ballistic exercise.

TRAINING METHODS FOR POWER DEVELOPMENT

Training for power is accomplished by improving maximal force capability and by enhancing the rate at which a submaximal force can be exerted. However, where the emphasis should be and how that is manipulated is largely determined by the experience and strength level of the athlete. Novice athletes or athletes that are weak would benefit primarily from training programs designed to enhance maximal strength. That may be enough of a stimulus to increase power performance (Cormie et al, 2010). However, for the experienced athlete, the inclusion of plyometric drills, ballistic training and Olympic style resistance training may provide the necessary stimulus to enhance power performance.

Plyometrics

Plyometrics are exercises that stretch and then shorten the muscle to accelerate the body or limb. The initial movement in a plyometric exercise is for the muscle to be rapidly stretched (eccentric contraction), as in a countermovement jump, and then shortened to accelerate the body upward (concentric contraction). The use of the eccentric movement appears to enhance the amount of stored elastic energy acquired during the eccentric phase that is able to be recruited during the upward movement of the jump (Bosco and Komi 1979). In addition, the prestretch during the lower movement of the jump results in a greater neural stimulation (Schmidtbleicher et al. 1988) as well as the torque generating ability at the start of the upward movement (Kraemer and Newton 2000). The greater torque at the onset of the jump begins with a greater force exerted against the ground with a subsequent increase in impulse (force applied over time) resulting in a more rapid acceleration of the body upward.

Plyometric training is a training method that is used to enhance power performance. The primary question is whether plyometric drills should be considered a supplement to the normal training regimen or an alternative way of training. Combining traditional resistance training and plyometric drills is often used during the power phase in the yearly training program of the strength/power athlete. The body weight of the athletes is most often used as the overload, but the use of external objects such as medicine balls also provide a good training stimulus for certain plyometric exercises. To increase intensity of effort or difficulty, experienced athletes may perform the plyometric drills wearing weighted vests or holding dumbbells in their hands when performing some of the jumps.

A number of different studies have demonstrated the effectiveness of plyometric training for improving power, generally reported as improvements in vertical jump height (Hoffman, 2014). Although traditional resistance training has been shown to improve vertical jump performance as well, these improvements may be limited in experienced, resistance trained athletes (Hakkinen et al. 1985), or in athletes who have a high vertical jump ability (Hoffman 2014). When plyometric drills are combined with a traditional resistance training program, vertical jump performance appears to be enhanced to a significantly greater extent than if performing either resistance training or plyometric training alone (Hoffman, 2014).

Plyometric Training Program Design

A primary concern when beginning a plyometric training program is the increased potential for injury, because the drills place high forces on the musculoskeletal system. However, no epidemiological studies have addressed the issue of whether plyometric training places the athlete at a greater risk for injury in comparison with other forms of training. However, one should keep in mind that plyometric drills used by athletes are the same exercises that are commonly seen being used by children in the schoolyard. Hops, skips and jumps are generally movements that are part of elementary school physical education curriculum and have been shown to be an effective and safe way of improving physical fitness in youth (Hoffman, 2014). Interestingly, there has been evidence supporting the use of plyometrics training as part of the strength training program of competitive women athletes, may actually reduce the risk for anterior cruciate ligament injury. As with any training program, certain precautions should be in place to insure a safe environment to conduct these drills. Some recommendations for participating in plyometric training are listed here:

- Use footwear and landing surfaces with good shock-absorbing qualities.Allow for a proper warm-up before beginning the exercise session.
- Use proper progression of drills; master lower-intensity drills before beginning more complex plyometric exercises.
- All boxes used for drills should be stable and have a nonslip top surface.
- Make sure that there is sufficient space for the desired drill. For most bounding and running drills, 33-44 yards (30-40 m) of straightaway are required, whereas for some of the vertical and depth jumps, only 3-4 yards (3-4 m) of space are needed. For jumping drills, ceiling height should be approximately 4 yards (4 m).
- Select exercises that have a high degree of specificity within the athlete's sport to enhance performance gains.
- Ensure that all drills are performed with proper technique.
- Allow for sufficient recovery between exercise sessions, and do not perform plyometric drills when fatigued.

Intensity of Training

Intensity of training is controlled by the type of exercise performed. Considering that most plyometric drills use the athlete's body mass, the complexity of the drill dictates the intensity level (i.e., one leg hops versus two leg jumps). In certain situations, increasing or adding weights (e.g., weight of medicine ball), may also increase the intensity of training.

Volume of Training

The volume of training is the total work performed in an exercise session. During plyometric training, volume often refers to the number of foot contacts during each session. Foot contacts provide a means of prescribing and monitoring exercise volume, especially for drills involving jumping. In drills that involve exaggerated running exercises such as bounding, the volume of training may be measured by distance. The time needed to complete a plyometric exercise session should not exceed 20-30 min for a beginner. This does not include the time needed for warm-up and cool-down. As the experience level of the athlete increases and a greater number of high-intensity drills are incorporated into the training program, the time needed to complete the workout may increase.

Frequency of Training

Frequency is the number of plyometric training sessions performed per week. To date, research has not focused on the optimum number of weekly training sessions. The athlete's need for reco-

very has been suggested as a basis for the frequency of training for plyometrics. Low-intensity drills such as skipping or front or diagonal cone hops may be performed daily, whereas more complex drills and higher-intensity exercises such as bounding or depth jumps may require a longer recovery period (48-72 h) before the next exercise session (Hoffman, 2014). Athletic teams may hold two to three plyometric sessions per week. However, this depends on the time of the year. During the off-season, the frequency of plyometric exercise sessions may be relatively high because they are integrated into the off-season strength and conditioning program. However, during the season, coaches and players focus primarily on practices. The number of plyometric sessions, although not necessarily eliminated, is substantially reduced. Nevertheless, common sense should prevail when using plyometric drills during the season. For basketball and volleyball players who play several games a week, and continually scrimmage during practices, the addition of plyometric exercises may be more likely to cause injury than enhance power performance. In contrast, track and field athletes who compete in a limited schedule often train through several meets to peak at the more important competitions. Maintaining a high frequency and volume of plyometric sessions during the season may be beneficial for these athletes.

Rest and Recovery

Plyometric training is not used as conditioning exercises, As such, adequate recovery between each repetition and set is desired to maximize performance. The quality of each repetition must take precedence over the quantity. Similar to resistance training, a 2-3 min recovery period should separate each set to permit adequate phosphagen replenishment. Although less information is available for proper rest intervals between repetitions, the goal is to perform a high quality repetition, as such the athlete should rest 5-10 s between repetitions, especially for the more intense plyometric drills

Ballistic Training

Ballistic exercises such as jump squats, bench throws or medicine ball throws allow the athlete to accelerate a force through a complete range of motion. The benefits of ballistic movements have been demonstrated in several studies. One investigation compared traditional resistance training, ballistic resistance training, and plyometric training in recreational athletes with at least 1 year of resistance training experience (Wilson et al., 1993). Following 10 weeks of training, the ballistic resistance group showed improvements in a greater number of variables tested—jump height in both the counter-movement and squat jumps, isokinetic leg extensions, 30-m sprint time, and peak power on a 6-s cycle test—than either the traditional resistance training (improvements in the counter-movement and squat jumps and 6-s cycle test) or plyometric training groups (improvements in counter-movement jump only). All three training programs resulted in significant improvements in countermovement jump performance. However, the subjects that performed ballistic training improved to a significantly greater extent than the subjects that performed traditional resistance training but not plyometric training. Others have shown that when ballistic exercises (jump squats) are added to a traditional resistance training program for 5-weeks significant improvements are noted in maximal squat and power clean performance indicating the additive benefits of the ballistic exercise (Hoffman et al., 2005). Another study compared 8-weeks of traditional resistance training to a combination of traditional resistance training plus ballistic training (jump squats, bench press throws and ballistic push-ups) (Mangine et al., 2008). All subjects performed a 4-day per week split routine (two days upper body and two days lower body). At the end of 8-weeks of training the combined group experienced a 13.6% improvement in jump power, while the traditional resistance training group actually decreased 9.6%. The combined group had a 6.2% increase in upper body power (measured from ballistic push-up performed on a force plate), while the traditional resistance trained group improved by 1.4%. However, ballistic exercises may not provide any additional benefit from traditional resistance training in the weak or novice individual (Cormie, et al. 2010).

Athletic performance improvements (jump power, sprint speed) in relatively weak men were similar between subjects performing a traditional resistance training program compared to a power training program (Cormie et al, 2010). The investigators suggested that the incorporation of ballistic training probably should be integrated into the training programs of athletes that have developed a solid strength foundation (squat 1-RM/body mass ratio > 1.60). For weaker athletes, the focus on basic strength improvement will increase both strength and power. As discussed earlier, the experienced strength trained athlete will need a greater stimulus to make additional improvements in power performance.

Ballistic exercises are incorporated into the traditional resistance training program of the athlete. These exercises are often integrated in the strength, power and peaking phases of the annual periodized training program. High-velocity, ballistic movements selectively recruit higher-threshold, fast twitch motor units which are also critical to maximal strength development (Kawamori and Haff, 2004). Peak power outputs have been shown to be attained using a wide range of loads (between 15-60%) of the athlete's 1-RM for ballistic exercises such as the jump squat and ballistic bench press (Hoffman, 2014). The large range in intensity used in these exercises are likely related to differences in muscle mass recruitment, single versus multiple joint, training experience, methods used to measure power output, and strength level of the subjects.

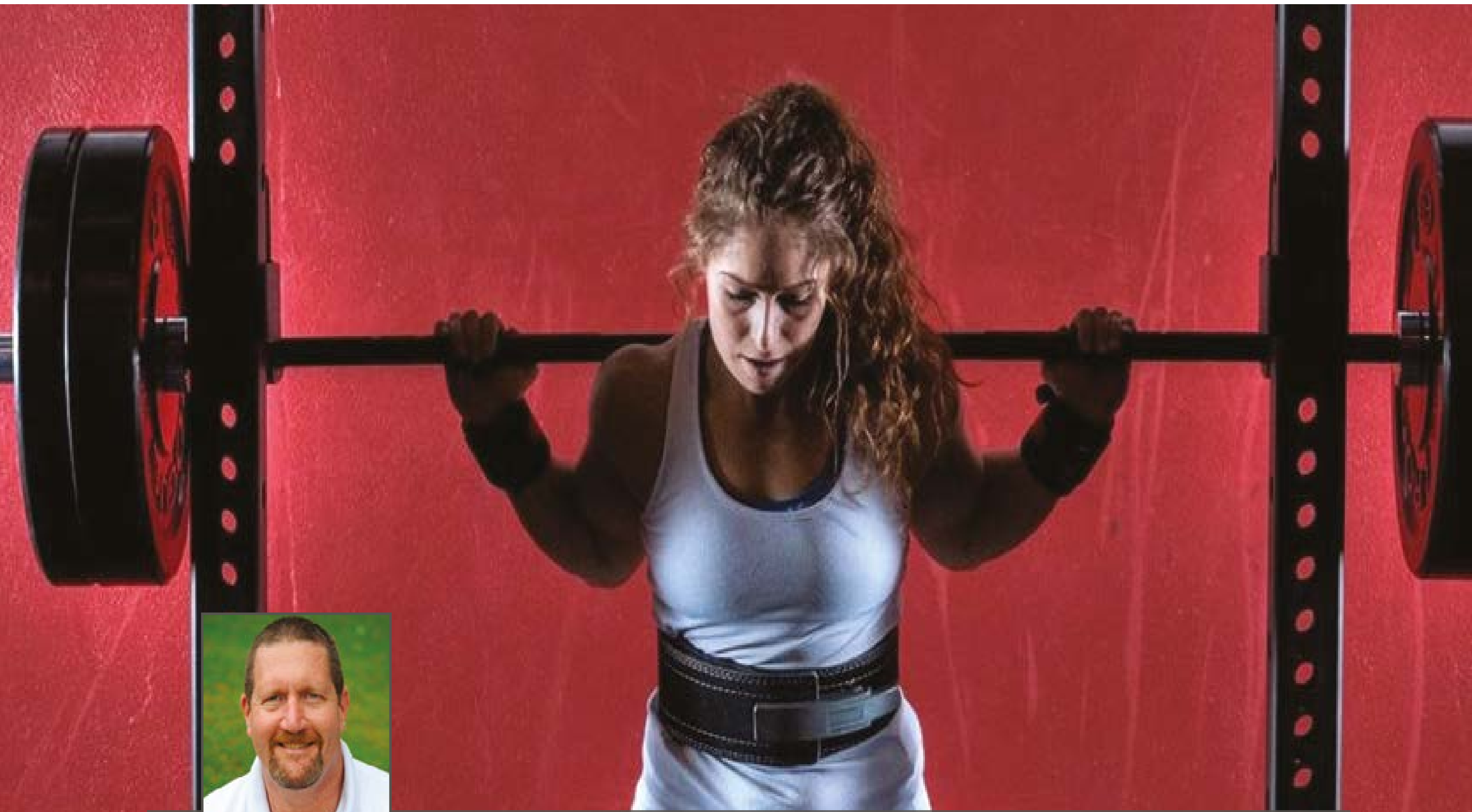
Olympic Weight Lifting

The snatch, clean and jerk, and their variants (high pulls, power cleans, power snatch, hang clean and hang snatch) are generally referred to as the Olympic weight lifting movements. Similar to the ballistic exercises the athlete accelerates the bar through the various pulls that often results in the bar and or the body being projected into the air. The loading used to elicit the highest power output in these exercises is between 70% - 80% 1-RM (Hoffman 2014). An important benefit for incorporating the Olympic movements into the training program of strength and power athletes is the similarity of these exercises to athletic movements such as jumping and sprinting.

A study comparing Olympic weight lifting to traditional power lifting training in competitive strength/power athletes demonstrated the benefits of Olympic lifting (Hoffman et al., 2004). During the 15-week training study, participants in both groups significantly improved their squat strength, however the strength improvements in the Olympic lifting group were 18% greater than the power lifting groups. In addition, those athletes that trained with the Olympic weight lifting exercises experienced a two-fold improvement change in time for the 40 yd sprint compared to the power lifting group (0.07 0.14 s compared to 0.04 0.11 s, respectively). Although these results were not statistically different, the practical difference for a competitive group of athletes was impressive. A significantly greater improvement in vertical jump height was also seen in the Olympic lifting group compared to the power lifting group.

SUMMARY

The use of plyometric, ballistic and Olympic exercises has been demonstrated to be advantageous in the training programs of experienced, resistance trained athletes interested in maximizing power production. Athletes with limited resistance training experience may improve their power performance with the use of traditional resistance training exercises until they have developed a strength base. The power exercises (e.g., jump squats, plyometrics, and Olympic movements) can be successfully integrated into the resistance training programs of strength/power athletes. In addition, as the window of adaptation is reduced for slow-velocity strength (traditional resistance training programs), the combination of resistance training and these other forms of training may provide a new window for adaptation that further enhances the power production of the athlete.



DR. JAY HOFFMAN

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Dr. Hoffman is a fellow of the American College of Sports Medicine and the National Strength and Conditioning Association (NSCA).

He served as President of the National Strength and Conditioning Association Board of Directors from 2009-2012. Dr. Hoffman also served on the Board of Directors of the USA Bobsled and Skeleton Federation. Dr. Hoffman holds a unique perspective in his sport science background. Prior to his academic career he signed free agent contracts with the NY Jets and Philadelphia Eagles of the NFL and the Tampa Bay Bandits of the USFL. A dual national of the USA and Israel, Dr. Hoffman commanded the Physiological Unit of the Israel Air Force and served as a Research Officer in the Combat Fitness Unit of the IDF during his military service. Dr. Hoffman has been honored or awarded the 2007 Outstanding Sport Scientist of the Year from the NSCA, 2005 Outstanding Kinesiology Professional Award from the Neag School of Education Alumni Society of the University of Connecticut, 2003 Educator of the Year NSCA, and 2003 Neag School of Education Outstanding Alumni Research Award (University of Connecticut).

Dr. Hoffman's primary area of study focuses on physiological adaptations resulting from nutritional and exercise intervention. Dr. Hoffman has published more than 200 articles and chapters in peer-reviewed journals. His books Physiological Aspects of Sport Training and Performance, Norms for Fitness, Performance, and Health, and Program Design were published by Human Kinetics. A Practical Guide to Designing Resistance Training Programs and Total Fitness for Baseball were published by Coaches Choice. Further sharing his research and findings, Dr. Hoffman has lectured at more than 380 national and international conferences and meetings.

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The official journal of the European Weightlifting Federation

ISOMETRIC STRENGTH ASSESSMENT IN WEIGHTLIFTING

BY CARLO VARALDA

The official journal of the European Weightlifting Federation

When the decision was made to carry out the isometric deadlift test, some very important aspects were addressed in order to make the test effective as regards the analysis of the resulting numbers.

Firstly, it was necessary to adapt the system to make the starting position as close as possible to that of the technical exercise. Then, it was necessary to define the type of grip required of the athlete, the "snatch" (a wider grip) or the "clean & jerk" (more narrow). Lastly, it was necessary to identify the precise moment in the exercise in which the barbell would be locked in order to measure the expressed force.
The same iron platform used previously was adopted for the starting position; the only change made was a slight raise in the place where the feet are positioned so as to create a system that reduces the "run-up" to the bar. The "snatch" grip (wider one) was decided on, as it is considered less traumatic, and allows to anticipate the barbell lock.

We decided to implement the barbell lock as soon as movement of the barbell raises the weight plates slightly, basically, when the bar is located halfway up the tibia. The purpose of this is to keep the angles of the body very narrow, which consequently does not create substantial differences in athletes with short limbs and those with long limbs. Another aspect: if you want to measure the muscle "potential" of individuals taking the test, it is considered more useful to do so when the angle at the knee is still narrow so as not to distort the results. In fact, if the lock point of the barbell was taken at kneecap height, it would be easier, even for those with an inferior technique, to produce positively good muscle performance.
A final consideration, with a narrow angle it is not possible to "piggy-back" the system carrying out the test and so, it is not possible to use one's own body weight.
The isometric deadlift test should be analyzed from two points of view:

- The correct position in performance
- The ability to express force quickly.

It is important to assume a correct starting position, in order to render the body effective during the muscle contraction phase of the lower limbs. This presupposes a relatively sound knowledge of the technique

ISOMETRIC DEADLIFT TEST										
n	m f	1 RM deadlift	kg barbell	kg iso	t	kg barbell	kg iso	t	kg 1st test	kg 2nd test
1	F	115	70	121	0,08	80	115,2	0,08	191	195,2
2	F	120	80	110,6	0,07	75	113,6	0,07	190,6	188,6
3	F	125	80	147,5	0,08	85	123,2	0,08	227,5	208,2
4	F	110	70	106,8	0,06	75	138	0,08	176,8	213
5	F	100	65	59,7	0,06	65	85	0,08	124,7	150
6	F	90	65	33,2	0,04	65	75,1	0,06	98,2	140,1
7	F	100	65	100	0,07	65	96,1	0,06	165	161,1
8	M	180	130	237	0,10	150	159,9	0,10	367	309,9
9	M	155	70	184,3	0,07	100	184,8	0,09	254,3	284,8
10	M	205	100	140	0,08	100	193,8	0,08	240	293,8
11	M	170	130	207,3	0,09	150	192,9	0,12	337,3	342,9
12	M	170	130	165,2	0,09	150	121,4	0,10	295,2	271,4
13	M	160	70	83,3	0,06	80	99,1	0,06	153,3	179,1

TABLE NO. 1 ISOMETRIC DEADLIFT TEST IN ADVANCED ATHLETES

ISOMETRIC DEADLIFT TEST								
n	m f	max clean	barbell	iso	T	barbell	iso	T
1	M	75	40	151	0,06	40	135	0,06
2	F	79	40	105	0,06	40	111	0,06
3	M	105	40	184	0,05	40	163	0,07
4	M	90	40	95	0,07	40	127	0,06
5	M	55	40	70,8	0,05	40	95,4	0,07
6	F	60	40	68,8	0,06	40	93,6	0,07
7	M	105	40	194	0,05	40	211	0,05
8	M	70	40	140	0,05	40	114	0,05
9	M	115	40	172	0,06	40	202	0,07
10	M	113	40	166	0,05	40	178	0,06
11	M	135	40	188	0,06	40	177	0,07
12	F	60	40	71,5	0,07	40	78,8	0,08
13	M	70	40	139	0,07	40	117	0,06
14	F	50	40	70,6	0,06	40	85,7	0,04
15	F	78	40	89,2	0,06	40	86,1	0,07
16	F		40	84,5	0,05	40	103	0,05
17	M	50	40	113	0,07	40	127	0,06
18	M	65	40	74,6	0,07	40	103	0,07

TABLE NO. 2 ISOMETRIC DEADLIFT TEST IN YOUTH CATEGORIES

and good joint mobility. Without delving into the technical aspects of the snatch exercise, a very low performance time (less than 1 second) obliges the athlete to apply force in a very short time.

The Globus Iso Control allows us to see both the peak force, expressed in kg, and the time in which the peak force was reached from the moment in which the load cell has been subjected to traction. This way it is also possible to verify the features and abilities of the application of the athlete's maximal strength. In an initial phase, an empty barbell tied to a chain was used. The results obtained were already good, but a question arose: would an athlete used to feeling a "heavy" load in his hands, make less of an effort given the lightness of the equipment used during the test? So, the barbell was loaded with two 10kg plates and the results improved. The weight was subsequently increased and the results were even better, all within the correct confines of the exercise/test. At this point, it was decided to standardise the load on the barbell for both men and women: about 70% of the deadlift maximal. Naturally, in order to make the tests perfectly compatible with the actual sport, the female athletes used the women's barbell and the male athletes used the men's one.

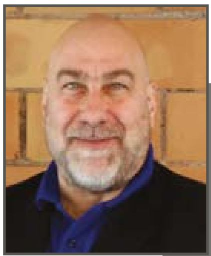
The results were very interesting, and are summarised in **Table 1.** Table n.1 shows the data of a number of advanced athletes. In some cases, you can see that even when the weight of the barbell is increased, the total weight moved does not change. For some athletes, the difference between 1 RM and the isometric test is not very different. This may mean that this athlete has still some work to do on the actual muscle structure aspects.

For some athletes, there is a major difference between the 1 RM and the isometric test. This may mean that the athlete has great muscle potential that he fails to express as his level of neuromuscular training is quite low. At this point, the same test was also carried out with younger athletes (categories: children, beginners, under 17).

Given the young age and lack of experience, many of them they did not have a deadlift maximal. It was decided to take the clean maximal as it is a statistic that coaches and athletes acquire very early on.
For organisational and practical reasons, the work proposed was based on a fixed load rather than on load percentages; this was to prevent the youths from being too enthusiastic and overdoing things, which could have resulted in injury. The data obtained are shown in **Table 2**. There were some interesting results also in this case, from different points of view. Not only for the loads produced, but also as regards start up times.

It must also be said that, on this occasion, there were also some errors in the technical approach, mainly due to lack of experience, but it can be extremely useful to coaches to plan training workouts even better.
It is clear that we are only at the beginning, and that the numbers are still inadequate to produce comprehensive statistics, however, it was decided to use this test in all gatherings of the *Progetto Italia Youth* of the Italian Weightlifting Federation. In this way, we will obtain the data of the most promising athletes on the Italian weightlifting scene, and we will be able to see how performances change, using these guidelines to direct the sessions of physical training sessions.

One last point: as the maximal isometric contraction has a great effect on neuromuscular activation, what would happen if an athlete performed an isometric test before stepping up on the platform?
But more about that another time.



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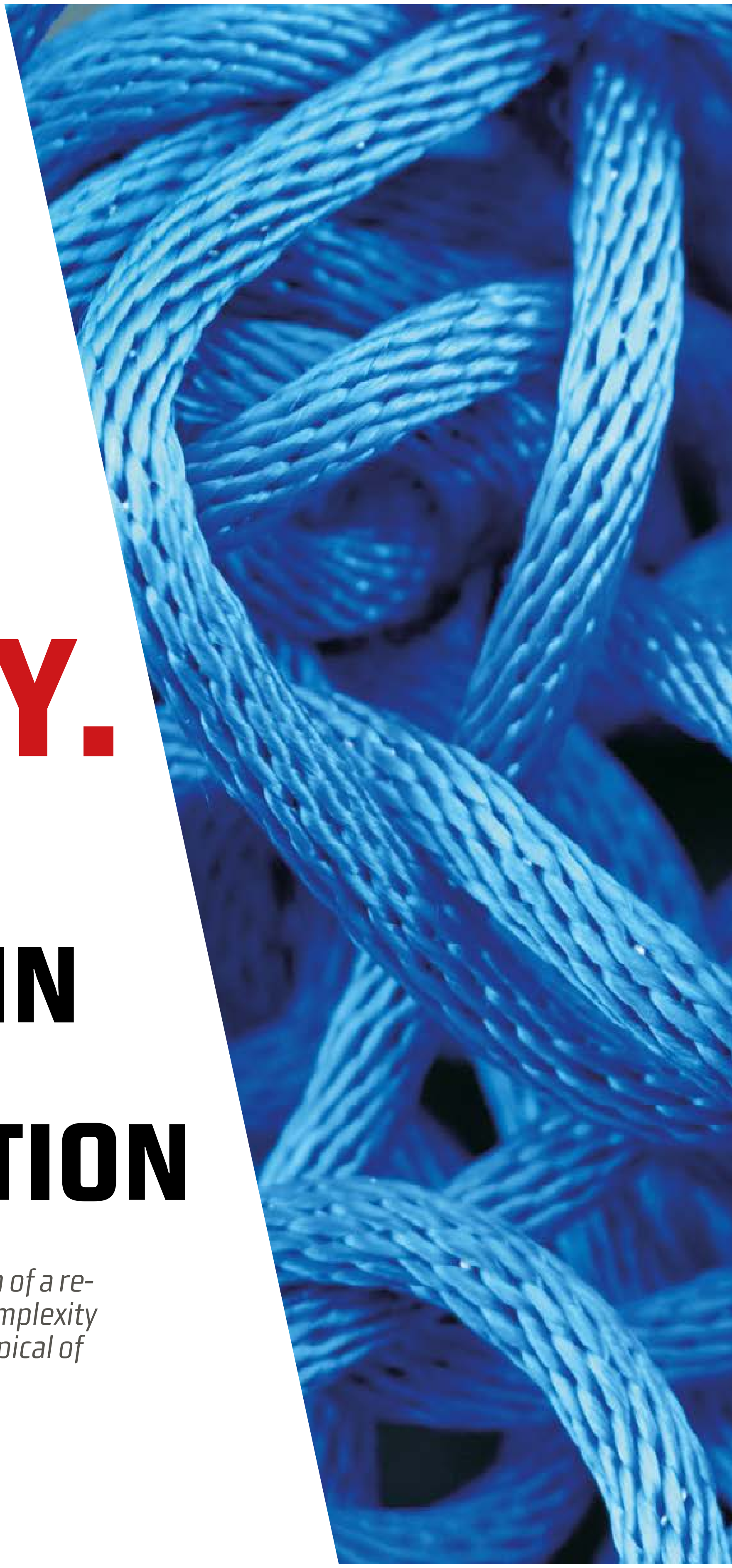
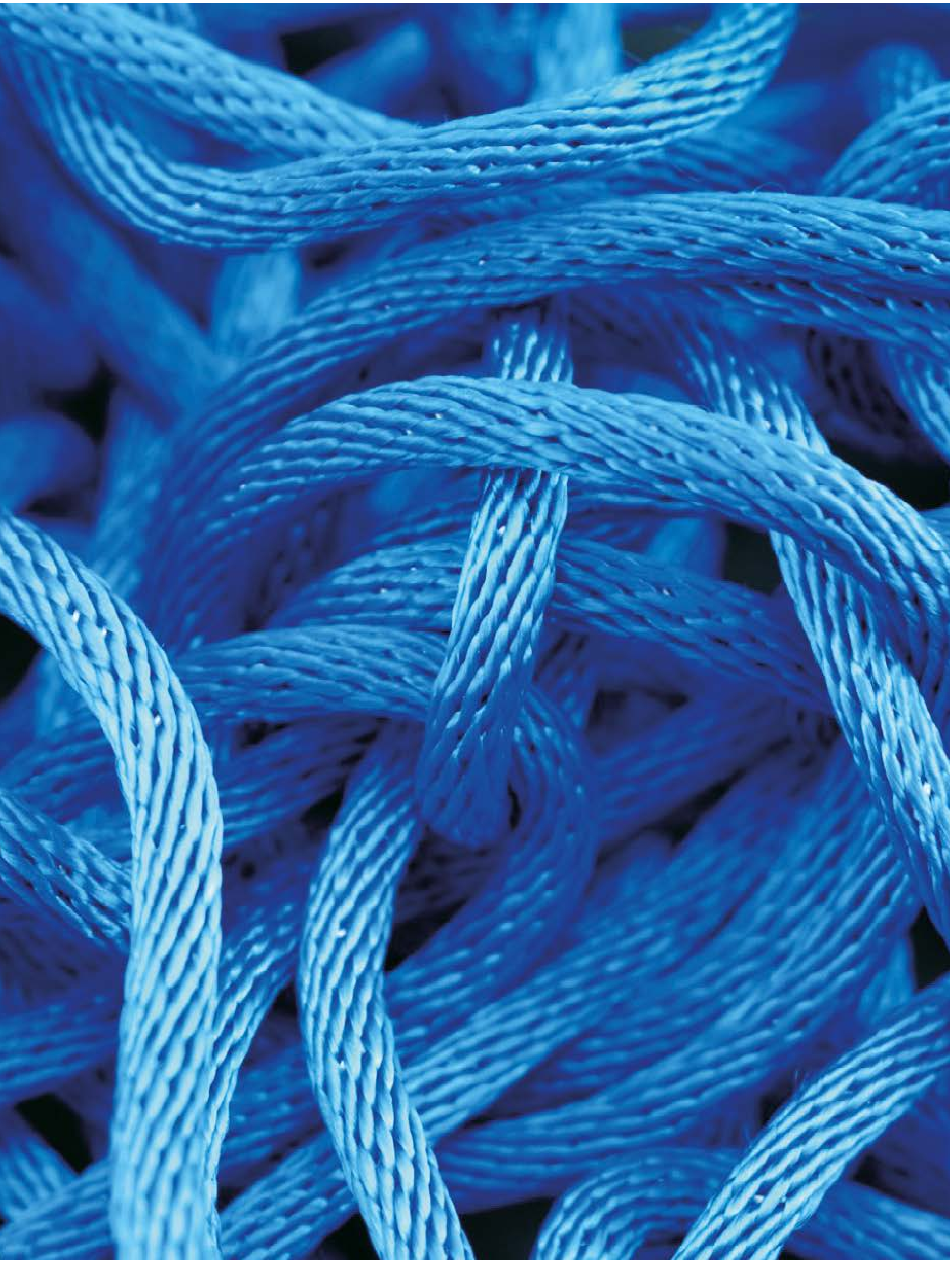


COMPLEXITY. HOW TO STUDY IT AND OBTAIN USEFUL INFORMATION

The position and innovative approach of a renowned physicist, to comprehend complexity and study it in various phenomena typical of modern society. And also of sport.

(Part one)

BY LUCIANO PIETRONERO



The editorial staff of EWF- SM put a series of questions to Professor Pietronero, who took due note and proceeded to answer them precisely. The following is the text, with minimal modifications made, of the encounter between Professor Pietronero and various members of the Physics Department. As the reader will see, we have chosen to conserve the spontaneous and lively nature of the interview and the encounter.

1. TOTALIZING VISIONS AND REDUCTIONIST VISIONS OF LIFE AND THE UNIVERSE

1.1. As we all know, Enrico Fermi (1901-1954) and Guglielmo Marconi (1874-1937) were two great Italian scientists. Putting it briefly, we can say that they dealt with an aspect of science that can be defined as reductionist (in other words, tending to reduce all concepts and all systems to the most elementary entities possible, in order to study and comprehend them): instead of dealing with how the Universe is made as a whole, from Galileo Galilei (1564-1642) onwards, scientists have tried to focus their attention and interests, in their profession, on just one aspect at a time out of a thousand. There is a famous statement attributed to Galileo, pronounced during one of the trials he was subject to: to the question: “You study how a stone falls from the tower of Pisa: do you not think that God, if he wishes, can make this stone go where he wants?”, he replied: “certainly, if God wishes, this stone can go anywhere. But I deal with the cases He is not interested in”.

1.2 Galileo was, therefore, the first to embark on the reductionist study of reality: before him, physics and science in general tended to provide so-called “top-down” answers - in other words, God is made in such a way, then there are men, plants, etc. First came the total vision, that is, a general vision of the studied system, without addressing the details of its parts, only then followed the vision of the parts that make up the system itself, with a progressive specialisation and specification process, which allows to acquire all the details of each part of the system. Naturally, the top-down approach, or an initial comprehensive analysis of the systems with the aim of understanding them, is highly complicated, because global analysis is complicated. The so-called reductionist science begins when people start to say, “ok, let’s forget everything else, the whole, the entirety, and let’s concern ourselves with only one event, for example, how a stone falls.”

1.3 So, why exactly is it better to deal with how a stone falls? Because a stone falls in the same way from the Tower of Pisa, in Japan or in any other place in the world: it is something that can occur and can be measured: this measurement of a single event gave birth to the scientific method. We may call it the scientific reductionist method, with which the scope of study is reduced, going straight to the heart of a phenomenon and analysing the smallest piece of the element, of the matter, of the Universe. It is a method that, as you know, has been extremely successful and has given rise to serious implications: for example, by studying how a stone falls, you can understand the law of gravitation, from the law of gravitation we understand the movement of planets: therefore, it is clear that starting from something small, you can then move on to much larger systems, different to what had been studied since the beginning. It is ultimately this approach that has created the scientific corpus, for example, of Physics.

2. A SIMPLE INTRODUCTION TO THE CONCEPT OF COMPLEXITY: THE ERA OF GOOGLE

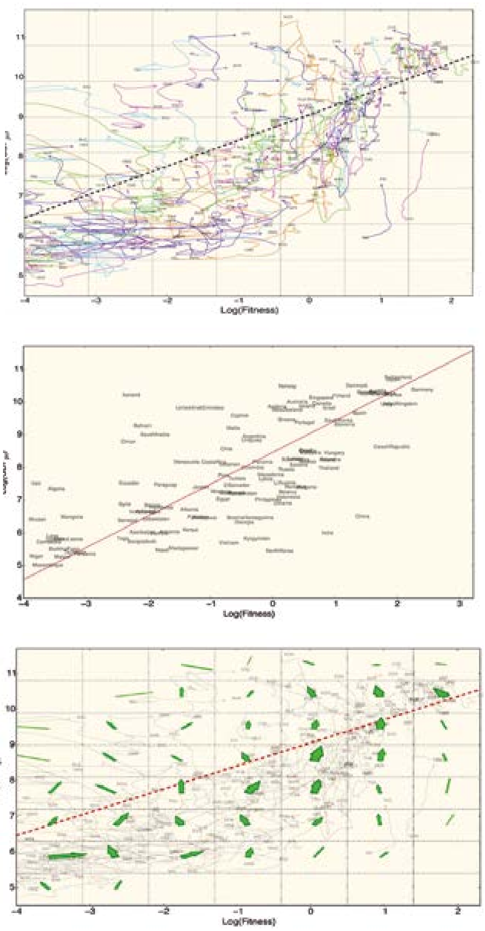
2.1 Therefore, reductionism was a huge success: this approach led to nuclear and sub-nuclear physics, atomic physics, the transis-

tor - that plays such a large part in today's life - is substantially from that, hence even our computers, etc. However, there are situations in which all of this is not enough to understand and explain: for example, if you look at a piece of matter that transforms from solid to liquid, we know for certain that we have many atoms, the same type of atom, which we know well: but even if we know all the properties of the atom, we cannot understand from these when a solid becomes liquid. That is, there are extremely important and very common properties, such as phase transitions, which are not connectable to the individual properties of a single atom of matter and are not explained by the latter. This can be considered a simple example of complexity and is necessary to help us understand that the "key" to comprehending the transition from solid to liquid state **is not in the properties of the atom, but lies instead in the properties of the interaction between different atoms.** Therefore, the subject, the single, the individual is not the key to the mechanism, it is rather the interaction with other individuals: therefore, a person who wants to understand the transition phase must change their perspective of observation and consider the entirety of the system and focus on the interactions between individuals, the single elements that compose it. This topic, which can be greatly extended, would lead us very far, to a point or to a context of still relatively unexplored knowledge, which is represented by biology: how is it possible that those atoms, of which we know almost everything, if put together to form a cell, can create a living organism, a life, life? The latter is another emerging property, much more complex than the solid-liquid transition, but in which even knowledge of the individual elements is not enough to understand something of the properties, such as the division of the cell or the different properties of biological matter. Typically, in the "complex", there is the change of perspective that, compared to the analysis of the singularly intended individual, considers the analysis of the interaction between different individuals (here we are already within the complexity: a serious approach to the latter starts precisely from such a change of perspective).

2.2 We can now make a digression and address a modern phenomenon that clearly explains the meaning and significance of complexity: the phenomenon we are referring to is Google and its incredibly successful search engine. Before the era of Google, the previously existing search engine focused on the specific characteristics of each existing website, so, for example if you needed to study hunting and hunters, you looked at a hunting site, the properties of a rifle, where hunters went hunting, etc. and then you compared the information obtained with those of another hunter. The pre-Google vision was in a sense reductionist. Google has completely changed the perspective, because it does not focus on the characteristics of a single site, it rather examines the existing connections between one site and another. It is therefore clear that if many hunters direct their hyperlinks to the site of a certain hunter - the hypothetical one that we are considering - this means that that particular hunter is highly regarded. So Google has moved the vision analysis of websites from a reductionist vision to a complex vision that focuses more on the interaction between the sites than the site itself.

3. THE SO-CALLED BIG DATA. THE GOOGLE PHENOMENON, SPORT

3.1 Naturally, what has been said so far enables us to make another important step, one related to the Big Data question (as we know, Big Data is the term used when dealing with very large quantities of data,



relating to different aspects, such as volume, number and variety of the same), and to the specific technologies and the methods of analysis: Google is a perfect example of big data analysis, because it has the typical complexity of the Internet system. Here I would like to make another slight digression concerning what is a complex system. Let's take, for example, the telephone network: before the Internet, it was a network designed by an engineer, or by a group of engineers; in any case, somewhere there was a written project, and the network was built along the lines of this project, therefore we knew exactly how the telecommunications network was structured and made. A radically different situation has been created with the Internet, in other words, an object has been activated that has not been planned by an engineer, and its growth resembles that of a biological organism, in which each of us can participate and make a contribution, but that none of us can control, (we see that even very powerful governments have serious difficulty in controlling the properties of a system such as the Internet).

3.2 Therefore, we can certainly conclude that the Internet is an excellent example of a complex system that has elements that transcend the single discipline involved, for instance, that of telecommunications, or physics or mathematics, and which also contains knowledge about other different disciplines. And so the questions that inevitably arise are: "if nobody designed it, how do we understand how it works, how do we control it, how do we know if it will be stable or if one day everything will collapse?". And these are, as you can imagine, the modern-day questions which apply to the Internet, to the new complex and globalised economy, to modern medicine and also to the analysis of sport.

3.3 Sport is certainly a complex system, with a considerably high number of variables: the athlete's performance depends on the his physiological variables, training methods, diet and much more. So, sport is a phenomenon in which, as regards all things in today's world, a huge amount of information is accumulated, which is however, a double-edged sword, because on one hand it provides us with a lot of data, on the basis of which - if we know how to read and interpret it - we can also obtain an understanding of the phenomenon and, in any case, a quantity of useful information, and on the other hand, this information can create immense confusion. All this brings us back to the Big Data question, which reconnects us precisely to Google, a wonderful example of the approach to Big Data, an original and, as we can all see, highly successful approach and also more or less ideally very simple in its configuration. Therefore, all this can only mean that the difficulty lay not in the need to have a new Einstein, what we actually needed was quite a simple thing, and here we have the Google algorithm, that anyone with a good knowledge of math could have planned. So, consequently, we must admit that there are areas of knowledge and information-processing which are still totally unexplored and yet of the greatest importance, which certainly should be explored. And this is the situation today.

4. AN EXAMPLE OF THE APPLICATION OF GOOGLE'S ALGORITHM: COMPLEXITY APPLIED TO ECONOMICS AND ALSO TO SPORT

4.1 My personal opinion is that we are only at the beginning of this vision of the problems affecting society today, and in any case, we have the wonderful example of Google. Here I would like to report an interesting experience that we had, in this University, when we applied Google's philosophy to the analysis of competitiveness in countries and to the complexity of products from various countries across the world. This experience led us to introducing the concept of economic complexity, in which fitness is defined as the industrial capacity of a country, and the inherent complexity of products is considered: all this, in other words a similar approach, allows a new vision of macroeconomics, which has provided interesting results.

4.2 But I am not an expert in economics, I just looked at this problem through the eyes of the physics of complexity, that is, focusing on the interactions and not on the individual properties. What does this mean in this particular case? Suppose a person wishes to define Italy's competitiveness: he could start by studying the transport system and grade it, or the economy, education, pollution and a thousand other things and after each study give a final grade, having examined a hundred parameters. We did nothing of the sort. We look at what products Italy produces, which is an objective fact that requires no parameters, and from these products - by means of a mathematical algorithm inspired by Google, but different from Google's one - we try to reconstruct the real complexity of Italy. This too is an example of Big Data; and what do we learn from all this? In a Big Data case, we throw away 90% of the data that we start off with, as we focus on our study, in other words, we are going to examine only the products that Italy produces, we are not going to study phenomena that are difficult or impossible to know about, such as the level of corruption, the education system, etc. This is the standard view, but the topic is always the same: they are undoubtedly important data, but data that are very hard to collect and then interpret. For example, how can we add up the grades that we would give to the transportation system minus those for pollution? It is totally arbitrary. Therefore, considered in the traditional view, this information, does provide some data, but with it comes immense confusion (known as "noise"). On the contrary, we believe that the data of the products, despite being limited, providing genuine information that can be well interpreted, obviously with the appropriate algorithms. So, the idea is that rather than examining all the data that directly involve what we want to calculate, we neglect them and seek this information a posteriori, in other words, starting with the products, to define an overall capacity of the country's industrial competitiveness that, somehow, summarises all those aspects and all the properties contained in such a large system (Big Data) - education, transport, corruption, etc., - which summarises them starting from their result, as materialised in the country's products.

4.3 Naturally you will have understood that we are not far from sports statistics: for example, a football game is now digitized to the tenth of a second, in other words, we know for every tenth of a second, the location, the orientation of each player, the ball, etc. What will we do with all this data? Big Data is, in some ways, an enormous opportunity, but in the end it is also a myth, because the data alone do not generally speak. There are a few exceptions where data alone provide the answer: the famous French economist Thomas Piketty (born in 1971, is the author - among other things - of a famous book published in 2014, Capital in the Twenty-First Century) studied economic inequality due to capital in different countries and throughout history: he calculates inequality, that is, how much is invested, how much income comes from work as opposed to what comes from capital, with a somewhat neo-Marxist vision. This inequality does not require any kind of algorithm, the meritorious work of Piketty has been to accumulate an enormous amount of data (an excellent starting point for an evaluation of a scientific nature); in his case, the real hard work consisted in the accumulation of data: once the data was gathered, calculation was simple. This is a rare case, the most common case is that the Google type case, where there are a lot of data, but they do not speak for themselves. This complexity, which is objective, requires a data filter: as we have seen, we focus only on some data and we change the perspective, we are interested in the interactions, rather than individual properties. So, in brief, the Piketty case is a lucky (but rare) one, where, given the nature of the question, there is no great analysis to be made, because the data speak for themselves. In most cases, however, it is not so.

4.4 Where is this vision applied? The answer is…. everywhere, because by now the accumulation of data, such as in sport, economics, medicine (for example, in patients' responses to treatment: perhaps, with a similar approach, we may find correlations that are still unexplored, given the limitations of traditional data). So, the phenomenon of Big Data is really a new science, which permeates all other sciences or human activities such as the organisation of a city, and that poses new problems related to information theory, to the possible ways and methods of extracting truly useful information from this huge mass of data. Here, everyone has different opinions: according to some computer scientists, the problem of Big Data is only accumulating data and having fast access on the computer. I do not agree with this: as in our example of economic complexity, first there is a filter problem, we need to understand what data is most important, how to eliminate the so-called noise (hence, it is not true that the more information you possess, the better), and then how to focus the efforts on a precise way of extracting information. So my personal view of Big Data is that there will be many new algorithms, that is, for every problem we will have to create this filter, apply this algorithm or use this specific mathematical/computer analysis of the data: after this we will extract information that are not apparent, data without any special treatment. This view implies that Big Data is a scientific problem, of understanding, that it is not only a problem of data accumulation, and that for each topic, there must be a different strategy in the future to extract the information. For example, I repeat, we have studied with good results the crucial problem of the competitiveness of the countries: if those interested in this type of research simply change the subject and apply it to the industrial competitiveness of companies, they will find that the characteristics are completely different, in other words, it is a good thing for countries to be diversified, it is good that companies are specialised: therefore, this means that, for the companies, we will have to look at a set of data that give us information other than that we examine for the various countries. It is, of course, a process that is under active work in progress.

L'algoritmo italiano nelle analisi della Banca Mondiale

(f.mas.) La Banca Mondiale si affida ai «big data» economici elaborati da un gruppo di fisici della Sapienza e del Cnr per le previsioni sull'economia. Si tratta di un sistema di previsioni del Pil chiamato «economic complexity» ideato da Luciano Pietronero, 66 anni, professore di Fisica, e dal suo team (Matthieu Cristelli, Andrea Tacchella e Andrea Zaccaria): un algoritmo stile Google, spiega Pietronero, ma molto più sviluppato e preciso, e che analizzando i dati in maniera scientifica, crea un indice — ribattezzato «Fitness» — che misura la competitività di un Paese sul mercato globale in base alla varietà e complessità dei prodotti esportati. Ora il modello di Pietronero verrà testato sul campo su temi specifici: come i Paesi subsahariani possono uscire dalla trappola della povertà, e poi la previsione di crescita della Turchia. Se avrà successo, l'algoritmo potrebbe diventare un modello sistematico da parte della banca mondiale.

BORSE ESTERE

N° 5 / September-December 2016

LUCIANO Pietronero, Physicist.

Extensive international experience in scientific and industrial laboratories (Xerox USA and Brown Boveri CH for a total of 10 years) and in the academic field (Full Professor in Groningen NL for 5 years).

Since 1987, Professor of Condensed Matter Physics at the University of Rome, "La Sapienza".

Fields of interest: Theory of the Structure of Matter, Superconductivity, Statistical Physics,

Physics of Complex Systems, Economic Complexity.

In 2004, Professor Pietronero founded the Institute of Complex Systems of the National Research Council in Rome (200 people), which he directed until 2014. The goal was to study issues that go beyond the individual disciplines such as the Internet, Bioinformatics, Complex Systems in general, Smart Cities and more recently, Economic Complexity.

He has created a generation of young scientists (more than 100) determined to overcome disciplinary barriers to devote themselves to the more current and important issues of science and society. Many of these young people hold leading positions both in Italy and abroad. In 2008, he received the Fermi Award, the highest award conferred by the Italian Physical Society. Recently he developed the theme of Economic Complexity, consisting of a radically new scientific approach to the economy, consisting of a scientific and verifiable way to understand what factors lead to the development and success of a country, or how a poor country can get out of the poverty trap. These works have had great resonance in both the academic world and in the policy making and business sectors, and have been subjects of a "Nature" editorial: http://www.nature.com/news/physicists-make-weather-forecasts-for-economies-1.16963

Recently the World Bank, whose mission statement is to eradicate poverty from the world by 2030, has decided to adopt these new methods for its studies on strategies for the industrial and economic success of developing countries.

Russian

ТЕХНИКА РЫВКА В МУЖСКОЙ ТЯЖЁЛОЙ АТЛЕТИКЕ МИРОВОГО УРОВНЯ: ДОЛГОСРОЧНЫЙ АНАЛИЗ

Ingo Sandau, Jürgen Lippmann, Ilka Seidel

SM (ing), n.º 5, anno II, settembre-dicembre 2016, pagine 4-13

Цель данного исследования заключалась в изучении изменений техники рывка происшедших в период с 2004 по 2014, базируясь на кинематике штанги. С этой целью были исследованы шесть лучших спортсменов мужского пола всех восьми весовых категорий, участников четырёх международных чемпионатов по тяжёлой атлетике. Для оценки долгосрочных изменений, техника рывка была поанализированна с помощью двухмерной видеометрии штанги. Результаты долгосрочного анализа показывают что в течении периода 2004–2014 произошол значительный сдвиг от первой ко второй тяге в производстве скорости, состоящий в уменьшении максимальной скорости в перой тяге и увеличении максимальной вертикальной скорости во второй тяге. В соответствии с чрезмерным акцентом перешедшим на вторую тягу наблюдается ухудшение выполнения так называемых фаз переворота (turnover) и стабилизации под штангой.

Изменяя способ ускорения штанги для достижения скорости необходимой для максимального подъёма, тяга теоретически может быть улучшена, избегая падения скорости в переходной фазе. Тем не менее это изменение техники подёма в фазе ускорения сопровождается некоторыми недостатками в последующих фазах движения. В результате не было отмечено увеличение максимальных весов поднятых на соревнованиях в период 2004–2014. Тренеры по тяжёлой атлетике должны осозновать что существует чрезмерный акцент на второй тяге е последующие негативные эффекты этого акцента в фазах переворота (turnover) и стабилизации под штангой.

МЕХАНИЗМ ОБРАТНОГО ПРОЕКТИРОВАНИЯ (REVERSE ENGINEERING) ТРАВМЫ

Andrew Charniga, Jr.

SM (ing), n.º 5, anno II, settembre-dicembre 2016, pagine 14-23

Многочисленные исследования травм передней крестообразной связки (ПКС) колена у женщин в таких видах спорта как волейбол, футбол, баскетбол и даже софтбол содержат значительные ошибки, связанные с неверными предположениями (и соответствующими предрассудками) о так называемой «женской биомеханике» и об особенностях физиологии связанных с полом, которые воспринимаются как биологические недостатки; с необходимостью избежания растяжения связок и срресса связок вызваннного движениями нижних конечностей; с чуством необходимости коррекции недостатков типичных для женщин; с полной путаницей между научно–исследовательскими аспектами и коммерческими потребностями.

Автор пытается упорядочить познания, предлогая и используя так называемый механизм обратного проектирования (reverse engineering) и приходит к весьма интересным и полезным выводам.

ФИЗИКА ПРИСЕДАНИЯ СО ШТАНГОЙ НА ПЛЕЧАХ (SQUAT)

Paolo Evangelista e Agiampietro Alberti

SM (ing), n.º 5, anno II, settembre-dicembre 2016, pagine 24-37

Авторы рассматривают классический жест «squat» (в сущности, приседание) как упражнение зависящее от многих факторов, среди которых решающую роль играют антропометрические характеристики, подвижность суставов, мышечная сила и мысленное представление спортсмена о себе во время выполнения упражнения. Авторы приводят ряд интересных соображений о различных типах упражнения squat, об использовании этого упражнения с детьми, о результатах различных исследований реализованных в мире. И всё это сопровождается интересным и богатым иллюстрационным и библиографическим материалом.

ПРЕДВОСХИЩАТЬ ВРЕМЯ. ОТ ТЕОРИИ ИДЕЙ К ВЫПОЛНЕНИЮ ДВИЖЕНИЙ (ПЕРВАЯ И ВТОРАЯ ЧАСТЬ)

Alberto Andorlini

SM (ing), n.º 5, anno II, settembre-dicembre 2016, pagine 38-54

ечь идёт о первой части долгого исследования, озаглавленного «Предвосхищать время», в котором автор представляет новую серию размышлений о возможности «тренировать движение» и «двигать тренировку», то есть о дискуссии которая привлекла интерес многочисленных исследователей и «исполнителей» движения, чьи идеи привлекаются в игру, в краткой форме, простой, сжатой и легко консультируемой, которая в состоянии указать, хотя бы частично, в каком направлении движется мир тренировки.

НАУЧНЫЕ ОСНОВЫ ТРЕНИРОВКИ МОЩНОСТИ

Jay R. Hoffman

SM (ing), n.º 5, anno II, settembre-dicembre 2016, pagine 56-65

Продемонстрировано что использование плиометрических, баллистических и соревновательных (олимпийских) упражнений может быть успешным в тренировочных программах спортсменов высокой квалификации и высокого уровня тренировки с сопротивлениями, заинтересованных в максимизации мощности. Спортсмены с ограниченным опытом силовой тренировки, до тех пор пока не создана необходимая силовая база, могут повысить мощность, используя традиционные тренировочные упражнения с сопротивлениями. Упражнения для развития мощности (например, jump squat (приседания с прыжком), плиометричекие и соревновательныедвижения) могут быть успешно включены в тренировочные программы спортсменов в видах спорта требующих развития силы и мощности. Кроме того, если суживается «окно» адаптации для развития быстрой/медленной силы (традиционные программы тренировки с сопротивлениями), сочетание тренировки с сопротивлениями и других форм подготовки может открыть новое «окно» для адаптации, что повысит ещё больше мощность спортсменов.

ИЗОМЕТРИЧЕКИЙ КОНТРОЛЬ (ОЦЕНКА) В ТЯЖЁЛОЙ АТЛЕТИКЕ

Carlo Varalda

SM (ing), n.º 5, anno II, settembre-dicembre 2016, pagine 66-71

В лаборатории силы (Strength Lab) Итальянской Федерации Тяжёлой Атлетики (FIPE) продолжают изучать уже долгое время проявление силы в изометрической форме, что является очень полезным для понимания мышечного потенциала спортсмена. Автор представляет первые результаты этого исследования базирующегося на сборе данных о упражнении приседания со штангой на плечах (squat) и об упражнении отрыва штанги (становой тяги). Эти два упражнения очень связаны – как уже упоминалось – с результатами в тяжёлой атлетике.

СЛОЖНОСТЬ, СПОСОБЫ ИЗУЧЕНИЯ СЛОЖНОСТИ И ИЗВЛЕЧЕНИЯ ИЗ ЭТОГО ПОЛЕЗНОЙ ИНФОРМАЦИИ (ПЕРВАЯ ЧАСТЬ)

Luciano Pietronero

SM (ing), n.º 5, anno II, settembre-dicembre 2016, pagine 72-79

Статья представляет собой первую часть рассуждения о сложности в котором автор, известный физик, представляет свою точку зрения и инновационный подход к изучению проблемы сложности и её различных проявлений типичных для современного общества в том числе, и не в последнюю очередь, в области спорта. Автор – Лучано Pietronero, профессор теории строения материи Физического факультета Римского университета «La Sapienza».

Spanish resumenes

LA TÉCNICA DE ARRANCADA EN EL LEVANTAMIENTO DE PESAS MASCULINO DE NIVEL INTERNACIONAL: UN ANÁLISIS A LARGO PLAZO
Ingo Sandau, Jürgen Lippmann, Ilka Seidel
SM (ing), n.º 5, año II, septiembre-diciembre de 2016, págs. 4-13
El objetivo del presente estudio ha sido analizar los cambios que se han producido en la técnica de arrancada entre los años 2004 y 2014 por lo que hace al movimiento de la barra. Con esta finalidad, se han examinado los primeros seis deportistas de sexo masculino de las ocho categorías de peso en cuatro campeonatos internacionales de halterofilia. Con el propósito de evaluar los cambios a largo plazo, la técnica de arrancada se ha analizado utilizando la videometría bidimensional de la barra. Los resultados de los análisis a largo plazo ponen de manifiesto una inclinación neta, a lo largo del tiempo, de la producción de la velocidad del primer tirón al segundo, con una reducción de la velocidad máxima en el primer tirón y un aumento de la velocidad vertical máxima en el segundo. En coherencia con el énfasis excesivo puesto en el segundo tirón, la ejecución de las denominadas fases de turnover y de encaje empeora. Cambiando la forma en que se acelera la barra para alcanzar la velocidad necesaria y realizar un levantamiento máximo, en teoría la propulsión puede mejorarse evitando una reducción de la velocidad en la fase de transición. Sin embargo, esta modificación de la técnica de levantamiento en la fase de aceleración lleva consigo algunos inconvenientes en las fases de movimiento posteriores. En consecuencia, no se produce ningún aumento del peso máximo levantado en las competiciones entre 2004 y 2014. Los entrenadores de levantamiento de pesas han de ser conscientes del énfasis excesivo en el segundo tirón y de los consiguientes efectos negativos que este comporta en las fases de turnover y de encaje.

EL MECANISMO DE LAS LESIONES MEDIANTE LA INGENIERÍA INVERSA
Andrew Charniga, Jr.
SM (ing), n.º 5, año II, septiembre-diciembre de 2016, págs. 14-23
Los numerosos estudios que se han llevado a cabo sobre las lesiones del ligamento cruzado anterior en las mujeres, en deportes como el voleibol, el fútbol, el baloncesto e incluso el sófbol, contienen errores destacables, que se basan en hipótesis erróneas y en los prejuicios consiguientes, relativos a la denominada biomecánica de las mujeres y a las características de la fisiología vinculada al sexo, que se perciben como carencias biológicas; a la necesidad de evitar el estiramiento de los ligamentos o la tensión ejercida sobre ellos por los movimientos de las extremidades inferiores; a la necesidad percibida de corregir las carencias de las mujeres; y a la total confusión de los aspectos relativos a la investigación científica con las exigencias comerciales. El autor trata de poner orden en los conocimientos y presenta y aplica lo que él mismo denomina ingeniería inversa, y extrae conclusiones muy interesantes y aclaradoras.

LA FÍSICA DE LA SENTADILLA
Paolo Evangelista e Giampietro Alberti
SM (ing), n.º 5, año II, septiembre-diciembre de 2016, págs. 24-37
Los autores presentan el gesto clásico de la sentadilla como un ejercicio multifactorial en el que desempeñan una función determinante las características antropométricas, la movilidad de las articulaciones, la fuerza muscular y la representación mental de uno mismo durante su propia ejecución. Los autores realizan una serie de consideraciones sobre distintos tipos de sentadilla, sobre la sentadilla en niños y sobre diversos estudios realizados en el mundo; todo ello acompañado de un eficaz conjunto de imágenes y referencias bibliográficas.

"PRERRECORRER" LOS TIEMPOS: DE LA TEORÍA DE LAS IDEAS AL EJERCICIO DE LOS MOVIMIENTOS (PARTES PRIMERA Y SEGUNDA)
Alberto Andorlini
SM (ing), n.º 5, año II, septiembre-diciembre de 2016, págs. 38-54
Se trata de la primera parte de un extenso estudio en el que el autor aborda una nueva serie de reflexiones con el título: "Prerrecorrer" los tiempos, sobre la posibilidad de entrenar el movimiento y mover el entrenamiento, un debate que ha suscitado el interés de numerosos pensadores y ejecutores del movimiento, a quienes se ha pedido su opinión para elaborar casi un compendio de consulta rápida, simple y comprimido, capaz de indicar, aunque sea parcialmente, hacia dónde se está dirigiendo el mundo del entrenamiento.

FUNDAMENTO CIENTÍFICO DEL ENTRENAMIENTO DE POTENCIA
Jay R. Hoffman
SM (ing), n.º 5, año II, septiembre-diciembre de 2016, págs. 56-65
La utilización de ejercicios pliométricos, balísticos y olímpicos ha demostrado ser ventajosa en los programas de entrenamiento de deportistas experimentados, entrenados con sobrecargas, que están interesados en aumentar al máximo la producción de potencia. Los deportistas con una experiencia limitada en el entrenamiento de la fuerza pueden mejorar su potencia con la utilización de ejercicios con sobrecargas tradicionales hasta que hayan desarrollado una base de fuerza. Los ejercicios de potencia (como las sentadillas con saltos, la pliometría o los movimientos olímpicos) pueden integrarse bien en los programas de entrenamiento de fuerza de los deportistas de fuerza y de potencia. Asimismo, como el tiempo de adaptación para la potencia de baja velocidad es reducido (programas tradicionales de entrenamiento de la fuerza), la combinación del entrenamiento con sobrecargas y estas otras formas de entrenamiento puede proporcionar un nuevo margen de adaptación que aumente ulteriormente la producción de potencia del deportista.

EVALUACIÓN ISOMÉTRICA EN LA HALTEROFILIA
Carlo Varalda
SM (ing), n.º 5, año II, septiembre-diciembre de 2016, págs. 66-71
En el Strengh Lab de la Federación Italiana de Halterofilia (FIPE) se está procediendo, desde hace tiempo, a evaluar la capacidad de aplicación de la fuerza de forma isométrica, lo que se considera muy útil para comprender la potencialidad muscular del deportista. El autor expone los primeros resultados de dicha experiencia, basada en la obtención de datos relativos al ejercicio de la sentadilla y del peso muerto (deadlift), ambos, como se ha mencionado anteriormente, muy relacionados con la práctica de la halterofilia.

LA COMPLEJIDAD Y LA FORMA DE ESTUDIARLA Y DE EXTRAER INFORMACIÓN ÚTIL (PRIMERA PARTE)
Luciano Pietronero
SM (ing), n.º 5, año II, septiembre-diciembre de 2016, págs. 72-79
Se trata de la primera parte de una disertación sobre la complejidad en la que se presenta el punto de vista y el planteamiento innovador de un físico de renombre, para comprender la complejidad en cuestión y para estudiarla en diversos fenómenos característicos de la sociedad moderna, entre los cuales también se encuentra, y no en último lugar, el deporte.
El autor es el profesor Luciano Pietronero, catedrático de teoría de la estructura de la materia en la Universidad de Roma "La Sapienza", Departamento de Física.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