Applied Mathematical Science of Physical Training Part 1: Barbell Loading

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1. Executive Summary

This work will detail the construction of the foundational elements necessary for developing a complete applied mathematical science of physical training: the Internal Training Load.

The internal load is a qualitative and quantitative combination of the *intensity* and *amount* of a given training unit (set, activity, session, day, microcycle, mesocycle, period, macrocycle). It is equivalent to the internal stress level applied in the training unit.

By the end of this paper, I will define a protocol for the precise quantification of the internal training load. This is the key to effective optimization of the training process, not only for elite athletes but also for average gym clients.

2. Introduction

There are two interrelated aspects of the training load: The external load and the internal load. The external load is ultimately prescribed to a trainee in the form of the exercises (spatial forms) and metrics (kilograms, meters, reps, sets). For example, a training prescription for a single activity will look something like this:

Bench Press: 100 KG x 3 reps x 4 Sets

These are the metrics of the external load. This external load causes the development of an internal load in the trainee's organism, which determines the quality and quantity of the adaptation the trainee will undergo. If the load is of a sufficient level, the adaptation results in a gain in performance; this is the purpose of training. This work will precisely determine the internal load according to a training unit's spatial forms, intensities, and amounts. This internal load calculation will determine the prescription of the external load values.

The point of departure for this project is the seminal work of Soviet weightlifting coach Alexander Sergeyevitch Prilepin (1975-1985). "Prilepin's Table" (or chart) became the fundamental organizational tool for training programming, not only for high-level weightlifting but also for powerlifting, and later the strength training programming for athletes in all other

serious sports. Recently serious bodybuilders have also begun using the table to organize their hypertrophy training utilizing the major barbell exercises.

After analyzing Prilepin's table, I will employ the work of Hristo Hristov to define an approximate abstract internal loading equation from the table's underlying principles. Hristov's concepts were pivotal to the broader application of the table's principles to the rest of the serious barbell universe outside of weightlifting: competitive powerlifting and bodybuilding training.

Upon further analysis, this abstract equation, although ground-breaking, is too approximate when applied to intensities lower than 80%, which are those most often used by bodybuilders and other lifters during mass-building phases. I will detail the mathematical idea to rectify this issue.

After laying the groundwork for the calculation 0f the abstract internal training load, the process of actualizing this load is detailed. For this purpose, I will use the physics quantities of the all-time world records (human best performance) of all major competitive lifts in the super-heavyweight class. I will compare the physics quantities of the all-time best (raw) performances in the Conventional Deadlift, Powerlifting Squat, Bench Press, Olympic Press, Seated Press, and Strict Curl to those of the all-time-best Snatch and Clean, which are the lifts that were the basis of Prilepin's chart. I also included the all-time-best heavy-rep performance in the bent-over row, as this is one of the essential exercises in a bodybuilder's repertoire.

The analysis and comparison of the quantities derived for the all-time-best performances allow for a Spatial Form Stress Factor to be attached to each exercise, which can then actualize any abstract internal load according to the spatial form performed.

With an actual load in hand, it is then possible to look at Prilepin's table to see what the venerable coach determined to be optimal for a given set of reps and total activity (total for a single exercise in a session).

The actual load for four different lifting competition formats is then determined. I will show the actual load for a Historic Weightlifting meet (Snatch, Clean & Jerk, Clean & Press), Modern Weightlifting meet (Snatch, Clean & Jerk), Standard Powerlifting Meet (Bench Press, Powerlifting Squat, Deadlift), and a Powerlifting Meet with the Strict Curl. The actual internal loading values for each particular competitive activity and the total loads from all the meet formats are definitive for determining heavy, very-heavy, submaximal, and maximal lifting loads for training activities, sessions, and days. We can use them as measurement tools for this purpose.

3. The Concept of Loading

The purpose of physical training is to cause serial *adaptations* to the organism (trainee) over a period of time, which add up to become certain physical qualities, the possession of which improve the trainees' performance (in athletics, work, life in general). These adaptations affect all aspects of the organism (mental, neural, structural, metabolic, hormonal, circulatory, etc.)

In order to cause an adaptation, we must apply a critical *load* of *stressors* must through training. The concept is simple; an organism encounters a new stressor in its environment; this stressor then induces a genetic mutation in the organism, which secures its future survival when encountering that same or a similar stressor again.

Effective training involves controlling and optimizing these adaptations by correctly calculating, prescribing, and applying the dosage of **stressors** according to a trainee's purpose**.** This is where the concept of training load comes into play.

3.1 Aspects Of The Load

There are two interrelated aspects of the training load; the *external* load and the *internal* load.

The **external load** is defined by calculating the relevant physical quantities according to the type of training done (i.e., kilograms lifted, meters ran/swam/cycled, a number of throws, etc.) It describes the amount of work done. The external load variables are finally prescribed to a trainee in the form of weight and the number of reps and sets to perform.

External Load: Kg Lifted, distance ran and with what speed, number of jumps and at what height, number of throws and what distance, etc.

The **internal load** refers to the effect this external load has on the organism internally (i.e., its biological impact on all the subsystems of the organism.) Another less training-specific word for the internal load is simply "stress."

Stress: Either physiological or biological, is an organism's response to a stressor such as an environmental condition.

Internal Load: The adaptational effect a certain external load has on all the biological subsystems of a trainee.

The internal load/stress developed in training must be above a critical level for the adaptive process(es) to engage. If the internal load is significant enough, it becomes the catalyst of adaptation. A sufficient adaptational load is known as an **overload** stimulus.

Overload: A training load exceeding the normal/habitual magnitude the trainee has currently adapted to.

Simply put, a training adaptation will take place only if the external load prescribed is above the habitual level so that the internal load developed in reaction to it is greater than what the organism has already adapted to. Suppose a standard exercise with the same weight and number of sets and reps is used repeatedly for a period of time. In that case, no additional adaptations will occur, and physical fitness will not improve after the initial phase (in which the external load was enough to cause overload). After a more extended period, slow decay of the ability will occur. For this reason, it is necessary to increase either the average intensity (% maximum for a given exercise) or the total amount (of sets and reps, or total time) of training over a period of time.

The methods of manipulating the external load in training over a long period of time can be very complex. The internal load from the same external load can vary from trainee to trainee according to age, genetic factors, training history, and their current level of previous adaptation. For this reason, the way the external load increases over time will vary from person to person. The more advanced a trainee is, the longer a training cycle that constitutes an overload stimulus will be. For a beginner, a single moderate training session constitutes an overload; for advanced trainees, it can take several sessions, microcycles, or even mesocycles. This is just one example of how much the amount of external load needed to cause overload can vary between different trainees.

Overall, we define **load** as the qualitative and quantitative combination of the intensity and amount of a training unit.

The art of training comes down to calculating and prescribing external loads across time, which will develop the optimal level and kind of internal loading at the correct times, which finally causes the desired adaptation(s) to manifest right when the coach and athlete desire it. This is the essence of athletic preparation and applies to all competitive and non—competitive trainees.

4. Abstract Internal Training Load

The most precise way to prescribe an external load is to reverse engineer it based on the desired level of internal load. The internal load has two primary factors—the *amount* of work and its *intensity*. **Amount** refers to the total number of reps and sets, the total time, distance, or the most appropriate metric. For instance, we calculate the amount for the bench press in reps * sets.

The **exercise intensity** refers to the percentage of the trainee's maximum with which they did the work. For bench press (and other barbell/dumbbell lifts), this refers to the percentage of the trainee's one-repetition maximum; for running (swimming, cycling), this refers to the percentage of the trainee's maximal speed with which the distance was covered (measured as the meter per second of their 100m dash).

If we increase either the intensity or the amount in training without reducing the other, the internal load increases. If we increase either the weight (intensity) or reps done (amount) for the bench press, the internal load increases.

4.1 Prilepin's Table

Alexander Sergeyevitch Prilepin was the Russian coach (scientist) put in charge of optimizing the long-term training of elite weightlifters in the former USSR (1975-1985). Understanding the practical mathematical application of internal loading starts with Prilepin's table. This table (or chart) is the foundation for effective control of strength training.

Prilepin studied decades of training logs and competition results of thousands of highly qualified European weightlifters to develop his table. Through comparing the training intensities and amounts with competition results, he was able to delineate the minimal, optimal, and maximal reps for a single set and for a whole spatial form (i.e., Snatch, Clean, Olympic Squat, etc.) in a workout that would lead to success in high-level competition.

Although the chart was initially designed for weightlifting, serious powerlifters quickly started using it for training programming. Eventually, most athletes using barbell programs for building strength, power, and muscle mass began applying the guidelines of the chart to prepare for athletic competition.

Intensity Range	Reps Per Set	Optimal Total Reps	Range of Total Reps
55-65	3-6	24	18-30
70-80	3-6	18	12-24
80-90	2-4	15	10-20
90+	1-2	4	1-10

Table 1: Prilepin's table/chart

In his chart, Prilepin gave intensity *ranges* and amount *ranges.* While these ranges are beneficial and following them ensures that a program will not be irrational, a range is approximate, and we require precision for complete optimization. It is possible that Prilepin purposefully left this inexactitude in the chart, so international competitors would not exactly know what the dominant Russian team was doing in training.

Despite its approximate nature, Prilepin's chart is the exact point of departure for the intelligent organization of physical training.

4.2 Taking the Chart A Step Further: Hristo Hristov's INOL

An equation is needed to fully utilize the chart, which returns a single value from the intensity and amount used in training. An equation that reveals what mathematical realities underlie Prilepin's chart provides a very exact tool for organizing training.

Hristo Hristov provided this equation. Hristov eliminated the ambiguity of the chart and delivered a sharp mathematical tool for using Prilepin's ideas with precision for *weightlifters*—the INOL: Intensity Number Of Lifts score.

Hristov noticed the sum of Prilepin's upper limit number of lifts (NOL). The corresponding intensity is *around* 100 (this is more precise as the intensity increases because most weightlifting training occurs with high intensity).

Intensity	Upper Number Of Lifts	Intensity + NOL
60	30	90
70	24	94
80	20	100
90	10	100

Table 2: Prilepin Number of Lifts Score (right-hand column)

This discovery naturally led to the following equation, which provides an approximate practical equation for calculating the abstract internal load. This equation integrates the number of reps done (amount) and the intensity of the work into a single qualitative and quantitative value. Hristov referred to this value as the Intensity Number of Lifts Score (INOLS).

$$\text{INOL Of A Set} = \frac{\text{Number Of Lifts (at a given intensity)}}{\text{100 - Intensity}}$$

Using the INOL Score concept, we can determine the optimal number of total reps for a whole exercise and in individual sets of it in a single workout, according to Prilepin. Applying the INOL score equation to Prilepin's table, we find that an INOL score of 0.8 is optimal for a whole exercise, and 0.2 is optimal for a single set. The results are in table 3. Note that Prilepin did not prescribe more than six reps per set for any intensity due to the highly technical nature of the lifts of competitive weightlifting, but I will expand the reps per set here to make it more relevant to the realms of powerlifting and bodybuilding.

Intensity	Optimal Total INOL Score	Total Reps	Optimal Set INOL Score	Reps Per Set	Sets
60	0.8	32	0.2	8	4.0
65	0.8	28	0.2	7	4.0
70	0.8	24	0.2	6	4.0
75	0.8	20	0.2	5	4.0
80	0.8	16	0.2	4	4.0
85	0.8	12	0.2	3	4.0
90	0.8	8	0.2	2	4.0
95	0.8	4	0.2	1	4.0

Table 3: Optimal INOL scores and the corresponding reps and sets with specific intensities for a whole exercise and individual sets in training.

Hristov's INOL score was a significant step in the evolution of the prescription and control of serious weight training. Since its publication, serious weightlifters and powerlifters have used it to program and control training.

4.3 Minuend Precision Innovation

There is only one problem with the INOL score equation. The maximum Intensity + NOL for intensities below 80% is not exactly 100. In table 2, we can see that the intensity + Prilepin's upper NOLs for 70% is 94 and 55% is 85, so the INOL score equation will return increasingly approximate loads as the intensity decreases. For this reason, the minuend in the denominator of the equation must increase as intensity decreases.

The most precisely correlating values in Prilepin's table are the high-end NOLs for a given range and the low-end intensity for that range. By determining the percentage 100 is over these High-End NOLs+low-end Intensities, we can determine the percentage to increase the minuend in the INOL equation for these intensities.

Low End Intensity of Range	High End Number of Total Reps for Range	INOL	Percentage 100 Over INOL
90	10	100	0.00%
70	24	94	6.38%
55	30	85	17.65%

Table 4: Percentages by which we must increase minuends in the INOL equation.

We then increase Hristov's Minuend of 100 by the corresponding percentage to return the most accurate value. The final minuends are in table 5.

Low End Intensity of Range	High End Number of Total Reps for Range	INOL	Percentage 100 Over INOL	Accurate Minuend
90	10	100	0.00%	100.00
70	24	94	6.38%	106.38
55	30	85	17.65%	117.65

Table 5: Accurate minuends for the intensities and NOLs most exactly defined by Prilepin.

We can then use an exponential change function to determine minuends for intensities from 90 to 70 and 70 and 55. The results are in table 6.

Intensity	Minuend
90	100.0
89	100.3
88	100.6
87	100.9
86	101.2
85	101.6
84	101.9
83	102.2
82	102.5
81	102.8
80	103.1
79	103.5
78	103.8
77	104.1
76	104.4
75	104.8
74	105.1
73	105.4
72	105.7
71	106.1
70	106.4
69	107.1
68	107.8
67	108.5
66	109.3
65	110.0
64	110.8
63	111.5
62	112.2
61	113.0
60	113.8
59	114.5
58	115.3
57	116.1
56	116.9
55	117.6

Table 6: Accurate Minuends

The same rate of change from 70 to 55% is used from 55 to 1% to return accurate minuends for every intensity.

This value should be known as the Prilepin Minuend. The following equation returns the correct minuend for every intensity:

Prilepin Minuend =

$$(100/(I>89\rightarrow 100, I>69\rightarrow 94^{(((LOG(100,94)-1)/(90-70))*((I-70))+1))}, I<70\rightarrow 85^{(((LOG(94,85)-1)/(70-55))*((I-55))+1))})*100)$$

Where:

I is the Intensity of the work.

Adding the Prilepin Minuend to Hristov's INOL score equation transforms the INOL score into a precise abstract internal load value, which we can calculate for training sets, exercises, sessions, days, microcycles, mesocycles, periods, and even training years. Completely accurate optimal abstract internal loads and the corresponding reps and sets for the same intensities as displayed in table 3 are in table 7.

Intensity	Optimal Total INOL Score	Updated Total Reps	Optimal Set INOL Score	Updated Reps Per Set	Updated Sets
60	0.8	43	0.2	11	3.9
65	0.8	36	0.2	9	4.0
70	0.8	30	0.2	7	4.3
75	0.8	24	0.2	6	4.0
80	0.8	18	0.2	5	3.6
85	0.8	13	0.2	3	4.3
90	0.8	8	0.2	2	4.0
95	0.8	4	0.2	1	4.0

Table 7: Completely Accurate optimal reps and sets with given intensities.

For weightlifting exercises (snatch, clean, jerk, and their variations), lifters should still use Prilepin's original prescriptions for the number of reps per set, but this updated total number of reps is a more precise quantity according to the underlying principles of his table. For powerlifting and bodybuilding training and hypertrophy exercises for weightlifting (squats, presses, rows), the reps per set displayed in table 7 are optimal.

We can round the number of sets for convenience, but it is best to do the prescribed number of sets with the optimal reps per set, then do one set with fewer reps to complete the total optimal number of reps. For instance, an optimal total Squat exercise with 60% intensity would look like this:

Intensity: 60
Total Reps: 43

Optimal Reps Per set: 11
Sets: 3.9
Set 1: 11 Reps
Set 2: 11 Reps
Set 3: 11 Reps
Set 4: 10 Reps

The development of peak performance through training is a very exact process. Doing the precise amount of total reps in training could seem tedious compared to rounding the sets off, but over a long period of time, exact precision can be the difference between hitting a performance peak and slightly missing it.

A comparison between the original optimal reps and sets from the INOL score concept with those of the abstract internal loading concept is in table 8. Experienced lifters (weightlifters, powerlifters, and bodybuilders) and coaches will testify that the updated idea has the most utility for optimizing training loads.

Intensity	Optimal Total INOL Score	Original Total Reps	Updated Total Reps	Optimal Set INOL Score	Original Reps Per Set	Updated Reps Per Set	Original Sets	Updated Sets
60	0.8	32	43	0.2	8	11	4.0	3.9
65	0.8	28	36	0.2	7	9	4.0	4.0
70	0.8	24	30	0.2	6	7	4.0	4.3
75	0.8	20	24	0.2	5	6	4.0	4.0
80	0.8	16	18	0.2	4	5	4.0	3.6
85	0.8	12	13	0.2	3	3	4.0	4.3
90	0.8	8	8	0.2	2	2	4.0	4.0
95	0.8	4	4	0.2	1	1	4.0	4.0

Table 8 compares the original approximate optimal total and set level reps and the final precise values.

The final Abstract Internal Training Load equation is then:

Abstract Internal Training Load =

$$R/((100/(I>89 \rightarrow 100, I>69 \rightarrow 94^{(((LOG(100,94)-1)/(90-70))*((I-70))+1))}, I<70 \rightarrow 85^{(((LOG(94,85)-1)/(70-55))*((I-55))+1))})*100)-I)$$

Where:
R is Repetitions performed in the set, activity, workout, etc.;
I is the Intensity of the work.

5. Spatial Form Stress Factor Logic

Loading from training is not merely an abstract concept. The load is determined to prescribe, as precisely as possible, the magnitude of stress which should be applied to the organism through training to bring about the desired training effect. This is the broad foundation of training programming.

The intensity and number of reps (the variables of the Abstract Load) are not the only factors that must be taken into account when determining the *actual* load. We can use the abstract internal load equation to determine the optimal number of reps per set with 90% intensity for both the Bench Press and the Conventional Deadlift- 2 in both cases. The abstract load for both would, of course, be 0.2. However, the actual Load (stress) on the whole organism from each exercise is much different. The force of the barbell and the total work done in each performance would differ significantly. The *actual* Load from the Deadlift is much higher.

In order to actualize the abstract internal training load, it is necessary to develop an equation that relates the stress of every spatial form to all others and to training in general.

5.1 All-Time Best Human Performances in Strength

For this purpose, I will use the all-time raw (weight belt only; no wraps, suits, bench shirts, or straps) world records (human best performance) of the major lifts in the heavyweight/super-heavyweight classes. These performances represent the absolute pinnacle of human strength.

Spatial Form	Record Holder	All Time Human Best Mass Maximum KG
Conventional Deadlift	B. Magnusson	461
Powerlifting Squat	R. WIlliams	427
Bench Press	K. Sarychev	335
Bent Over Barbell Row	R. Coleman	285*
Full CLean	L. Taranenko	267*
Olympic Press	V. Alexeev	236
Full Snatch	L. Talakhadze	220
Strict Curl	D. Cyplenkov	113

Table 9: All-Time heaviest raw lifts in Weightlifting and Powerlifting. *Bent Over Barbell Row 1RM World Record estimated based on an all-time best 8RM. The Clean of 267 was followed by a slight miss on the Jerk.

5.2 The Physics of All-time Performance

Three primary factors determine the stress of a movement, which are three quantities of physics. The total Work done (measured in Newton-meters), the time under tension (amount of time the lifter was supporting the force, measured in Newton Seconds), and the amount of power produced (Measured in Watts).

5.2.1 All-Time-Best Force

To determine any of these quantities, it is first necessary to determine the Force that the record holder must overcome in the spatial form. In most spatial forms, the external force of an implement (barbell) is not the only force the lifter overcomes. The lifter must also overcome some amount of his body's mass in the movement. Each segment of the body is a standard percentage of the total mass of the whole body. To determine the KG of body mass overcome in a movement, it is necessary to determine the percentage of the body mass that the lifter must lift. Table 10 displays these values for the major spatial forms.

Spatial Form	BODY SEGMENTS				
	Head	Whole Trunk	Total Two Arms	Total Two Legs	Total % Of Body Mass Lifted
Conventional Deadlift	6.81		9.43		16.24
Powerlifting Squat	6.81	43.02	9.43		59.26
Bench Press			4.24		4.24
Bent Over Barbell Row			4.24		4.24
Full CLean	6.81	43.02	9.43		59.26
Olympic Press			4.24		4.24
Full Snatch	6.81	43.02	9.43		59.26
Strict Curl					0.00

Table 10: Percentage of Body mass lifted in the major lifts.

Once the percentage of body mass lifted is known, it is possible to determine the KG of body mass that the record holder overcame in each of the world record lifts. This data is in table 11.

Spatial Form	Record Holder	Body Weight	KG of Body Mass lifted in World Record Performance
Conventional Deadlift	B. Magnusson	171	28
Powerlifting Squat	R. WIlliams	183	108
Bench Press	K. Sarychev	175	7
Bent Over Barbell Row	R. Coleman	136	6
Full Clean	L. Taranenko	144	85
Olympic Press	V. Alexeev	162	7
Full Snatch	L. Talakhadze	169	100
Strict Curl	D. Cyplenkov	144	0

Table 11: Body mass (KG) lifted in the major lifts.

Now that both the barbell mass and body mass lifted is known, it is possible to determine the force of each by multiplying the KG by Gravitational Acceleration (9.8 Meters Per Second Squared). These values are in table 12.

Spatial Form	Record Holder	Mass	Force
Conventional Deadlift	B. Magnusson	Barbell	4517.80
		BodyWeight	272.15
Powerlifting Squat	R. WIlliams	Barbell	4184.60
		BodyWeight	1062.77
Bench Press	K. Sarychev	Barbell	3283.00
		BodyWeight	72.78
Bent Over Barbell Row	R. Coleman	Barbell	2793.00
		BodyWeight	56.56
Full Clean	L. Taranenko	Barbell	2621.50
		BodyWeight	836.28
Olympic Press	V. Alexeev	Barbell	2312.80
		BodyWeight	67.37
Full Snatch	L. Talakhadze	Barbell	2156.00
		BodyWeight	981.46
Strict Curl	D. Cyplenkov	Barbell	1107.40
		BodyWeight	0.00

Table 12: World Record Forces.

5.2.2 All-Time-Best Work

The first of the three quantities required for determining the stress of a spatial form is Work (Newton Meter). Work is the product of Force and Distance (Force x Distance: Newton x Meter). The movement distance of the barbell and the bodyweight for each of the major spatial forms are standard percentages of the lifter's height. We can then multiply these percentages by the world record holder's height to determine the actual distances he moved the barbell against gravity in the all-time best performances. These values are in table 13.

Spatial Form	Record Holder	Height Meter	Lift Distance % of Height	Lift Distance
Conventional Deadlift	B. Magnusson	1.83	0.27	0.4941
Powerlifting Squat	R. WIlliams	1.82	0.27	0.4914
Bench Press	K. Sarychev	1.97	0.23	0.4531
Bent Over Barbell Row	R. Coleman	1.8	0.24	0.432
Full Clean	L. Taranenko	1.83	Clean Pull + Clean Squat Distances	
Olympic Press	V. Alexeev	1.85	0.24	0.444
Full Snatch	L. Talakhadze	1.97	Snatch Pull + Snatch Squat Distances	
Strict Curl	D. Cyplenkov	1.85	0.34	0.629

Table 13: World Record Distances.

The distances for both the Snatch and Clean are composites of the "pull" and the "recovery" ("squat") phases of each lift, which are separated by the unloaded "pull-under" phase (the unloaded phase after the pull in which the lifter rapidly moves under barbell to "catch" it). The movement distance of the barbell and body mass moved are not equivalent for the pull phases in both the snatch and clean (the barbell movement is greater in both). For brevity, the snatch and clean distance values are not displayed but used to calculate all subsequent quantities.

Now that the forces and distances for the all-time best performances are determined, it is possible to determine the work (Newton Meter) for each. For a complete picture of Work, it is necessary to include any eccentric (the lowering phase in which the working muscles lengthen) work performed in the lift. Verkhoshansky and Siff determined that the eccentric work of an exercise is equal to 70% of the concentric work. The eccentric work values are not displayed separately but are in the totals. The work quantities are in table 14.

Spatial Form	Record Holder	Total Work
Conventional Deadlift	B. Magnusson	4023
Powerlifting Squat	R. WIlliams	4384
Bench Press	K. Sarychev	2585
Bent Over Barbell Row	R. Coleman	2093
Full Clean	L. Taranenko	5506
Olympic Press	V. Alexeev	1797
Full Snatch	L. Talakhadze	5880
Strict Curl	D. Cyplenkov	1184

Table 14: World Record Work.

The Snatch and Clean do not have any eccentric phases because the lifter lifts the bar from the floor to start the movement and then drops it back to the floor after fixing it overhead. The Conventional Deadlift (and Sumo) and the Strict Curl begin from the bottom positions. Still, most competitive organizations require the lifter to lower the barbell back to the starting position after the lift, and there is usually an eccentric phase performed between reps during training sets. For this reason, I took account of the eccentric phase work for these lifts.

5.2.3 All-Time-Best Time Under Tension

The second necessary quantity mentioned above for determining the stress of a spatial form was the duration of time the lifter must support the force (or "be under the barbell"). We know this quantity as "time under tension." We determine it by finding the product of the force by the time the lifter supported it. I determined the time for each by using a stopwatch while analyzing each all-time best performance. The total time included the eccentric phase, any

coupling time (the amortization/isometric phase of the Stretch-Shortening Cycle, which connects the eccentric and concentric phases), and the concentric (shortening) phase. These time values are in seconds in table 15, along with the Newton Seconds (force x time).

Spatial Form	Record Holder	Time	Newton Seconds
Conventional Deadlift	B. Magnusson	4.20	20118
Powerlifting Squat	R. WIlliams	3.75	19678
Bench Press	K. Sarychev	3.15	10571
Bent Over Barbell Row	R. Coleman	3.88	11048
Full Clean	L. Taranenko	3.14 (Total: Pull + Squat)	10842
Olympic Press	V. Alexeev	3.30	7855
Full Snatch	L. Talakhadze	2.68 (Total: Pull + Squat)	8422
Strict Curl	D. Cyplenkov	8.10	8970

Table 15: World Record Work.

5.2.4 All-Time-Best Power

With the work and time under tension in hand, it is now possible to determine the final necessary quantity of spatial form stress: Power. Power is the quotient of work and time (work/time, Newton Meter / Seconds). The unit of power is the Watt. The stress of Wattage production on a lifter is qualitatively different from that of Newton Meters and Newton Seconds. The stress of the latter two quantities can be seen as more vegetative/structural (especially with NM being more associated with the degradation of muscular proteins and hence the more direct development of muscular hypertrophy) in nature, while that of the former is more neural. The high wattage production associated with the maximum power spatial forms (snatch and clean) is also associated with more significant mental and psychological stress (mostly due to the feed-forward mechanical nature of these lifts and the fear that induces).

Only the maximum power in a movement is relevant for our purpose. For the snatch and clean, only the time of the pull phase was used (I did not take the time of the “recovery” or “squat” phase into account). For the same reason, only the concentric phase of the other spatial forms was used (I did not take eccentric and coupling times into account). The wattage values are in table 16.

Spatial Form	Record Holder	Max Power During Movement
Conventional Deadlift	B. Magnusson	816
Powerlifting Squat	R. WIlliams	847
Bench Press	K. Sarychev	674
Bent Over Barbell Row	R. Coleman	486
Full Clean	L. Taranenko	3451 (From Pull Portion)
Olympic Press	V. Alexeev	473
Full Snatch	L. Talakhadze	4083 (From Pull Portion)
Strict Curl	D. Cyplenkov	131

Table 16: World Record Power.

6. The Spatial Form Stress Factor

Now we know all necessary quantities (Newton Meter, Newton-Seconds, Watts) of the all-time best human performances for the major spatial forms. It is now possible to create a stress-related value that takes into account the quantity that is most stressful for each lift (i.e., Newton Meters for Powerlifting Squat, Newton Seconds for Strict Curl, Watts for Snatch…) which reflects relativity between them all in relation to the actual internal load that each imposes on the human neurological-biological system. We determine this value by summing the three quantities. The values are in table 17.

Spatial Form	Record Holder	Newton Meter + Newton Seconds + Watts
Conventional Deadlift	B. Magnusson	34537
Powerlifting Squat	R. WIlliams	35402
Bench Press	K. Sarychev	20541
Bent Over Barbell Row	R. Coleman	19326
Full Clean	L. Taranenko	**26716**
Olympic Press	V. Alexeev	14884
Full Snatch	L. Talakhadze	**24662**
Strict Curl	D. Cyplenkov	12499

Table 17: World Record Quantity Sums.

In order to make these sums relevant for determining an actual internal training load, it is necessary to mathematically relate them to Prilepin's chart since the table is the foundation of the equation of the *abstract* internal training load.

Intensity Range	Reps Per Set	Optimal Total Reps	Range of Total Reps
55-65	3-6	24	18-30
70-80	3-6	18	12-24
80-90	2-4	15	10-20
90+	1-2	4	1-10

Prilepin's table was based on an extensive study of elite-level Weightlifting (the sport which consists of the competitive lifts of the Snatch and the Clean & Jerk); so we can logically take the average of the physics quantity sums of the Snatch and the Clean to be a Stress Factor equivalent to 1. We then divide the quantity sums of all other spatial forms by this value to return a Stress Factor quotient for each. These values are in table 18.

Spatial Form	Record Holder	Newton Meter + Newton Seconds + Watts	Snatch, Clean: NM+NS+W Average	Spatial Form Stress Factor
Conventional Deadlift	B. Magnusson	34537	25689	**1.34**
Powerlifting Squat	R. WIlliams	35402	25689	**1.38**
Bench Press	K. Sarychev	20541	25689	**0.80**
Bent Over Barbell Row	R. Coleman	19326	25689	**0.75**
Full Clean	L. Taranenko	**26716**	25689	**1.04**
Olympic Press	V. Alexeev	14884	25689	**0.58**
Full Snatch	L. Talakhadze	**24662**	25689	**0.96**
Strict Curl	D. Cyplenkov	12499	25689	**0.49**

Table 18: The Stress Factors of the major barbell spatial forms.

7. Actual Internal Competitive Loads

In order to make the Actual Internal Load concept imminently practical, it is most informative to determine the total actual loading from each of the major competitive lifts from the strength sports of Weightlifting and Powerlifting and the totals of each type of meet. We can use these competitive examples as measuring sticks when prescribing loads at the activity (total exercise in a session), entire session, and total training day levels.

7.1 Method

In order to determine the total actual load for a competitive activity, it is necessary to take into account the three competitive attempts and the warmups leading to the first attempt on the platform.

For the warmups of the movements of competitive weightlifting (snatch, clean & jerk, clean & press), abbreviated reps per set are used with a more extensive number of sets relative to those used for the movements of Powerlifting. This is because of the very technical (mechanically feed-forward) and high-power nature of weightlifting requires a low number of reps per set to prevent the deterioration of technique, which is especially important in competition.

The warmups for the competitive lifts of powerlifting (Bench Press, Powerlifting Squat, Deadlift, Strict Curl) can contain a slightly higher number of reps per set due to their mechanical feedback nature. However, the high-force nature of these lifts, combined with their very taxing eccentric, demands more of an abbreviated total warmup. The warm-up format of each lift is displayed in the table of the total competitive activity.

It is standard for the first competitive attempt of any lift to be at around 90-95 percent of the weight, which is expected to be lifted in the final (third) attempt. The final attempt should be a new maximum (100% intensity) for the lifter, with the second attempt being somewhere in between. The abstract internal loading equation returns an irrational value if 100% is used as the intensity; for this reason, 99% is used as maximum intensity in the equation. The intensities of the three competitive attempts for all the theoretical competitive activities are:

1. 94%
2. 97%
3. 99%

The warmup intensities are structured to build up to the first attempt. The total abstract internal load and the total actual internal load are in each of the following tables.

7.2 Modern Weightlifting Meet

Modern weightlifting meets (post-1972) are composed of the competitive lifts of the snatch and the clean & jerk.

7.2.1 The Snatch

Competitive Snatch Activity				
Set		Intensity	Reps	Load
Warm-Up	1	32	2	0.02
	2	37	2	0.02
	3	42	2	0.02
	4	47	2	0.03
	5	52	2	0.03
	6	57	2	0.03
	7	62	1	0.02
	8	67	1	0.02
	9	70	1	0.03
	10	73	1	0.03
	11	75	1	0.03
	12	80	1	0.04
	13	85	1	0.06
	14	89	1	0.09
Attempts	1	94.0	1	0.17
	2	97.0	1	0.33
	3	99	1	1.00
Total		Abstract Internal Load		1.97
		Actual Internal Load		1.89

Table 19: The intensities, reps, sets, and load of the competitive Snatch activity.

The abstract internal load from the total competitive Snatch activity is 1.97. Multiplied by the snatch spatial form stress factor (0.96), the final actual internal load is 1.89.

7.2.2 The Clean & Jerk

Competitive Clean & Jerk Activity				
Set		Intensity	Reps	Load
Warm-Up	Clean	32	3	0.03
	Jerk	32	3	0.03
	Clean	37	2	0.02
	Jerk	37	2	0.02
	Clean	42	2	0.02
	Jerk	42	2	0.02
	Clean	47	2	0.03
	Jerk	47	2	0.03
	Clean	52	2	0.03
	Jerk	52	2	0.03
	Clean	57	1	0.02
	Jerk	57	1	0.02
	Clean	62	1	0.02
	Jerk	62	1	0.02
	Clean	67	1	0.02
	Jerk	67	1	0.02
	Clean	70	1	0.03
	Jerk	70	1	0.03
	Clean	73	1	0.03
	Jerk	73	1	0.03
	Clean	75	1	0.03
	Jerk	75	1	0.03
	Clean	80	1	0.04
	Jerk	80	1	0.04
	Clean	85	1	0.06
	Jerk	85	1	0.06
	Clean	89	1	0.09
	Jerk	89	1	0.09
Attempts	9 Clean	94.0	1	0.17
	9 Jerk	94	1	0.17
	10 Clean	97.0	1	0.33
	10 Jerk	97	1	0.33
	11 Clean	99	1	1.00
	11 Jerk	99	1	1.00
Total		Abstract Clean		1.97
		Abstract Jerk		1.97
		Actual Clean		2.05
		Actual Jerk		1.06

Table 20: The intensities, reps, sets, and load of the competitive Clean & Jerk activity.

The separate abstract loads of both the clean and the jerk are 1.97 (the all-time best jerk is only 1 KG less than the all-time clean; both were achieved by L. Taranenko). With its spatial form stress factor (1.04) applied, the actual internal clean load comes to 2.05, and the jerk (0.54) comes to 1.06. The total clean & jerk competitive activity comes to 3.11.

The combined actual internal training loads of the competitive activities of the snatch and clean & jerk bring the total internal training load of a modern weightlifting meet to 5.0.

7.3 Historic Weightlifting Meet

Historically (before 1972), weightlifting meets consisted of the snatch, the clean & jerk, and the clean & press. The reasons for the abolition of the press are controversial and outside of the scope of this work, the main issue being the judging of the presence or lack thereof of a "knee-kick" in a given competitive attempt. A legal Olympic press required a rigid knee joint, but often, a slight "push" with the legs would be noticeably present in the competitive lift of one lifter and not another, which resulted in many controversies. Therefore, in 1972, the clean & press was removed from competition. However, it is very informative to determine the total load from these historic meets. At one period in the history of elite human performance, athletes performed these loads in a single day.

7.3.1 The Clean & Olympic Press

The intensity of the cleans in the competitive clean & press activity is lower than those of the clean & jerk. This is because the weight a lifter can press after the clean is less than they can jerk. (All-time best Jerk: 266 KG, All-time best Press: 232 KG)

Competitive Clean & Press Activity				
Set		Intensity	Reps	Load
Warm-Up	Clean	28	1	0.01
	Press	32	3	0.03
	Clean	33	1	0.01
	Press	37	3	0.03
	Clean	37	1	0.01
	Press	42	3	0.03
	Clean	42	1	0.01
	Press	47	2	0.03
	Clean	46	1	0.01
	Press	52	1	0.01
	Clean	50	1	0.01
	Press	57	1	0.02
	Clean	55	1	0.02
	Press	62	1	0.02
	Clean	59	1	0.02
	Press	67	1	0.02
	Clean	62	1	0.02
	Press	70	1	0.03
	Clean	65	1	0.02
	Press	73	1	0.03
	Clean	66	1	0.02
	Press	75	1	0.03
	Clean	71	1	0.03
	Press	80	1	0.04
	Clean	75	1	0.03
	Press	85	1	0.06
	Clean	79	1	0.04
	Press	89	1	0.09
Attempts	Clean	83.1	1	0.05
	Press	94	1	0.17
	Clean	85.7	1	0.06
	Press	97	1	0.33
	Clean	88	1	0.07
	Press	99	1	1.00
Total		Abstract Clean		0.44
		Abstract Press		1.97
		Actual Clean		0.46
		Actual Press		1.12

Table 21: The intensities, reps, sets, and load of the competitive Clean & Press activity.

The abstract Internal Load of the clean is 0.44; that of the press is 1.97. With the spatial forms stress factors (clean: 1.04, Olympic Press: 0.58) applied, they come to actual internal loads of 0.46 and 1.12, respectively. The total actual load of the competitive Clean & Olympic Press activity is 1.60.

The combined actual internal training loads of the competitive activities of the snatch, clean & jerk, and clean & Olympic press bring the total actual internal training load of a historic weightlifting meet to 6.60.

7.4 Standard Powerlifting Meet

Standard Powerlifting meets consist of the competitive activities of the Powerlifting Squat (the bottom position being that in which the femur bone is parallel to the floor), the Bench Press, and the Deadlift (conventional or sumo style).

7.4.1 The Powerlifting Squat

	Competitive Powerlifting Squat Activity			
	Set	Intensity	Reps	Load
Warm-Up	1	30	10	0.09
	2	38	5	0.05
	3	47	4	0.05
	4	56	3	0.05
	5	66	2	0.05
	6	75	1	0.03
	7	85	1	0.06
	8	89	1	0.09
Attempts	9	94.0	1	0.17
	10	97.0	1	0.33
	11	99	1	1.00
Total		**Abstract Internal Load**		**1.97**
		Actual Internal Load		**2.71**

Table 22: The intensities, reps, sets, and load of the competitive Powerlifting Squat activity.

The abstract internal load from the competitive powerlifting squat activity is 1.97. Multiplied by the Powerlifting Squat spatial form stress factor (1.38), the final actual internal load is 2.71.

7.4.2 The Bench Press

	Competitive Bench Press Activity			
	Set	Intensity	Reps	Load
Warm-Up	1	30	10	0.09
	2	38	5	0.05
	3	47	4	0.05
	4	56	3	0.05
	5	66	2	0.05
	6	75	1	0.03
	7	85	1	0.06
	8	89	1	0.09
Attempts	9	94.0	1	0.17
	10	97.0	1	0.33
	11	99	1	1.00
Total	**Abstract Internal Load**			**1.97**
	Actual Internal Load			**1.58**

Table 23: The intensities, reps, sets, and load of the competitive Bench Press activity.

The abstract internal load from the competitive bench press activity is 1.97. Multiplied by the bench press spatial form stress factor (0.80), the final actual internal load is 1.58.

7.4.3 The Deadlift

	Competitive Deadlift Activity			
	Set	Intensity	Reps	Load
Warm-Up	1	30	10	0.09
	2	38	5	0.05
	3	47	4	0.05
	4	56	3	0.05
	5	66	2	0.05
	6	75	1	0.03
	7	85	1	0.06
	8	89	1	0.09
Attempts	9	94.0	1	0.17
	10	97.0	1	0.33
	11	99	1	1.00
Total	**Abstract Internal Load**			**1.97**
	Actual Internal Load			**2.65**

Table 24: The intensities, reps, sets, and load of the competitive deadlift activity.

The abstract internal load from the competitive deadlift activity is 1.97. Multiplied by the conventional deadlift spatial form stress factor (1.34), the final actual internal load is 2.65.

The combined actual internal training loads of the competitive activities of the powerlifting squat, bench press, and the deadlift bring the total actual internal training load of a standard powerlifting meet to 6.94.

7.5 Powerlifting Meet with The Strict Curl

There are special powerlifting meets in which the strict curl is included. These meets represent the maximal load of intensive heavy exercise (barbell and dumbbell lifting, as opposed to extensive light exercise like running or cycling) that an athlete can perform in a single day.

7.5.1 Strict Curl

	Competitive Strict Curl Activity			
	Set	Intensity	Reps	Load
Warm-Up	1	30	10	0.09
	2	38	5	0.05
	3	47	4	0.05
	4	56	3	0.05
	5	66	2	0.05
	6	75	1	0.03
	7	85	1	0.06
	8	89	1	0.09
Attempts	9	94.0	1	0.17
	10	97.0	1	0.33
	11	99	1	1.00
Total		**Abstract Internal Load**		**1.97**
		Actual Internal Load		**0.96**

Table 25: The intensities, reps, sets, and load of the competitive strict curl activity.

The abstract internal load from the total competitive strict curl activity is 1.97. Multiplied by the conventional deadlift spatial form stress factor (0.49), the final actual internal load is 0.96.

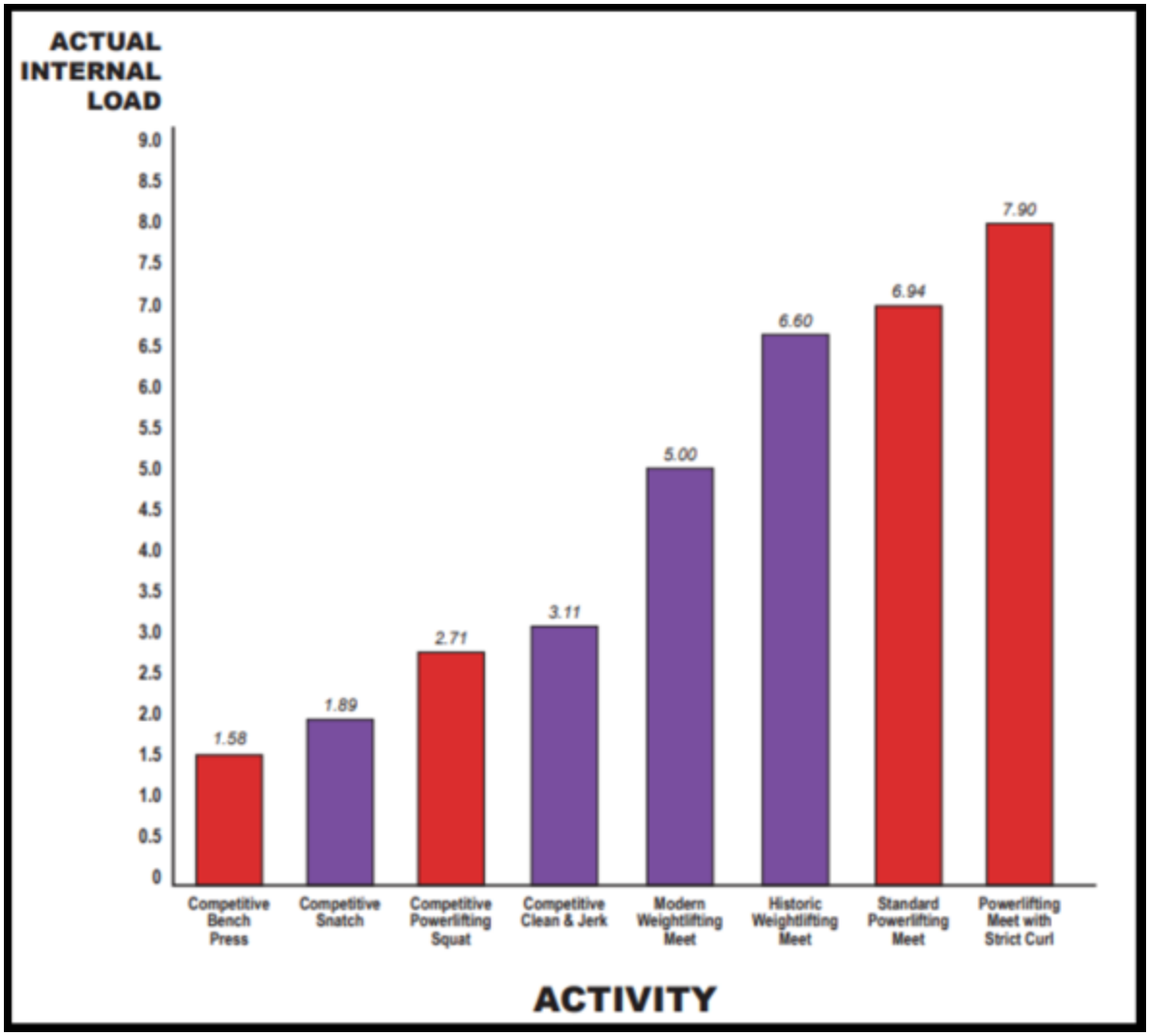
The combined actual internal training loads of the competitive activities of the powerlifting squat, bench press, deadlift, and strict curl bring the total actual internal training load of a powerlifting meet with the strict curl to 7.90.

8. Activity, Session, and Training Day Loading

Now that the actual internal loading values of all the major competitive activities are known, it is possible to analyze them and form some postulations regarding amounts of loading for single activities in a training session, whole sessions, and training days.

Activity	Actual Internal Load
Prilepin Optimal Activity	0.94
Competive Strict Curl	0.96
Competive Bench Press	1.58
Competive Clean & Press	1.60
Competitive Snatch	1.89
Competive Deadlift	2.65
Competive Powerlifting Squat	2.71
Competitive Clean & Jerk	3.11
Modern Weightlfitng Meet	5.00
Historic Weightlifting Meet	6.60
Standard Powerlifting Meet	6.94
Powerlifting Meet w/ Strict Curl	7.90

Table 26: Actual Internal Loads of competitive activities and whole competitions.



Graph 1: Actual Internal Loads of competitive activities and whole competitions.

These actual internal training loads represent the total stress effect on the entire organism, affecting the primary working muscles involved in the movement and all of its subsystems. For this reason, we can say that any spatial form can be done up to a maximal actual internal training load of 2.71, which is the maximum maximorum load of all the lifts in competition: the performance of the powerlifting squat in competition. However, this load would result in a very high amount of reps for spatial forms with much lower stress factors (like the strict curl and the press). A high level of local muscle and joint soreness would develop in those lifts' main working muscles and joints. Still, an athlete could theoretically do the 2.71 load if their coach desires a specific “shock” effect for rapid, short-term adaptations for the particular lift. However, we should not do this often. It is better to consider the competitive actual internal training load of a given spatial form as its own maximal training load for a single day. It is most informative to look at what an optimal load was, according to Prilepin.

The Optimal load for a single activity in a training day, according to Prilepin's chart, is 0.8, and we include the loading of an average warmup, bringing the optimal load to 0.94.

As stated earlier, the basis of Prilepin's Table is the Snatch and the Clean, so the optimum described above of 0.94 applies to those lifts (as always, the load of any jerks done should be calculated separately from the clean). So we can now see the ratio of the average internal load of the *competitive activities* of the snatch & clean to what Prilepin determined to be the average optimal internal training load of the snatch & clean *in training*.

Snatch and Clean Average Competition Load	1.97
Prilepin Optimal Load	0.94
Ratio of Optimal Load to Competitve Load	0.48

Table 27: Ratio of optimal internal training load to competition load.

The Ratio of the Optimal internal training load to the competitive internal training load is 0.48. To determine the optimal abstract internal training load of any other lift, we multiply the specific competitive abstract load by 0.48. This process returns an abstract internal optimal load for the main sets of every lift of 0.8, exactly what was optimal according to Prilepin.

We can use the abstract load to determine the optimal sets and reps for any single exercise in a session/day for simplicity. As stated above, the abstract optimal internal load for every exercise comes to 0.8, and the abstract internal load of all the competitive activities is 1.97 (cleans & jerks considered separately, and excluding the submaximal clean of the clean & press), so we can deduce that an abstract internal load of 1.97 is the limit for a single spatial form in a single day. Hristo Hristov came to this same conclusion (rounded to 2.0) in his work on the Intensity Number Of Lifts Score.

8.1 Planning Training Sessions and Days

With the precise actual internal loading quantities of optimal training activities, competitive activities, and whole competitions in hand, it is possible to propose valuable guidelines for planning training sessions and days.

One effective and common way to structure a training session for almost any athletic purpose is to start with a highly technical and high power exercise (weightlifting movement) followed by a heavy strength exercise for the upper body and finish up with a heavy strength exercise for the lower body. We can use a theoretical session including the snatch, bench press, and Olympic squat —competitive weightlifters would use full-depth Olympic Squats [Stress Factor: 1.47], as this movement pattern is more related to the recovery out of the bottom of the snatch or clean. If we use a plan for a Prilepin optimal abstract internal load and warmup for each (with any intensity) activity, the actual internal loading of the whole session will be the results in table 28.

Session					
Activity 1		**Activity 2**		**Activity 3**	
Spatial Form	Snatch	Spatial Form	Bench Press	Spatial Form	Olympic Squat
Warmup	0.14	Warmup	0.14	Warmup	0.14
Main Sets	0.8	Main Sets	0.8	Main Sets	0.8
Total	0.94	Total	0.94	Total	0.94
Actual Internal Load	**0.90**	**Actual Internal Load**	**0.75**	**Actual Internal Load**	**1.38**

Total Session Actual Internal Training Load	**3.03**

Table 28: Actual internal training load of an optimal session format.

The total actual internal training load from this optimal or medium training session comes to 3.03.

It is also common to add one more accessory lift to such a session, normally to develop more muscle mass and muscular endurance. The Bent-Over Row is one of the most valuable and common exercises for this purpose. If we plan this activity in our theoretical session as another Prilepin optimal abstract internal load, the whole session will now look like the results in table 29.

Session							
Activity 1		**Activity 2**		**Activity 3**		**Activity 4**	
Spatial Form	Snatch	Spatial Form	Bench Press	Spatial Form	Olympic Squat	Spatial Form	Bent Over Row
Warmup	0.14	Warmup	0.14	Warmup	0.14	Warmup	0.14
Main Sets	0.8	Main Sets	0.8	Main Sets	0.8	Main Sets	0.8
Total	0.94	Total	0.94	Total	0.94	Total	0.94
Actual Internal Load	**0.90**	**Actual Internal Load**	**0.75**	**Actual Internal Load**	**1.38**	**Actual Internal Load**	**0.71**

Total Session Actual Internal Training Load	**3.74**

Table 29: Actual internal training load of an optimal plus bent over row session format.

This session's final actual internal load would be 3.74; this should be called a Heavy or Large session.

We can break the load up into two sessions to look at loading at the day level. A common way to do this is to have one session in the morning consisting of highly technical/high-power exercises (weightlifting), followed by an evening session consisting of heavy strength and hypertrophy exercises. Our theoretical day will include a morning session with optimal loads for both the snatch and clean & jerk and an evening session with the same for the bench press and Olympic squat. The results are in table 30.

Session 1			
Activity 1		Activity 2	
Spatial Form	Snatch	Spatial Form	Clean & Jerk
Warmup	0.14	Warmup	0.28
Main Sets	0.8	Main Sets	1.6
Total	0.94	Total	1.88
Actual Internal Load	**0.90**	**Actual Internal Load**	**1.49**

Session 2			
Activity 3		Activity 4	
Spatial Form	Bench Press	Spatial Form	Olympic Squat
Warmup	0.14	Warmup	0.14
Main Sets	0.8	Main Sets	0.8
Total	0.94	Total	0.94
Actual Internal Load	**0.75**	**Actual Internal Load**	**1.38**

Total Actual Internal Training Load	**4.52**

Table 30: Actual internal training load of a heavy training day.

The total actual internal load from this training day comes to 4.52; this should be known as a Heavy / Large Training Day, as it contains four optimal loads of major lifts (5 if we consider the clean and jerk separately).

We can again add the bent-over row as an accessory lift at the end of the evening session.

Session 1			
Activity 1		Activity 2	
Spatial Form	Snatch	Spatial Form	Clean & Jerk
Warmup	0.14	Warmup	0.28
Main Sets	0.8	Main Sets	1.6
Total	0.94	Total	1.88
Actual Internal Load	**0.90**	**Actual Internal Load**	**1.49**

Session 2					
Activity 3		Activity 4		Activity 5	
Spatial Form	Bench Press	Spatial Form	Olympic Squat	Spatial Form	Bent Over Row
Warmup	0.14	Warmup	0.14	Warmup	0.14
Main Sets	0.8	Main Sets	0.8	Main Sets	0.8
Total	0.94	Total	0.94	Total	0.94
Actual Internal Load	**0.75**	**Actual Internal Load**	**1.38**	**Actual Internal Load**	**0.71**

Total Actual Internal Training Load	**5.23**

Table 31: Actual internal training load of a heavy training day plus bent-over row.

The total internal load from this training day comes to 5.23; we will label this a Very Large / Extreme Training Day.

We can add these practical examples to the actual internal loading table with all the competitive activities to see how all these activities compare. The results are in table 32.

Activity	Actual Internal Load
Prilepin Optimal Activity	0.94
Competive Strict Curl	0.96
Competive Bench Press	1.58
Competive Clean & Press	1.60
Competitive Snatch	1.89
Competive Deadlift	2.65
Competive Powerlifting Squat	2.71
Medium Session	3.03
Competitive Clean & Jerk	3.11
Large Session	3.74
Large Training Day	4.52
Modern Weightlfitng Meet	5.00
Very Large Training Day	5.23
Historic Weightlifting Meet	6.60
Standard Powerlifting Meet	6.94
Powerlifting Meet w/ Strict Curl	7.90

Table 32: Various actual internal training loads- Training: White, Weightlifting: Purple, Powerlifting: Red.

We can see that a Very Large Training Day is precisely that as it develops an actual internal load that is greater than an actual modern weightlifting meet (the mental/psychological stress of competition obviously qualitatively adds to the load, but these comparisons are very useful none-the-less).

The theoretical examples of training sessions above and the actual loads from all the competitive activities make it possible to determine loading level zones at the session and day levels. The results are in table 33.

Loading Level	Session	Day
Very Small / Light	<1	1.1 - 2
Small / Light	1.1 - 2	2.1 - 3
Medium / Optimal	2.1 - 3	3.1 - 4
Large / Heavy	3.1 - 4	4.1 - 5
Very Large / Very Heavy	4.1 - 5	>5
Extremely Large / Extremely Heavy	>5	>5
Maximal	7.90	7.90

Table 33: Actual internal training loading level zones.

The table's maximal internal load is the amount of a powerlifting meet with the strict curl; this represents the maximum internal loading from all barbell, dumbbell, kettlebell, calisthenic body lifting, and weight machine training that an athlete should do in a day. If the lifter performs other types of (less intensive/lower force) training, such as ball-sport practice, running, cycling, or swimming, we can increase the maximal load(s).

It is extremely useful to know how training activities, sessions, and days stack up against the actual internal loads of competitive activities and whole competitions, as it can help a coach to organize training across time in a way that ensures that the athlete will be ready for the actual internal load of his/her competition. The coach may not want to use the actual competition intensities in training, but he/she can use the same load to ensure sufficient conditioning for success is present in the athlete. The coach might even want to place a training session/day with a load equivalent to the competition in training at some point prior to competition to ensure the athlete is ultimately ready for the competitive load.

These values are just as useful for the programming of training for non-competitive trainees as their success in the pursuit of better health, or a better body is entirely dependent on the use of proper loads according to their current state.

In future work, I will detail how the stress factor concept can be applied to all other barbell, dumbbell, and calisthenic spatial forms so that many more exercises can be integrated and controlled using this system. I will also detail how we can determine actual internal loading for other non-lifting activities like running, cycling, jumping, and specific sports activities, including combat sports matches, ball games, and more, and how to regulate the loading of all the various elements of the training process; this allows for exact control of fitness and fatigue and hence **preparedness**.

It is also possible to use the actual internal loading concept to determine the loading levels of larger training units, including microcycles and weeks, mesocycles and months, periods, macrocycles and years. For this purpose, we will apply the actual internal loading calculation to the training journals of elite weight lifters and powerlifters. Detail of this will be in a forthcoming paper.

Summary

In this work, I detailed the foundational element of training organization: Loading. I broke loading down into its two interrelated aspects: the external and internal loads.

A way to precisely determine the abstract internal loading from a training activity was given based on the historical work of A.S. Prilepin and Hristo Hristov. An innovation for calculating abstract internal loading was developed in the form of the Prilepin Minuend.

After providing the process for determining the abstract internal loading, I introduced a novel concept for actualizing loading: the Spatial From Stress Factor. The historical all-time best raw human performances in the competitive exercises of the major strength sports were analyzed in-depth to show the logic of the concept.

The application of the stress factors to the competitive activities of the strength sports was fully developed, which showed the precise actual internal loading of each of the individual competitive activities and whole competitions, both historical and modern.

Finally, the actual internal loading of standard training sessions and days was determined and compared with the loading of competitions to provide the reader a direct orientation of this loading calculation system to his/her own training process or the process of his/her trainees.

Conclusion

The purpose of his work was to develop a system that allows coaches and trainees/athletes much greater insight and control over their training process, which will eventually lead to a revolution in training results that will radically change the entirety of human physical endeavor for the better. This will lead to higher-level achievement in athletic performances for athletes and greater health improvements for all people who are willing to put in the effort to improve their own physical existence. The major barbell lifts and the sports they comprise represent the most obvious, direct, and concentrated interaction of the human organism with external force and hence internal loading. The internal loading applied to an organism is the determinant factor in how much adaptation it will undergo. The amount of adaptation an

organism undergoes determines its fitness and health. This work has given a rational way to optimize this process and improve the results and business of any coach/trainer and the performance, health, and experience of living for any trainee to whom it is applied.

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