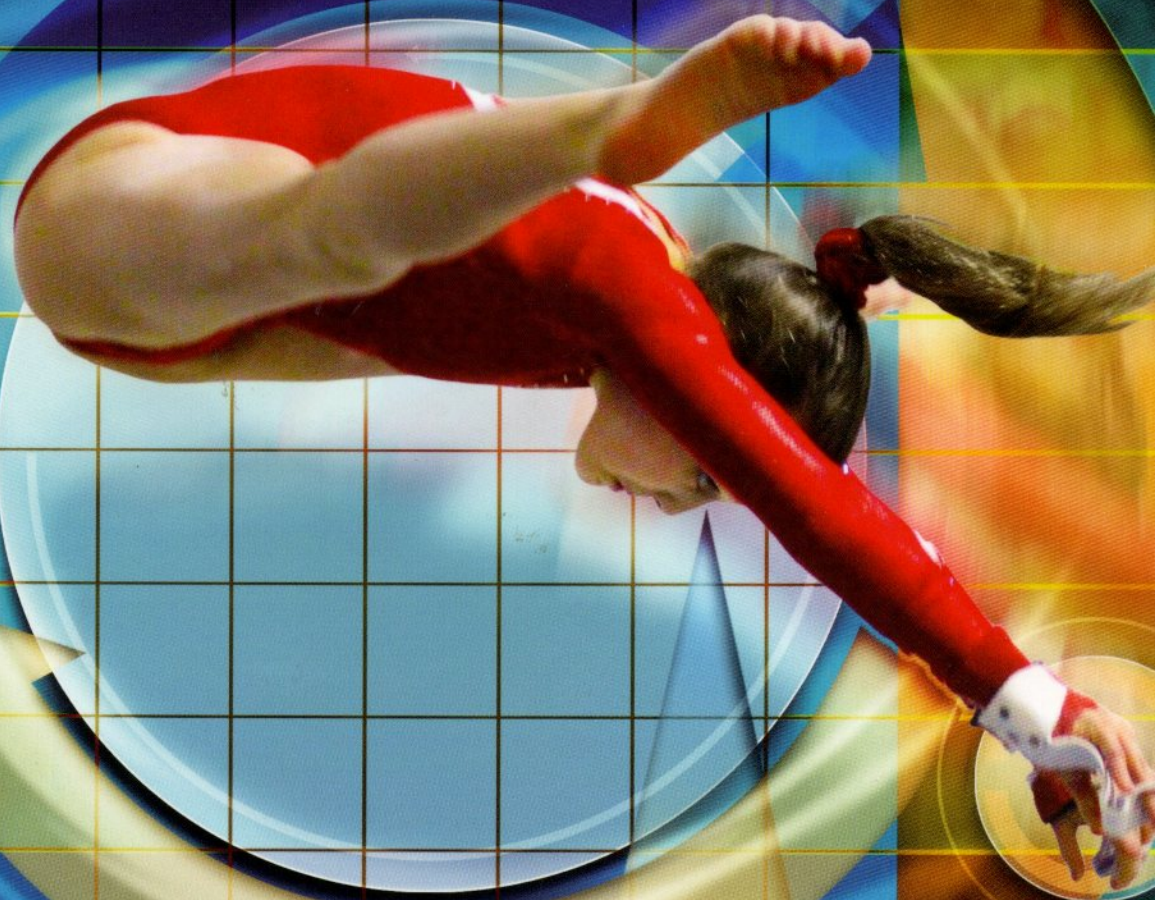


Championship Gymnastics

BIOMECHANICAL TECHNIQUES FOR SHAPING WINNERS



GERALD S. GEORGE, Ph.D.

Illustrated by James H. Stephenson

To Become a CHAMPION:

Take your worst event and make it your best...

AND THEN,

take your worst event and make it your best...

AND THEN,

take your worst event and make it your best...

—Gerald S. George, Ph.D.

EXPERT REVIEWS ON CHAMPIONSHIP GYMNASTICS

To expand your knowledge and enhance your understanding of the biomechanical complexities of gymnastics skill, read *Championship Gymnastics*. Dr. George's signature work, *Biomechanics of Women's Gymnastics*, is one of the best books ever written in gymnastics and, with his new book, *Championship Gymnastics*, he takes the study of movement and gymnastic techniques to an even higher level. We will be using this book in the training of our coaching staff, as well as in our Visiting Coaches' Educational Program.

Bruno Klaus, Owner, International Gymnastics Camp, Inc.

Professor Emeritus, East Stroudsburg State University

Former National Gymnastics Champion

USA Gymnastics Hall of Fame (Competitor, Coach, and Contributor)

Championship Gymnastics brings to life the fundamental concepts of motion for gymnastics, the basis of performance for acrosport including diving and trampoline. The text provides a conceptual map of the Path of Excellence where sports science meets the art and essence of coaching. Dr. Gerald George is the Leonardo Da Vinci of performance acrosport. His consummate understanding of the application of biomechanics to the possibilities for human motion gives form to perfect flight!

Janet Gabriel, Senior Editor/Project Director

U.S. Diving Safety Training Manual

Former Director of Education, Safety and Development, U.S. Diving, Inc.

Championship Gymnastics is a must-read for every gymnastics professional, both experienced and novice. The excellent "learn and relate to" writing style allows for a very positive and enriched learning experience. The book's thoroughness will allow any coach to become a more complete and effective problem-solver. *Championship Gymnastics* is evidence of Dr. George's comprehensive understanding of our sport's need for continued growth through learning, and will again prove to be another successful and excellent "go to" reference book. Dr. George has raised the gold standard for learning gymnastics, to be sure.

R. Scott Crouse, National Gymnastics Consultant

Former U.S. National Team Coach

Coach of over 25 U.S. National Team Members that participated in the Olympic Games, World Championships and Pan American Games

Championship Gymnastics is for the "Everyman" coach. It covers the fundamental components to success in gymnastics—foundations of skill development, effective training protocols, proper body-shaping techniques, and ideal model concepts for developing winners. Dr. George has managed to style his language from complex, technical terms to motivating, inspirational rhetoric so that coaches and gymnasts at all levels can readily understand and implement these innovative concepts into their programs. **Championship Gymnastics** is a must-read for every coach at every level.

Mary Wright, Owner/Head Coach of Olympus Gymnastics

USA Gymnastics Elite Coach of the Year

USA Gymnastics Elite Choreographer of the Year

Coach of numerous Olympic and World Championship Medalists

Dr. Gerald S. George has again given the sport of gymnastics another outstanding contribution with his new publication, **Championship Gymnastics**, soon to be the bookend to his first publication, **Biomechanics of Women's Gymnastics**, a book that remains the foundation for all gymnastic coaches. The USAIGC will use **Championship Gymnastics** as a must-read for our membership. This was long overdue. Congratulations, the key to success is education!

Paul Spadaro, President

United States Association of Independent Gymnastics Clubs

New York, NY

With **Championship Gymnastics**, Dr. Gerald George has managed to simultaneously capture the simplicity and complexity of gymnastics and make it easily understandable to the reader. This superb text is an essential guide for all students of gymnastics: performers, coaches and judges alike.

Kristi Krafft, Owner/Head Coach of Krafft Academy of Gymnastics

Former USA World Championship Coach

Elite Coaches Association Female Coach of the Year

International Brevet Judge

Gymnastics instructors and coaches need a thorough understanding of biomechanics to prevent injury and encourage athletes to safely achieve their personal best. **Championship Gymnastics** is an excellent text that gymnastics professionals can utilize as a resource and reference to learn, build upon and sharpen their knowledge of human movement and biomechanics.

Kathy Feldmann, Vice President of Member Services

USA Gymnastics, Inc.

National Brevet Judge

DEDICATION

To my beautiful wife,
and mother of my six children,
Janet,
who has always been there for me.

—Jerry

ABOUT THE ILLUSTRATOR

James H. Stephenson's career has been a unique balance of gymnastics and art. With a competitive background including NCAA All-American Honors and United States representation at the international level, he has been a USAG Club owner and Head Coach, Collegiate Head Coach as well as a Clinician and Consultant.

In 1972, Stephenson began an association with the USA Governing body that included over two decades of illustrating all of the women's and most of the men's compulsory routines. The logo which served the USGF in the 1980's and 90's was also his creation. The posters for the 1992 World Championships, the illustrations for the first two editions of the Safety Manual and the educational posters that accompanied that initial program also were produced by Stephenson. Furthermore, he served as biomechanical consultant and technical illustrator for the FIG Code of Points from 1993-1997. One of his finest works was the illustrations for the cutting-edge book, *Biomechanics of Women's Gymnastics* by Dr. Gerald S. George.

Stephenson also has illustrated several safety manuals and educational guides for other US governing bodies including Special Olympics International, US Diving, US Rowing, and The American Association of Cheerleading Coaches and Administrators. Two of Stephenson's most impressive works reside on the campuses of Oregon State University and the University of Georgia. They are life-size bronze sculptures which adorn their gymnastics training facilities.

Stephenson's excellent abilities as a technical illustrator in conjunction with Dr. Gerald George's unmatched biomechanical knowledge combine to create a state of the art gymnastics resource in *Championship Gymnastics*.

ACKNOWLEDGMENTS

Some 50-plus years ago, a skinny little inner-city kid from New Orleans flipped his cigarette onto the sidewalk and walked into the high school gym. What he found would forever change the course of his life...gymnastics!

Having been involved in almost every phase of the gymnastics spectrum, it would indeed be impossible for me to credit properly all the wonderful and dedicated people who, either directly or indirectly, influenced the writing of this book. For the enriched experiences they provided, as well as for their encouragement and friendship through the years, I would like to acknowledge the following people in particular:

- Elm D. "Buddy" Wood, my best and lifetime friend, who has always been there for me;
- Jim Stephenson, the very best artist/illustrator in the gymnastics world, whose mastery of line and form renders my words in this text obsolete;
- Fred Martinez, who helped a clumsy kid find himself through the magic of gymnastics;
- George Szypula, my college coach, who believed in me after I failed miserably;
- Yoshiro Hatano, who taught me to never give up;
- Bruno Klaus, a visionary, whose pure love for gymnastics I still admire and respect;
- Greg Marsden, my best student and long-time friend, who taught me more than I taught him;
- Abie Grossfeld, clearly the best gymnastics coach in the world, who has been my friend and mentor for more than half a century;
- Chic Johnson, although departed from this world, whose impact still resonates deeply in my very being;
- Ashley LaSalle, for her continuous encouragement to write this book;
- And finally, my beautiful wife, Janet, and our wonderful children, Tasha, James, Jonathan, Michael, Karen, and Lauren, who have always served as my base of support.

I thank and love all of you.

—Gerald S. George

In all of human history, there has been no greater expression of athletic ability and artistic performance than is found in gymnastics. It is an honor to have participated in the creation of a book that can so profoundly benefit everyone who has taken on the challenge of this ancient and most beautiful of sports.

As the illustrator whose task it has been to do justice to the artistry of gymnastics, I thank Angela K. Walker, who modeled for the master figures from which all the illustrations were developed, and my wife, Meg, whose continuing encouragement helped bring my work to a finer level.

—James H. Stephenson

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CHAPTER ONE

INTRODUCTION TO GYMNASTICS TECHNIQUE

And now the silence of the crowd becomes deafening. Electricity permeates the air as a wide-eyed child walks onto the international podium. The awesome, bland faces of the technical evaluators seem to employ X-ray vision as they pointedly stare through the child's eyes and into the back of her skull. The stage is set, and irrevocable judgment will now be rendered. That "automatic pilot" inherent in all great gymnasts is called upon to tell its story. It is a story of performance quality, centering solely on the product and not the manner in which it was constituted...

But without a rigorous training program centered on tedious attention to detail, painstaking exactness, and uncompromising expectations—without persistence, focus, and courage to keep on getting up there to try again and again and again after failing—championship performance remains forever a dream, half hidden in the heart of the child.

The sport of gymnastics, perhaps more than most activities, encompasses a seemingly endless quantity of movement skills. Even more incredible is the amount and variety of information put forth to define and clarify these movements. One need only compare the analyses of almost any given gymnastics element presented by any number of alleged authorities to find strikingly different interpretations. Some might best be described as works of fiction! Compounding this dilemma, skills are often viewed as unique elements, each distinctly different from all others. While these efforts to expand our knowledge and practices in gymnastics mechanics and techniques are commendable, a critical review of contemporary methods leaves little wonder why they appear, at best, to be perplexing!

Actually, this should not be the case at all. Unlike many sports activities, *a majority of the movements in gymnastics are symmetrical in pattern and simplistic in nature.* Although skills differ according to their objectives, close observation reveals that the vast majority of differences exist more in degree than in kind. In fact, *the similarities in*

gymnastic movement patterns far outweigh the differences. The mechanics involved in executing even the most basic skills are precisely the same as those at the more advanced levels; many backward-moving skills are the mirror image of forward-moving skills; and the principles employed in landing mechanics are essentially the reciprocal of those in take-off mechanics. In that light, this book is based on a fundamental premise:

Gymnastics skills should be conceptualized and taught according to their technical and mechanical similarities.

THE IDEAL MODEL CONCEPT

The perspective of correct technical execution for any movement inevitably arises out of one's current, yet continuously evolving, concept of what is considered the "ideal model." Relying on available information and experience, the mind's eye attempts to create the very best model it can possibly conceive and then to use that model as the basis for correct technique. As the conceptual model becomes more and more refined, practical execution of the actual skill can more closely approach perfection.

Exacting movement is, of course, an ideal concept. After all, none of us is perfect. And yet, if a child were to be taught the concept of a straight line, would it not be wise to provide her with *as straight a line as possible*? Her conceptual model would thus be right on target, providing an accurate framework from which to approximate more closely the desired objective—understanding and drawing a truly straight line.

Consider the print styles used in this book. Notice bolding, italicizing, and underlining are employed in selected areas. Yet these variations in style of print do not determine the reader's ability to comprehend the fundamental meaning of the words. Why? Because *the reader relies on an already-learned ideal model for each letter of the alphabet in order to interpret the meaning of the words.* Even if this material were written freehand, would not the reader still understand its meaning?

The ability to conceptualize ideal models for technical execution of gymnastics skills is an essential first step toward championship performance. While in no way perfect or complete, this book's illustrations and interpretations are an attempt to provide such ideal-model concepts. Their fundamental purpose is to serve as a basic framework on which to develop even better ideal models. Although a working knowledge of biomechanics is essential to understanding and developing ideal models, this in and of itself is not enough. *One must be able to employ biomechanical principles not only accurately specific to what has been performed, but also creatively in terms of how it can and should be performed.* And this is unquestionably dependent on the quality and correctness of the perceived model.

The true art of gymnastics is in successfully manipulating the science!

A SYSTEMS APPROACH

It is extremely important for the ongoing development of our sport that judges, coaches, and gymnasts make an ongoing effort to improve continuously on all existing skill models, as well as to develop new models. This is the purpose underlying everything presented herein—a practical approach predicated on a system of principles that attempts to clarify and define optimum execution techniques. The gymnastics community wants and needs a relevant technical base, *a systems approach applicable to all skills and all performers.* Through an approach with relevant, universal application to gymnastics technique, critical performance variables become increasingly easier to identify, evaluate, and control. This text seeks to direct its readers along a new conceptual path and open their eyes to the endless potential and beauty in the dance of gymnastics. Remember:

There is an art to science, and there is a science to art.

FACTORS AFFECTING SUCCESS

A number of important training concepts directly influence the rate of progress, the quality of skill execution, and the resulting degree of success one can ultimately hope to achieve in gymnastics. Here are some of the more time-tested factors to consider.

1. Gymnastics—A Long and Winding Road

The human body is perhaps one of the most complex systems imaginable, while the four competitive events in women's gymnastics serve as a formidable medium through which to demonstrate the body's potential. For the system to operate at maximum efficiency, it must be prepared to meet the demands imposed by the medium. To establish the proper training protocol, *it is imperative that coaches have a clear and accurate understanding of not only the system (the performer) but also the medium (women's gymnastics).*

Wise coaches know the importance of carefully evaluating a would-be gymnast's inherent anatomical, physiological, and psychological readiness prior to her participation in a formal gymnastics program, particularly as related to the anticipated level of participation. Armed with this knowledge, coaches can then develop proper training protocols, and expected outcomes will be reasonably safe, predictable, and productive. From both the coach's and performer's perspectives, keep in mind:

There are no short-cuts... Take the long way home.

2. All Systems GO

Readiness to perform is perhaps the single most important consideration for success in any endeavor, and gymnastics is no exception. Time and effort must be expended to ensure the prospective performer is adequately prepared to participate in the gymnastics activity from the outset. Otherwise, the training experience will become inherently problematic, resulting in slow, ineffective learning with limited potential for advancement. In fact, ineffective learning environments, failures, and injuries can almost always be traced back to a lack of performer readiness relative to the task at hand. *Readiness to perform the given task should be continuously verified as part of ongoing training throughout the life cycle of the gymnast.*

If you're gonna fly, first verify that all systems are a "go."

In the beginning stages, the bulk of a participant's experience should center on gross body movements typically observed in callisthenic exercises—general gymnastics activities including dance, rhythms, and expressive movement. Once the performer can properly control and regulate these gross movements consistently, the training program should expand to incorporate gymnastics-specific exercises designed to improve body shaping, strength, power, and flexibility. In addition, exercise protocols for enhancing sprint speed and muscular and cardiovascular endurance should continue throughout the life cycle of the performer.

3. Mastery of Basic Skills

Task mastery of essential, core skills is the single most important criterion for predicting future success. How many coaches and performers, in blind aspiration for short-lived success, misuse this well-known yet seldom-followed guideline? *Too often, they mistakenly employ task-complexity techniques rather than task-execution techniques in search of the spectacular.* Difficulty levels are prematurely advanced at the expense of proper execution, natural mechanical progression, and a well-rounded experience in fundamental movement patterns and sequences.

*Failure to truly master the basics will,
as Shakespeare once said, "return to plague the inventor"!*

The term "*mastery*" implies far more than mere successful execution. It involves *the ability to perform skills consistently at a level of at least near-perfection in technique.* The gymnast should be able to demonstrate task mastery of basic skills to the point that the execution of each movement pattern is as natural as "a walk in the park"! However, one must appreciate that *basic skills*, which serve as building blocks for more advanced skills, *are actually much harder to master than advanced skills.* If maximum performance potential is to be achieved, the lion's share of the gymnast's entire career must be devoted to basic movement training.

The basic skills are the easiest to perform but the most difficult to master.

Not until mastery of the basic skills has been fully ingrained and demonstrated over an extended period should the performer proceed to the next level. At first blush, this approach may appear inefficient and cumbersome, lacking in any real productivity. One might ask, "Why spend seemingly inordinate amounts of time practicing what I can already do reasonably well?" The truth is that *advanced skills are really nothing more than a properly integrated series of basic movements.* Although it may appear initially that the race is being lost:

Never forget the story of the tortoise and the hare!

4. Persistent Use of Repetitions

The only realistic way to achieve task mastery of any gymnastics skill or element is through the persistent use of repetitions. This does not simply imply repetition is necessary to the learning of skills. More importantly, it points to the relentless use of repetitions applied to skills that have already been learned. The basic idea here is to *ensure that a vast majority of the daily workout session deals with successful executions*, rather than some haphazard trial-and-error scenario wherein the performer's experiences are mostly centered in confusion, frustration, and failure.

*Train smart, train hard, train forever,
that the seasons of victory are yours and not your inheritors'.*

5. Use of Appropriate Skill Progressions

The use of skill progressions alone is not enough—far more important is the knowledge of which sequence of progressions ought to be introduced and when. *To ensure a maximum rate of progress, the difficulty of the skill progression must be within the experience and readiness level of the performer.* The following guidelines will assist in the development of appropriate progressions:

- Select each skill progression based on how closely it approximates the previously mastered skill (the closer, the better);
- Make certain each progression is simplistic in nature, i.e., that it has a direct relationship to the previously mastered skill;
- Master as broad a range of sequentially related progressions as possible;
- Always proceed from simple-to-complex task mastery; and
- Remain at each progressional level until task mastery is consistently demonstrated for a significant period.

Ultimate success in technical execution of gymnastics skills inevitably depends on the degree of simple-to-complex task mastery. Because advanced skills are, in effect, nothing more than an integrated series of elementary movements, the necessity of truly mastering the basics should be quite obvious.

*Keep taking tiny steps, like the weathered old lady...
Only then will you begin to feel her beauty and her power.*

6. Learning versus Performance

The term "learning" implies a relatively permanent change in a behavior or a movement pattern, whereas "performance" is an intermittent variable that fluctuates from time to time, depending on the given situation. In the training setting, coaches and gymnasts sometimes fail to understand and differentiate between these two concepts when evaluating readiness to ascend to the next level of difficulty.

Attempting to ascend the progressional ladder prematurely is perhaps the central limiting factor in realizing the performer's full potential. Simply performing the given element or sequence a number of times does not necessarily mean that true learning has taken place. *For learning to have actually occurred, the performer must be able to demonstrate task mastery consistently over an extended period.* The very word "routine" implies that which a gymnast performs is regular, usual, and habitual. When elements and sequences are truly learned, their *execution becomes automatic, consistently accurate, and therefore predictable.*

Every great gymnast calls on her automatic pilot.

Gymnastics movements, particularly at the basic levels, should not only be mastered but also learned to the point of unconscious habit. Such a training protocol is the barometer for proceeding to the next level of skill progressions. In addition, having a set of well-ingrained movement patterns allows the gymnast to employ her automatic pilot to execute the routine so she can actively concentrate on maximizing and accentuating the finer aspects of championship performance.

7. Skill Sequencing

One often observes gymnasts spending inordinate amounts of time practicing individual skills or elements, hoping somehow to achieve absolute perfection before moving on. Although attaining a high level of skill mastery is essential, it should not be the ultimate focus of the training program. Rather, *the bulk of training sessions should center on skill sequencing, i.e., practicing already-learned skills in sequence and then as full routines.* This is true regardless of the level of the performer. After

all, success in gymnastics demands mastery of routines, not simply “tricks”! Even at the most elementary stages, every attempt should be made to blend basic skills into basic skill sequences and finally into basic routines. This same protocol should be followed at the intermediate and advanced levels of training.

When skills are practiced in sequence rather than as individual elements, the gymnast enjoys the opportunity to develop intimate familiarity and improved technique with the unique transitional components inherent in the sequence. A better feel for the interrelationships among these already-learned skills is thereby realized, ensuring more fluid patterns in the performer’s movement profile.

The practice of skill sequencing also serves as an excellent training protocol from the physiological perspective, as it develops (among other things) a performer’s muscular endurance specific to the demands imposed by the given gymnastics routine. Who can deny that fatigue, the great “robber baron” of success, secretly lurks in every deconditioned athlete? There’s an old Chinese proverb:

It’s never too early to start winning.

8. Compensatory Techniques—The Achilles Heel

Compensatory techniques are sequences, patterns, and shapes employed in place of correct technical execution. Look to any competition, any gymnast, any movement sequence, and one can observe scores of them. Although some degree of compensation is characteristic to all physical movement, the overzealous use of compensatory techniques tends to compound on itself, resulting in the performer ultimately “hitting a brick wall.” In the rush to achieve ever greater degrees of skill difficulty, coaches and gymnasts are often lured into the mistaken belief that proper technique can somehow be traded off without consequence. In the final analysis, however, nothing could be further from the truth. Just ask any would-be champion!

*Compensatory techniques enter your house a welcomed guest,
then your secret friend, and finally your master—in defeat, that is.*

9. Sureness of Execution

In artistic gymnastics, sureness of execution is the degree to which the gymnast demonstrates absolute command of her performance. This concept seeks to define how the story of movement technique is to be told. For success is not simply a matter of executing skills in a technically correct fashion—rather, *it is the level of sureness in technical excellence brought to the performance determines the ultimate champion.*

The concept of sureness applies to virtually all skills in all gymnastics events. The vaulter who lands without hopping or taking a step, yet tentatively wobbles, will never outscore the vaulter who stretches for the ground and "sticks" the landing like a dart! And what about the gymnast who, in performing a release-grip skill on the unevens, finds the bar slamming into her hands as opposed to her reaching for and confidently regripping the bar? The same can be said of the beam performer who displays technical excellence in a leap but does so with an air of uncertainty. In tumbling, landings are particularly vulnerable to scrutiny of "sureness," in that they often appear to come as a surprise to the performer rather than as a "command performance"! Simply put, *sureness of execution deals with the overall impression created in the mind's eye of the judges by the given performance.* Keep in mind:

Judges are not impressed with luck, only skill.

10. Psychological Readiness—The Ultimate Domain

Success in gymnastics is really no different from success in any other sports endeavor. First and foremost, *performers must possess the requisite physical capabilities to meet the demands of the gymnastics activity.* This aspect, often referred to as "*physiological readiness*," is similar to designing the engine for an Indy 500 racecar. Without first ensuring a sufficient performance source, the best-laid plans of mice and men lie dormant. And yet a finely tuned, high-powered engine is of limited value without the proper transmission to deliver its raw power effectively to the road. In terms of gymnastics success, the *correct mechanical techniques must be applied to optimize skill execution.* In other words, "*biomechanical readiness*" serves as the gymnast's transmission when it comes to "where the rubber meets the road."

Virtually all elite-level gymnastics competitors possess high levels of both physiological and biomechanical readiness. Consequently, the margin for victory is almost always based on "least-discernible differences." More often than not, one finds that mere hundredths of a point separate the champion from the would-be champion. So wherein lies the ultimate difference?

The difference is found in the ultimate domain, "psychological readiness"—the degree to which the performer is mentally and emotionally prepared to demonstrate absolute command of the performance. It deals with, among other things, a performer's perceptions, self-image, attitude, and work ethic. Learning how to cope effectively with fear, anxiety, onlookers, and the competitive setting are typical examples accounting for the least-discernible differences at the elite level.

Psychological readiness is a success-oriented mind-set allowing the gymnast to ignore all extraneous variables that can negatively affect performance in favor of the ability to focus clearly and only on the task at hand. And this ability is, without question, the ultimate key to giving one's very best effort.

Winning is simply giving the very best you have to offer.

A. External Amplitude

External amplitude is the range of motion achieved by the total body relative to the ground and/or apparatus in the execution of a skill. It is a descriptor of height attained (vertical amplitude), distance traveled (horizontal amplitude), or both. For example, figure 2.1 depicts the airborne phase of two gymnasts executing a Yurchenko Vault. The second gymnast attains greater vertical height and horizontal distance from the vault table during the postflight phase of the vault.

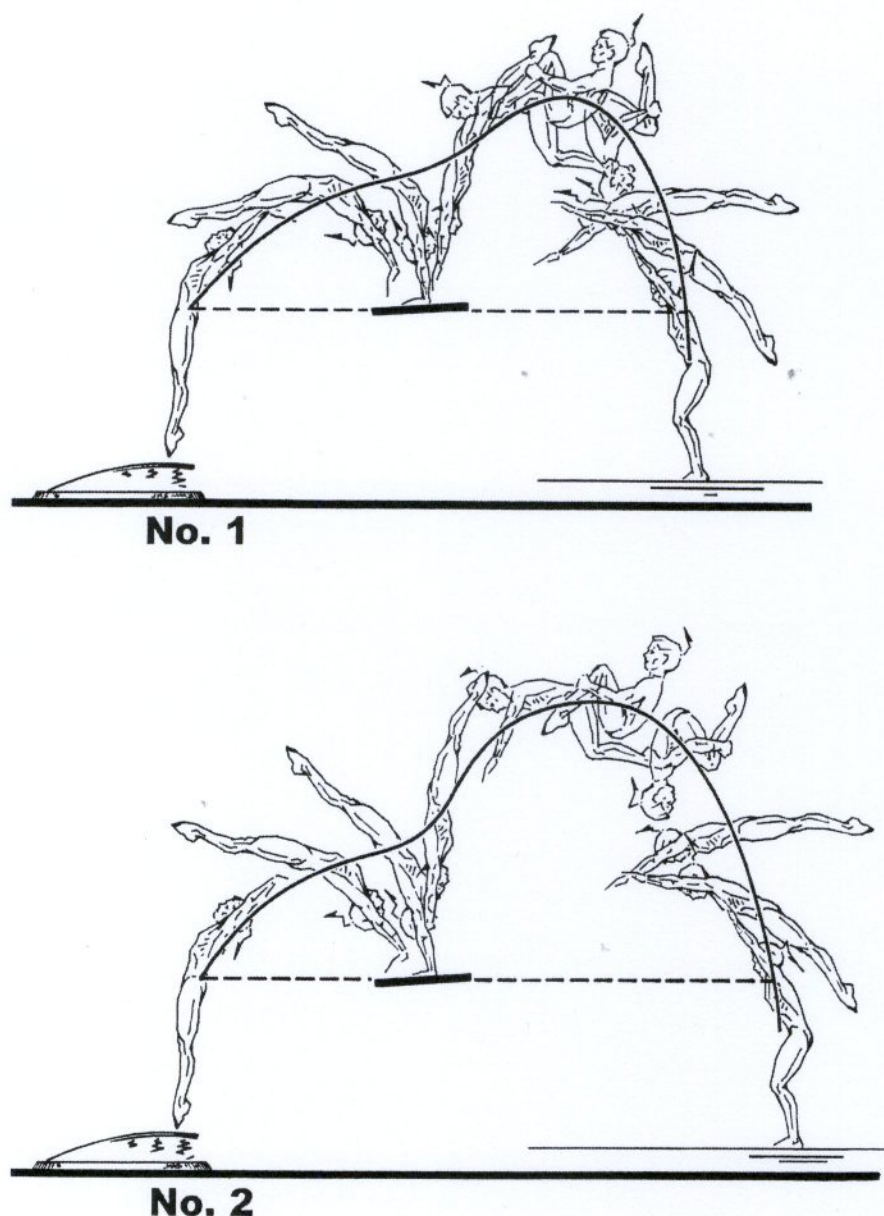


Figure 2.1. A comparison of external amplitude achieved in the postflight phase of a Yurchenko Vault: (1) less external amplitude; and (2) more external amplitude.

Obviously, to attain this additional external amplitude, the gymnast must coordinate each phase of the vault using proper technique. *However, the hidden component allowing the gymnast to take full advantage of technique is her internal power.* A very fast approach and Round-Off onto the board, an instantaneous take-off, and a most powerful repulsion from the vault table are the factors generating maximum external amplitude.

Note *the movement objective of the given skill dictates the desired direction of external amplitude.* Although the objective of all vaults centers on attaining maximum amounts of both horizontal and vertical amplitude in postflight, *many other gymnastics skills are characterized by external amplitude in primarily one direction.* The Backward Handspring–Tucked Backward Somersault in figure 2.2 illustrates the point. Because a large amount of horizontal amplitude is desirable in the handspring, the observed movement pattern should be long and flat relative to the ground. In the somersault, however, the reverse is true, as great vertical amplitude or “lift” from the ground is desirable. Hence, *the desired direction of external amplitude depends on an accurate understanding of the skill’s objective.*

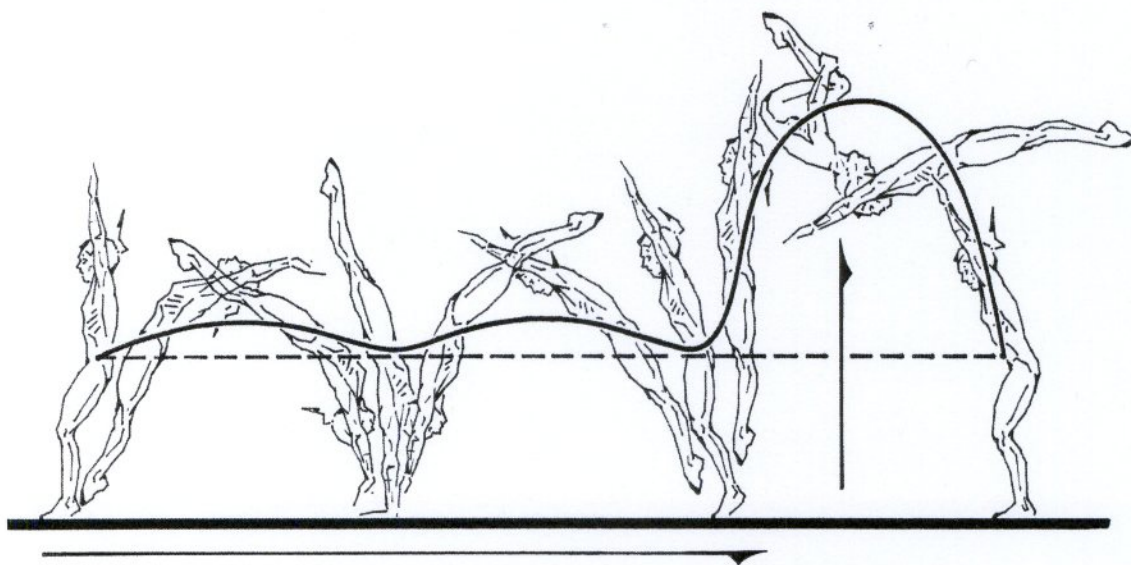


Figure 2.2. Emphasis of horizontal amplitude in the Backward Handspring phase and vertical amplitude in the Backward Somersault phase.

B. Internal Amplitude

Internal amplitude refers to the range of motion through which one or more body segments move relative to each another (joint range). Figure 2.3 depicts two performers executing the step-out phase of a Forward Walkover. The increased ranges of motion in the shoulders, back, and hips of the second performer

illustrate the employment of greater internal amplitude. In addition to its aesthetic appeal, this fuller use of the appropriate joint ranges of motion serves an important function—because the lead foot can be placed closer to the support hands, the weight transfer from hands to feet will not only be easier but also significantly smoother.

The aesthetic and functional values of maximum internal amplitude apply to numerous skills, including Backward Walkovers, Piked Somersaults, and most cartwheels, as well as straddles, Stalders, and stoop-ins on the uneven bars.

Just as power is the hidden component underlying external amplitude, joint flexibility is the key factor in maximizing internal amplitude.

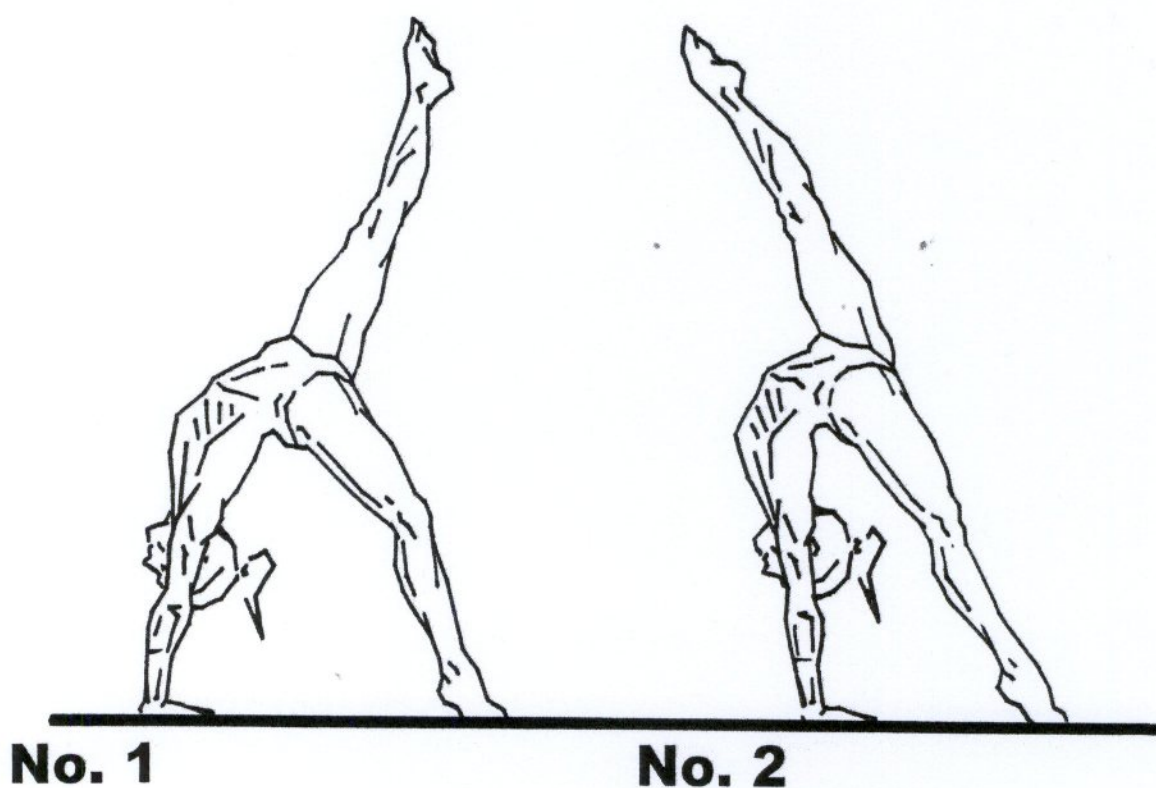


Figure 2.3. A comparison of internal amplitude achieved in the step-out phase of a Forward Walkover: (1) less internal amplitude; and (2) more internal amplitude.

Although many gymnasts find it difficult to achieve full joint ranges of motion (not to mention muscular control of these numerous ranges), the fact remains that, *without sufficient flexibility in all the major joints, the internal amplitude component of every movement pattern will suffer*. Furthermore, the degree to which the gymnast can achieve muscular control of total body shape is a core variable accounting for critical differences in performance quality.

Many gymnastics skills are characterized by a close interaction between *internal and external amplitude*. To see this relationship, compare the techniques shown in figure 2.4 for a Forward Head Kip. Performer 1 displays limited internal amplitude, as the maximum potential range of motion at the hips is not fully used. Because the distance through which she can accelerate her legs through hip-joint extension is restricted, the actual kip action is less than it could be. Limited internal amplitude reduces the potential to realize maximum external amplitude.

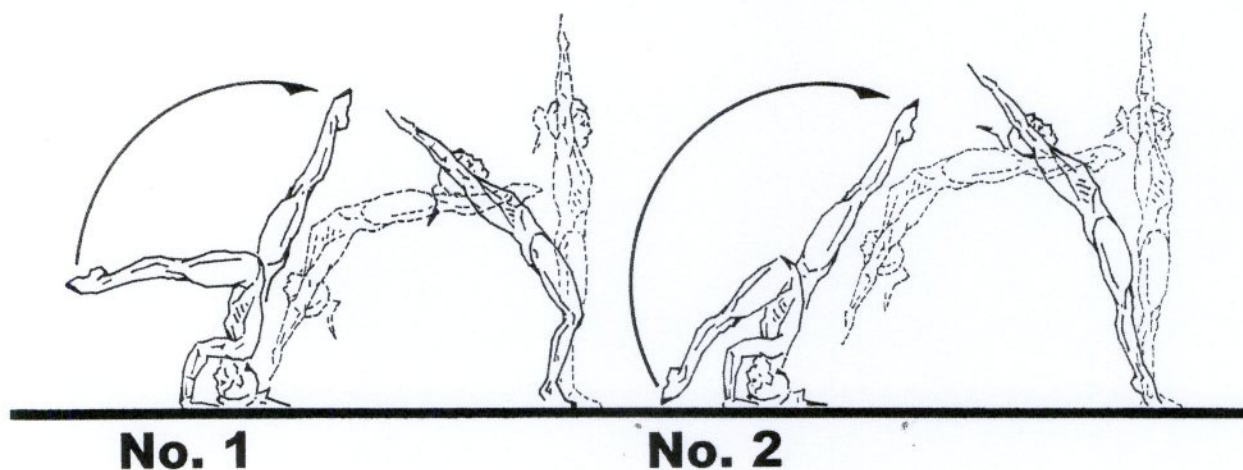


Figure 2.4. Comparative internal/external-amplitude techniques in executing a Forward Head Kip: (1) less amplitude = poor technique; and (2) more amplitude = good technique.

Performer 2, however, uses the fullest appropriate hip-joint range in setting up for the kip phase. *This increased distance through which force can be applied increases the potential for a more vigorous and effective kip action.* Because maximum internal amplitude is employed, the opportunity to realize maximum external amplitude is readily apparent. *To appreciate the effect of the Amplitude Principle, compare the performers' body shapes at ground contact.*

Attaining maximum amplitude is of prime importance in all gymnastics skills. The resulting movement patterns will appear "larger than life," be more aesthetically pleasing, and have a sound functional basis. Only look to any championship performance to see this principle holds true time and time again.

2. **Segmentation Principle:** as skill proficiency increases, the number of body segments used in its execution decreases.

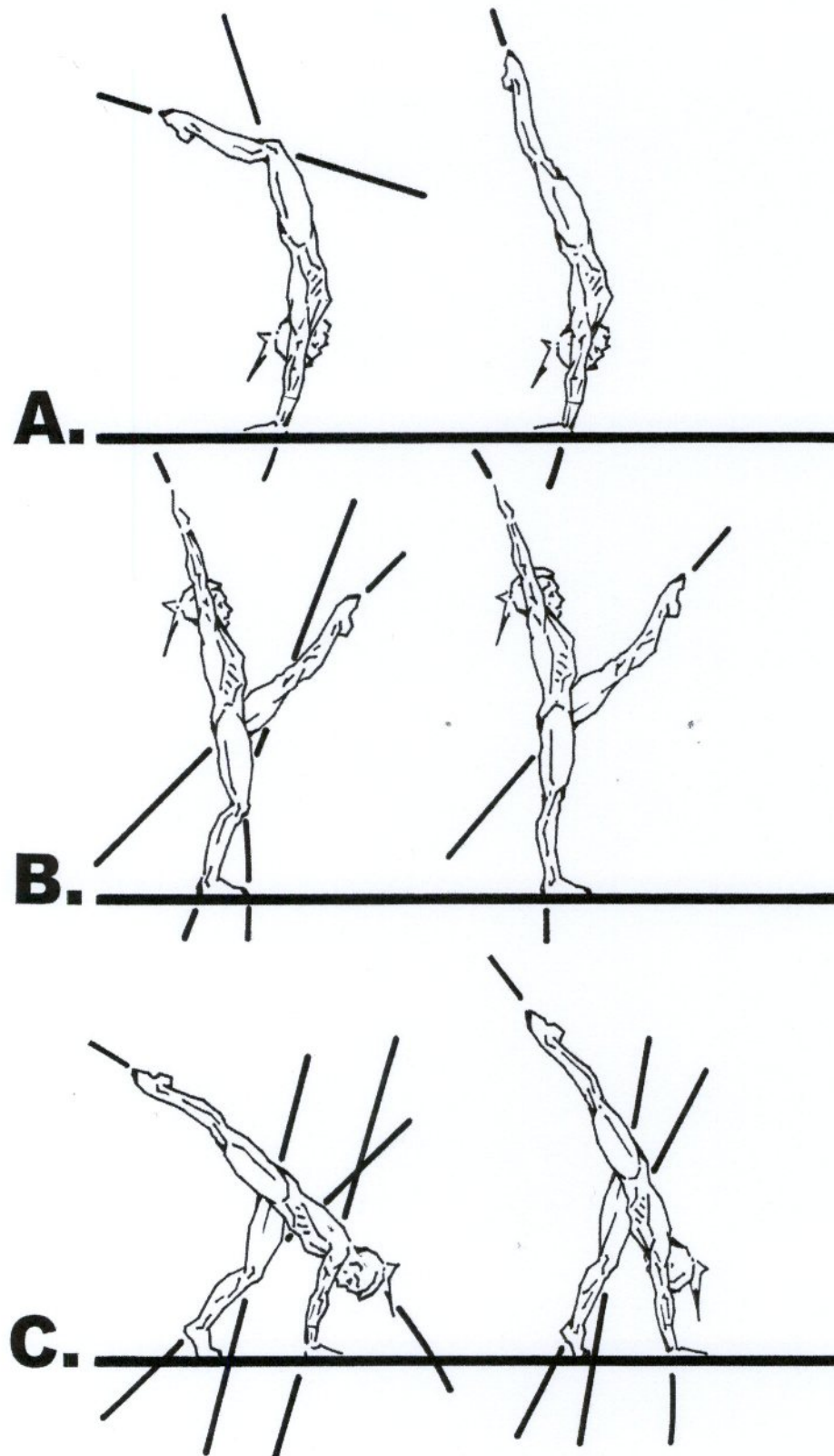


Figure 2.6. Examples of straight-line and curved-line segmentation: (A) Backward Handspring = 2 segments reduced to 1; (B) Standing Leg-Lift = 3 segments reduced to 2; and (C) Forward Handspring = 4 segments reduced to 3.

In the *hand-support phase of the Backward Handspring* in figure 2.6, notice the rather abrupt bend in the knees of the first gymnast, creating an unnecessary 2-segment shape (one straight, one curved). In addition to lessening the symmetry of the body, this untimely knee bend often interferes with the rhythm of the movement. Proper execution of *this dynamic tumbling skill requires the total body unit to be employed as a single curved shape*. Furthermore, a gymnast properly executing a Backward Handspring Series would employ a 1-segment body shape, vacillating from slightly arched to slightly hollowed, for each successive handspring.

A Standing Leg-Lift is essentially a 2-segment movement. Again, an unnecessary knee bend in the first gymnast's support leg creates an aesthetically questionable, nonfunctional third segment. Inadequate flexibility and muscular control of the hip joints commonly leads to this type of mechanical compensation. By reducing the number of segments to 2, the second gymnast demonstrates proper use of the Segmentation Principle. As a result, she possesses a more pleasing symmetry, stands taller, and has greater control of the skill.

The input phase of the Forward Handspring can be reduced to a 3-segment motion, but the exaggerated bend in the first gymnast's arm-trunk angle produces an unnecessary fourth segment. Because proper execution of the skill requires only momentary hand contact, this abrupt shoulder bend limits instantaneous repulsion (rebound) from the ground. By comparison, the second gymnast's slightly hollowed body shape puts her in a more advantageous position for a quick, powerful repulsion.

*The Segmentation Principle seeks
to create broad, expansive movement patterns.*

For virtually any gymnastics skill, the basic premise of reducing the number of segmental components to only the necessary few affords the performer a longer lever system with which to work. With fewer, longer links, the entire movement pattern becomes smoother in flow, more expansive, and mechanically more simplistic.

Motor-skill learning is a process rather than a product. It involves more than mere repetitive practice and the inherent capabilities of the performer. One must accurately understand the maximum execution potentials specific to each skill. In this way, gymnastics training is a continual process of motor-skill refinement.

Performing the skill is a product... Refining the performance is a process!

Continual motor-skill refinement brings forth championship performance. To demonstrate, figure 2.7 presents two techniques for a *Kick or Step-Up to Handstand*. Performer A's technique is commonly observed at the beginning level of learning.

Notice the rather large number of segmental components employed in this *1-3-5-3-1 system*. Nevertheless, the final product—performance of the skill—is achieved. At this level, using numerous segments to realize success is usually necessary. However:

The key to excellence is never-ending refinement of the performance!

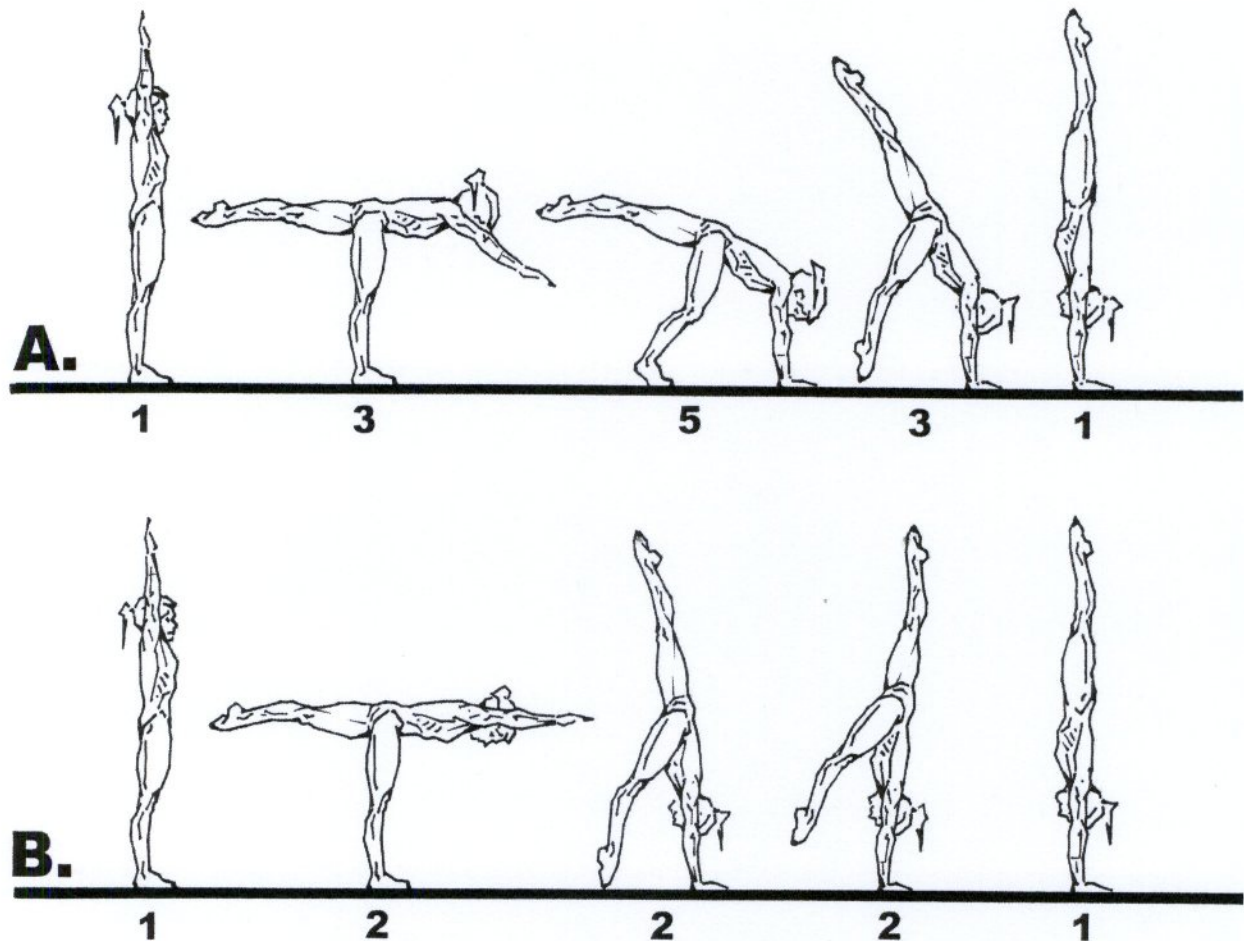


Figure 2.7. Comparative segmentation techniques in executing a Kick or Step-Up to Handstand: (A) 1-3-5-3-1 system; and (B) 1-2-2-2-1 system.

Proper application of the Segmentation Principle allows the performer to understand precisely how to refine the movement. Notice performer B decreases the number of segments to the critical few. Obviously, such a refinement requires greater muscular control as well as exceptional flexibility, particularly in the hips. The net effects of this *1-2-2-2-1 system* are a longer, smoother-flowing body line, maximum internal amplitude, and greater consistency of the movement pattern.

It is important to point out that *as the number of segmental components employed in executing any skill decreases, the technical and physical demands placed on the body correspondingly increase*. Included among these demands are greater total body flexibility, strength, and muscular power. The implication here is:

Difficulty levels should be conceived in terms of quality or degree of skill execution, rather than degree of skill complexity.

3. **Closure Principle:** as skill proficiency increases, use of the maximum tolerance limits of closure also increases.

Closure is the degree to which a performer alters body shape in executing a skill. The Closure Principle implies that *in the broad category of skills characterized by very obvious or extreme changes in body shape, such changes should occur as fully and completely as possible*. At the other end of the continuum, *another broad category of skills calls for unobvious, scarcely discernible body-shape changes, which should be as slight and discreet as possible*. To apply the Closure Principle effectively, both coach and gymnast must clearly understand the nature and objective inherent in the ideal model of the given skill.

The ideal model of *a basic Forward Handspring Vault*, for example, *is in the skills category calling for very slight, unobvious changes in body shape*. To demonstrate, figure 2.8 illustrates techniques for achieving proper body shape at the start of this vault. Notice performer A uses both the take-off phase and almost the entire pre-flight phase to assume a near-fully extended, yet slightly hollowed, shape—which should have been initially assumed upon becoming airborne. Close examination reveals the reason for this predicament: because the feet contact the board for less than a fraction of a second, there is not sufficient time for the compressed shape to be fully extended during take-off alone. This sorely compromises the take-off's net effectiveness—and worse, the performer has no choice but to exhaust much of her pre-flight trajectory in attempting a body shape that should have been achieved at take-off.

Perfect flight is being there!
—Richard Bach

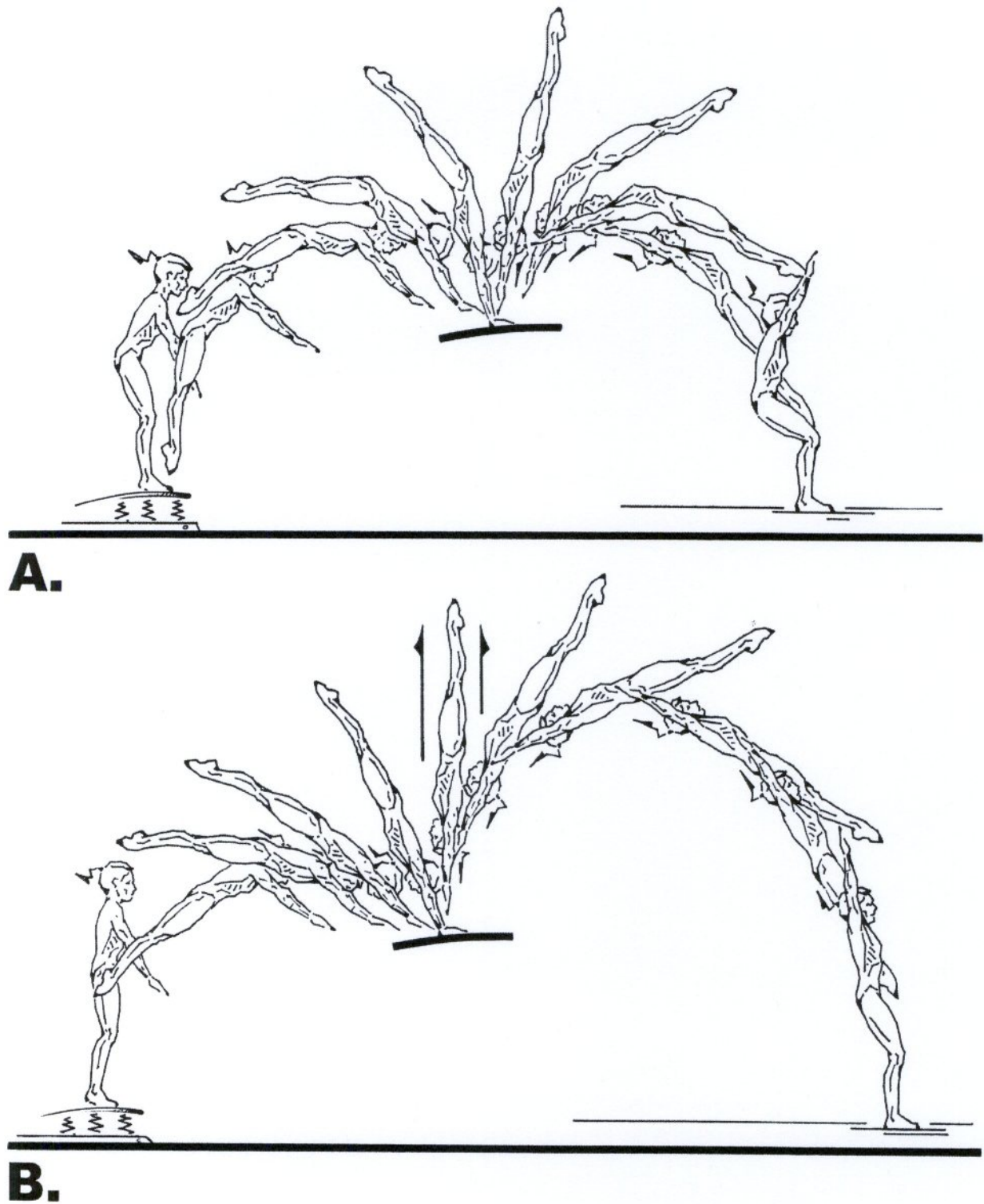


Figure 2.8. Comparative body-shaping techniques in executing a Forward Handspring Vault: (A) poor closure; and (B) good closure.

The experienced gymnast knows *proper take-off mechanics are characterized by a body shape that already most closely approximates the ultimately desired, slightly hollowed total body shape (B)*. The implication is for the performer to stand as tall and elongated as possible at take-off, so the shape changes from take-off to the initial aspect of pre-flight are as instantaneous and scarcely discernible as possible. Once the slightly hollowed shape is achieved, it should be steadfastly maintained throughout the remainder of the pre-flight phase. Only during the repulsion (hand contact) does one observe a vigorous, instantaneous shape change from slightly hollowed to fully extended. Vigorous repulsion off the vault table maximizes postflight amplitude. Notice performer B rises vertically off the table and maintains the fully extended shape throughout the postflight phase. Use of the Closure Principle maximizes the aesthetic and mechanical potentials for vault take-offs as well as for the wide range of other gymnastics skills entailing highly unobvious body-shape changes.

Skills that involve tucking, piking, straddling, stooping, and so forth are typical movement patterns at the other end of the continuum, characterized by large, highly obvious body-shape changes. *An example of maximum closure is changing from an elongated, extended body shape to one which is fully closed or compressed (or vice versa) at a precise moment.* To visualize this concept, consider the Handspring Forward Somersault Vault depicted in figure 2.9.

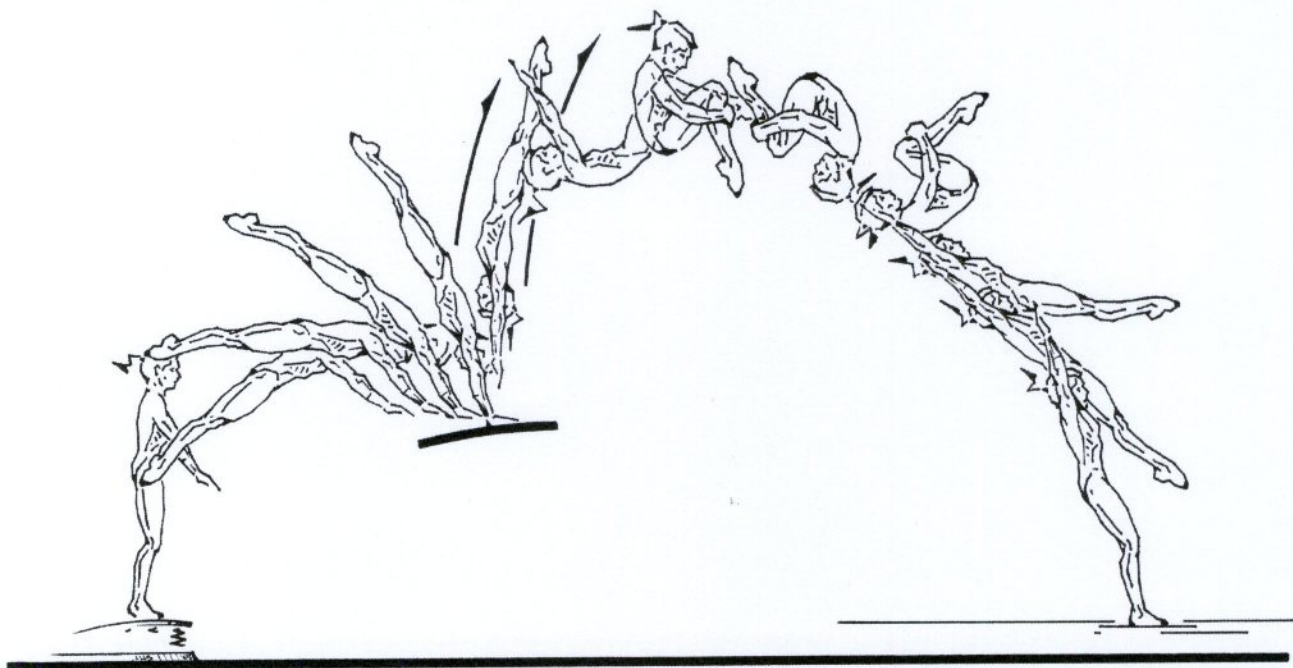


Figure 2.9. Maximizing closure in executing a Handspring Forward Somersault Vault.

Although the movement patterns for this skill's take-off and pre-flight phases are mostly identical to those in the Forward Handspring Vault, differences do exist—more in terms of degree than in kind. By minimizing the distance from board to vault table and employing a more vertical body position at board impact, the performer can generate a greater quantity of forward rotary motion through a comparatively lower (flatter), shorter pre-flight trajectory. This sets the stage to maximize both external amplitude and forward rotary motion for the impending somersault.

Precise timing of the required body-shape changes is fundamental for correct execution. For example, the required highly obvious changes are not employed until after the performer, as a direct result of repulsion, begins to rise from the vault table. In other words, the take-off, pre-flight, and repulsion phases, collectively, involve highly unobvious shape changes from slightly hollowed to slightly arched. *Not until lift-off from the table (ascent phase of the postflight trajectory) does the performer instantaneously initiate and complete the tucked shape.* That quick, seemingly unexpected change from elongated to fully compressed (as well as the return to full elongation prior to touch-down) forms the basis for maximizing the Closure Principle.

By the nature of its movement pattern, the Handspring Forward Somersault Vault is in the skills category characterized by extreme, highly obvious changes in body shape. The Closure Principle implies that such changes must be appropriately timed and should occur as rapidly, fully, and completely as mechanically possible.

From a judging perspective, the "litmus test" verifying correct technical execution is the observed effect of the repulsion. If sufficient rotary motion has been achieved, the instantaneous tuck action results in *the chest rising to the knees rather than the knees folding downward to the chest.* Done correctly, the forward-somersault action occurs as the total body is rising upward, over the top of the trajectory.

The degree of body-shape change employed in the performance of a skill, illustrated by the Closure Continuum in table 2.1, is an excellent measure for evaluating a gymnast's specific level of execution. During initial learning and performance, the shape changes observed in the vast majority of gymnastics skills are neither highly obvious nor highly unobvious in degree—rather, they cluster in the "average" range. Noticeable differences in movement shapes are therefore often difficult or impossible to ascertain. This is normal to the learning process.

With appropriate training habits directed toward achieving optimum technical execution, movement patterns become further and further refined. *As a result of this refinement process, the degree of body-shape change becomes either more or less*

obvious until the maximum potential level of each skill is finally reached. Full use of the Closure Principle is part of an essential framework for successful technical execution of virtually every gymnastics skill.

THE CLOSURE CONTINUUM

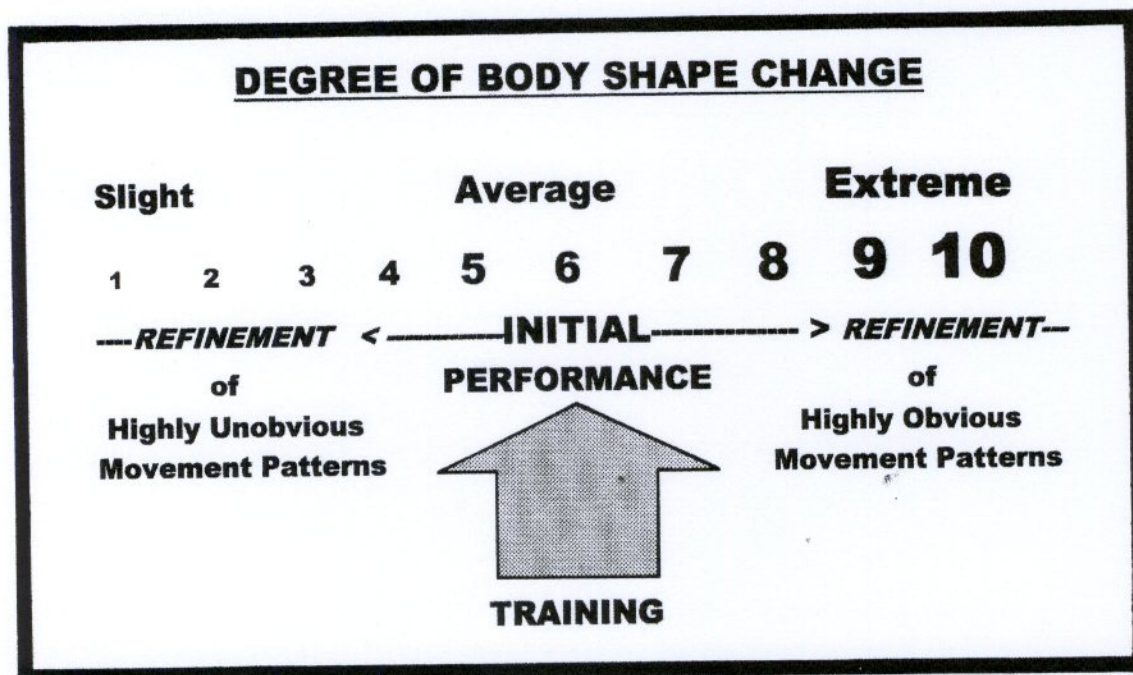


Table 2.1. The Closure Continuum: a range of body-shape change from highly unobvious to highly obvious.

4. **Peaking Principle:** as skill proficiency increases, the timing accuracy of the movement sequence correspondingly increases.

The term "peaking" can be defined as a technique for employing timing accuracy to reach the maximum execution tolerance limits of a skill. This concept addresses *when* to initiate, execute, and complete a given movement component to optimize technical execution. For a demonstration of peaking, compare the techniques shown in figure 2.10 for a basic Handstand Forward Roll to Stand.

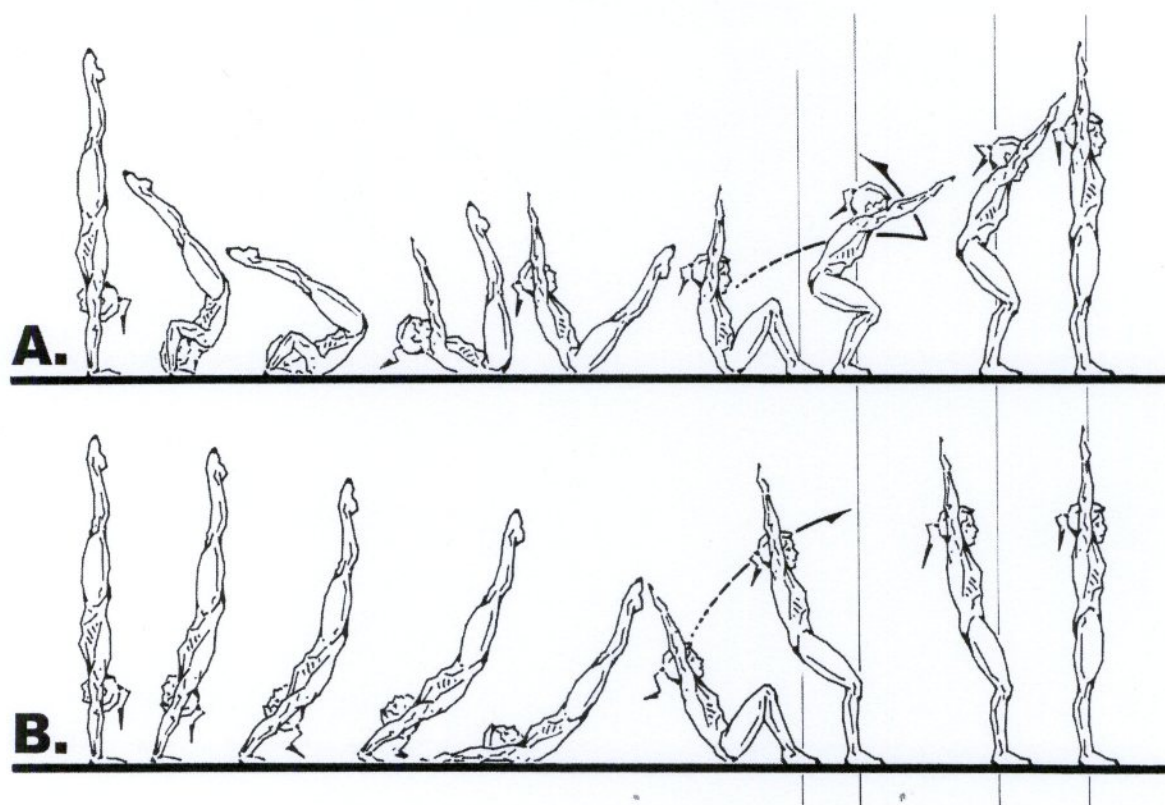


Figure 2.10. Comparative movement-timing techniques in executing a Handstand Forward Roll to Stand: (A) poor peaking; and (B) good peaking.

Performer A's poor roll technique out of the handstand significantly reduces the horizontal amplitude of the movement. Lacking sufficient forward-rolling motion, the performer has no choice but to wait until her mass is positioned directly over her feet (final base of support) before standing. *Notice that this inappropriate timing results in the arms, head, and trunk moving "backward" in the final stand-up phase of the "forward" roll.*

Performer B, however, assumes a rather extended body shape in the roll-out phase. This maximizing of horizontal amplitude during the descending roll from the handstand provides the necessary forward momentum to initiate and complete the entire stand-up phase without any body segments transcending the vertical. *Precise timing of the movement allows the performer an opportunity to "swing up to" a stand, rather than "rolling through" a tucked balanced position and then standing.* Simply put:

All body parts should move in the intended direction of motion!

The same movement objective exists for peaking virtually all swing-oriented skills in apparatus work. Observe the two techniques in figure 2.11 for a Backward

Rather than circling the bar and then kipping up to a handstand, performer B uses a large amount of backward circular swing to complete the entire hip circle, thus *arriving at the desired position without any body parts prematurely transcending the vertical*. Notice all the segments line up with one another and the upper vertical line at the exact same time. *Swinging up to, rather than through, the vertical* not only eliminates the use of compensatory techniques for handstand arrival, but more importantly *affords the performer the additional time so critical for optimum execution of any sequentially related skill*.

Most gymnastics enthusiasts have some understanding of how to speed and slow rotation while in the air. The very first somersault attempt, for example, makes an aspiring gymnast well aware that tucked (compressed) body shapes rotate more easily and quickly than extended (elongated) shapes. Although very important, this level of understanding is only sufficient during the initial stages of learning—it tells the gymnast precious little about how to maximize or peak the skill's rotational aspects.

Consider the Tucked Backward Somersault comparison in figure 2.12. Assume both performers employ the same approach in the preparatory phase, i.e., a Round-Off into a Backward Handspring. Although a compressed body shape (shortened radius of rotation) ensures the performer can rotate more easily (increased angular velocity) and therefore complete the somersault, *it is the actual the timing, quickness, and completeness of the body-shape change that determine the effectiveness of the application of the Peaking Principle*.

Notice performer 1 never achieves sufficient body extension at take-off, sorely compromising the effectiveness of the take-off as well as the timing and potential range of body-shape change (extended to compressed) in the somersault. Her tuck action is also comparatively slow, occurring throughout much of the ascent. This sluggish, incomplete tuck produces little appreciable change in rotation rate, and the rotation is rather evenly distributed over the trajectory. As a result, the rotational component appears flat, lacks crispness, and is neither exacting nor accentuated.

Although it must be emphasized that rotation actually occurs continuously throughout the airborne phase of any somersault, proper application of the Peaking Principle renders the illusion of initiating and completing the entire somersault rotation during the apex of the skill!

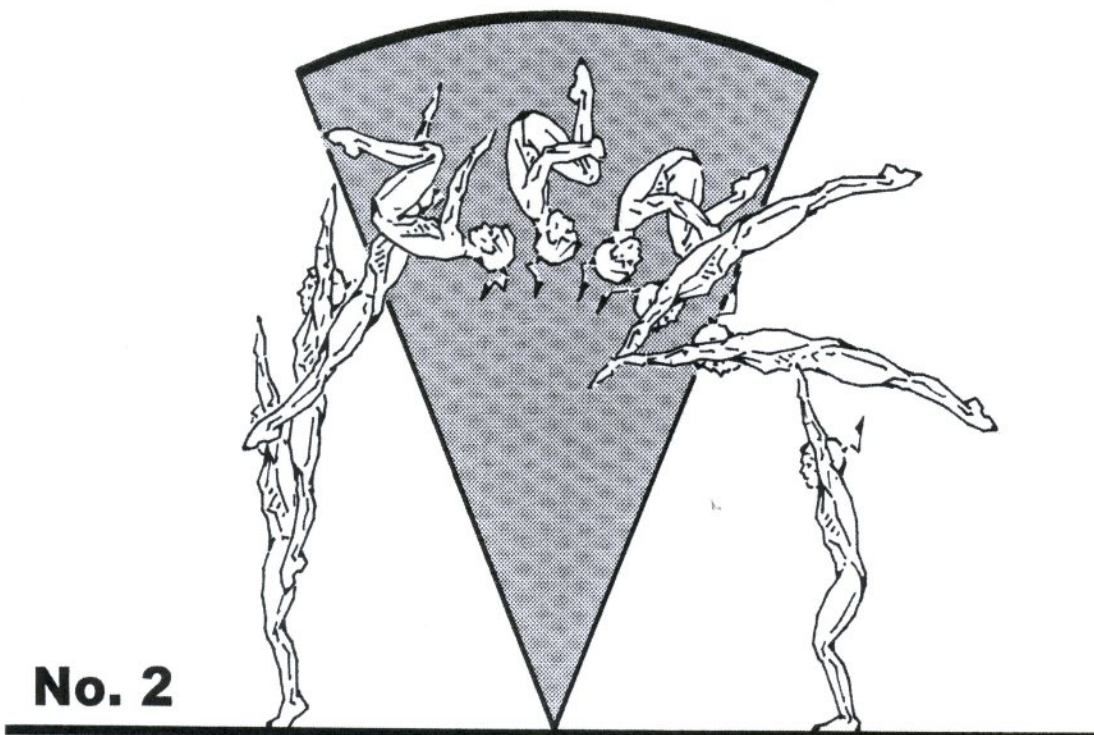
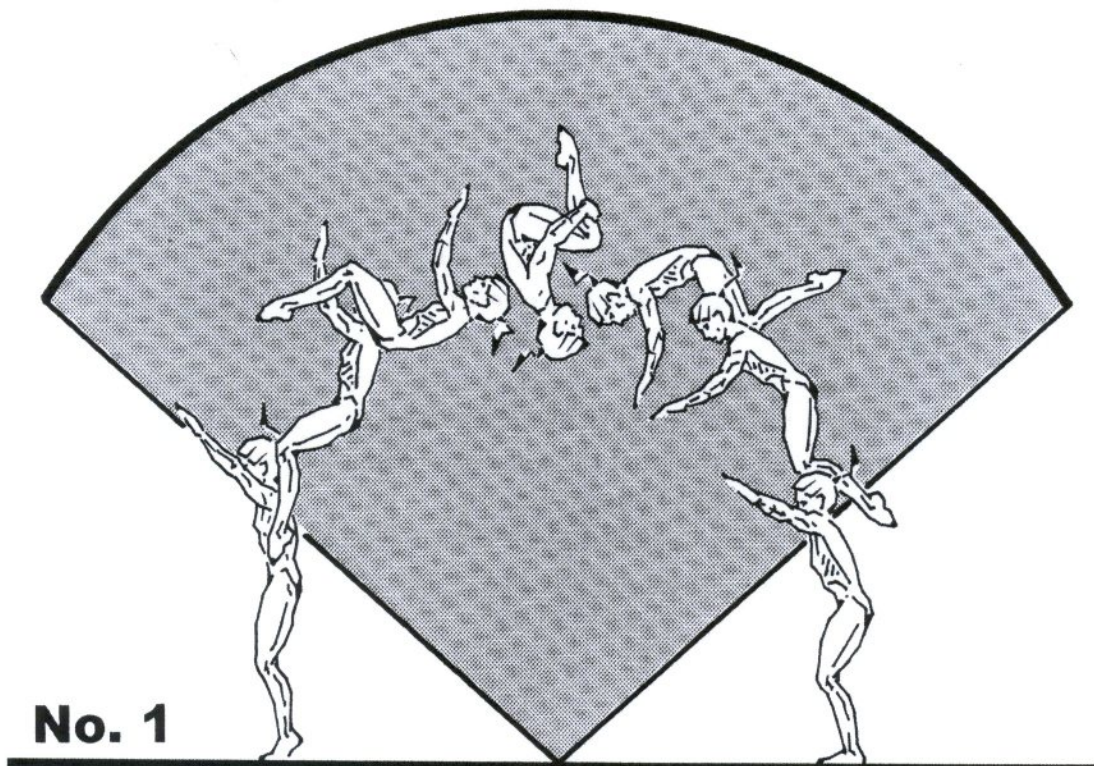


Figure 2.12. Comparative movement-timing techniques in executing a Tucked Backward Somersault: (1) poor peaking; and (2) good peaking.

Because performer 2 assumes a fully extended body shape (larger radius of rotation) during major portions of both the ascent and descent phases, little backward rotation (decreased angular velocity) is apparent at these times. Yet when approaching the apex of the skill, her instantaneous change to a fully tucked shape greatly increases her rotation speed. This timely shortening of the body's rotation radius causes a majority of the somersault to occur at the peak of the skill rather than being spread more equally throughout the trajectory. *In terms of further refinement, the ultimate objective is to squeeze the greatest percentage of the rotation into the smallest piece of the pie (apex phase)! Keep in mind:*

*It's not simply a rotating somersault that intrigues the judge's eye—
rather, it's the rapid change in its rate of rotation!*

Another way to describe the underlying mechanics of peaking can be found by *comparing the performer's vertical velocity with her rotational velocity at key points in the airborne phase of the somersault*. As depicted in the second example, maximum application of the Peaking Principle requires adherence to the following relationships:

- At initial take-off, when vertical velocity is very great, rotational velocity should be very small (fully extended shape);
- Approaching the trajectory's apex, when vertical velocity is very small, rotational velocity should be very great (fully compressed shape); and
- Approaching the landing phase, when vertical velocity is again very great, rotational velocity should again be very small (fully extended shape).

Maximizing the inverse relationship between vertical and rotational velocity determines how effectively the Peaking Principle has been employed!

5. **Diversification Principle:** a gymnastics routine of quality is characterized by the diversification of its parts.

A justification for what is more aesthetically pleasing can be found in the broad concept of *diversification—essentially, the degree to which the gymnast can achieve different body shapes, at different places and tempos, while maintaining correct sequential patterns in the routine*. The basic idea is for the gymnast to demonstrate the widest range of movement patterns and shapes over as much of the performing area/apparatus as possible. Diversification does not imply selecting elements based simply on the International Federation of Gymnastics (FIG) Code of Points. Rather, *routine construction should be gymnast-specific, based on selecting skills that best reflect her unique capabilities in order to display the widest variety of movement patterns*.

Who among us can deny that the observer's eye is most intrigued by a continually changing and/or evolving medium of movement—one that is not totally predictable; one that displays the unexpected, that surprisingly evolves; one that reveals itself in the prism of shapes, colors, and forms seen through a kaleidoscope!

To take best advantage of the Diversification Principle, wise coaches, performers, and even judges do well to *consider carefully whether the components selected for the routine strike the most effective balance of the following factors:*

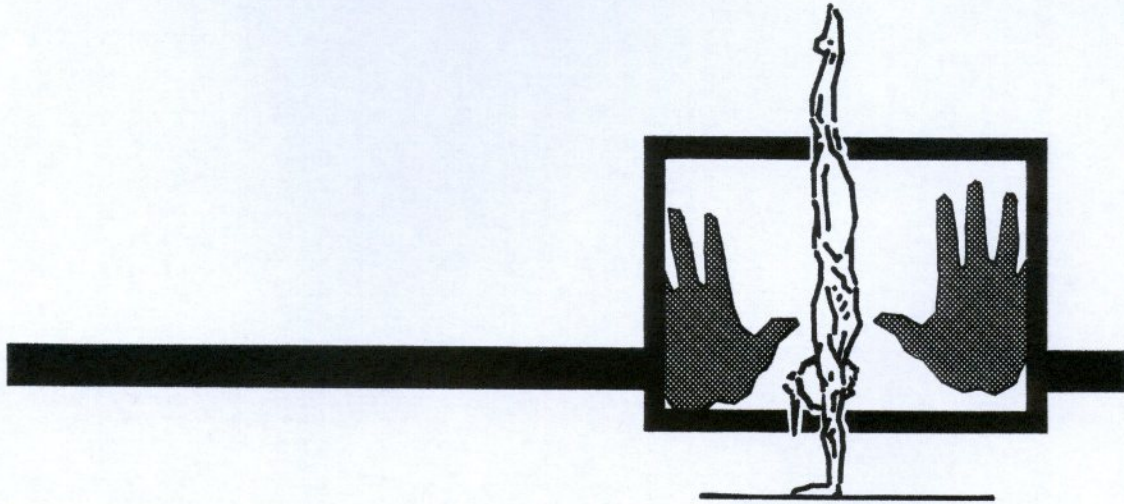
- **Speed** (fast, slow, sudden, sustained)
- **Force** (heavy, moderate, light)
- **Shape** (extended, hollowed, pucked, piked, tucked, straddled)
- **Flow** (free, constricted)
- **Rhythm** (even, uneven, patterned)
- **Direction** (forward, backward, upward, downward, sideward, diagonal)
- **Level** (high, medium, low)
- **Range** (broad, intermediate, narrow)
- **Transition** (natural sequential patterns into and out of each skill)

FUNDAMENTALS OF REFINED MOVEMENT

It is important to reemphasize that all gymnastic skills and routines can be described and evaluated in terms of these five basic movement-refining principles: *amplitude, segmentation, closure, peaking, and diversification*. The central purpose of these principles is to provide a conceptual framework for refining movement techniques, which can be universally applied to the broad spectrum of gymnastics skills. *The process of motor-skill refinement requires ongoing evaluation of the maximum execution potential for virtually every movement pattern.* Such an approach not only improves performance quality based on the skill models conceived at present, but it also ensures these models will continually evolve into ever more-ideal models! Keep in mind:

*The process of skill refinement can only be as effective
as one's conceptual model of the skill.*

CHAPTER THREE

THE COMMON DENOMINATOR—THE HANDSTAND

Always stand tall, because championship performance is in the balance!

The very symbol of the sport, the handstand, is indeed one of the most important fundamental elements in gymnastics. Although often viewed as an individual skill, the handstand shape is repeatedly seen in every event, every exercise, and virtually every movement sequence. In fact, *proper handstand technique serves as the basic foundation on which innumerable more advanced skills are built*. Because of its application at every level of skill technique, the handstand must be fully understood and mastered.

Traditionally, the handstand was perceived as a skill in which the gymnast merely assumed an inverted balance position. Little attention was given to proper alignment of body shape, much less to the handstand's inextricable relationship to correct execution of tumbling, vaulting, and virtually all long-hang swing skills. As shown in figure 3.1, the shape generally consisted of 2 segments, with the arms forming a straight line and the legs, trunk, and head forming a curved line—a shape steadfastly advocated by coaches and gymnasts alike for many years. Lifting the head and arching the back were not only in keeping with supposedly proper technique but were also considered key teaching points for balance control.

From a mechanical perspective, the arched body shape with its decreased arm-trunk angle can be at least partly justified, as this configuration remotely improves stability by positioning the body mass slightly closer to the ground. However, its use for enhancing stability applies more to inanimate objects than to living beings like gymnasts, who must actively check and countercheck the "sway" inherent in maintaining balance. Be aware:

It is not simply a question of achieving successful balance—rather, it is the way in which successful balance is achieved.

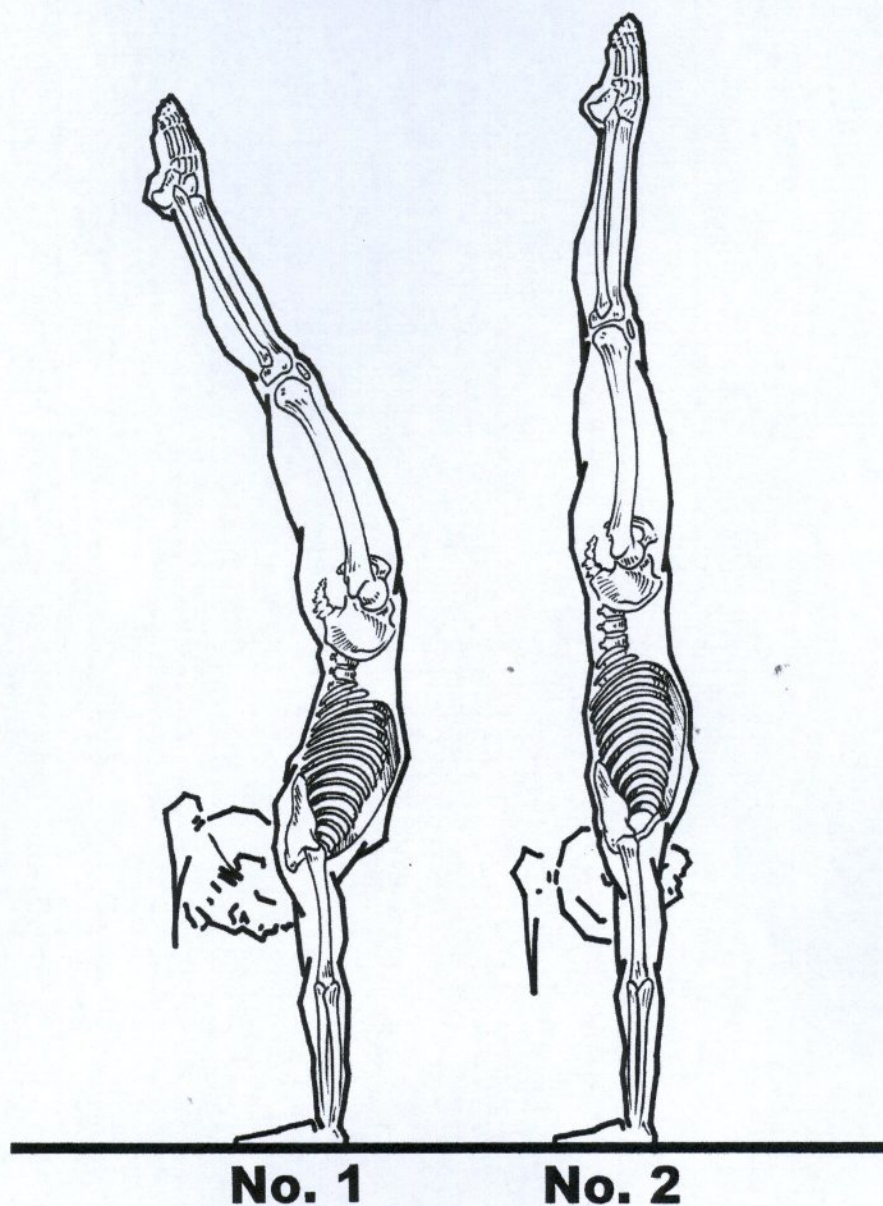


Figure 3.1. Comparative body-shaping techniques in executing a handstand: (1) arched shape = poor technique; and (2) straight-line shape = good technique.

Artistically speaking, it can be argued that the flow of a curved-line segment about a straight-line segment holds some appeal. This argument, however, fails to pinpoint the handstand's ultimate objective. Besides having aesthetic appeal, *proper technique requires that the prescribed body shape directly carry over to optimum technical execution in the broadest category of skills.* This realization inevitably leads to a search for a handstand shape that is truly the "common denominator" of gymnastics movement.

Furthermore, it should be noted *the arched body shape is actually a compensatory technique*. Due to inadequate shoulder flexibility, performer 1 is unable to prescribe a straight-line relationship between her arms and trunk. Consequently, she has no option other than arching her back to keep her mass directly over her hands (base of support).

Contrary to conventional thought, *this arched body shape is not the cause but rather the effect of the decreased shoulder-joint angle*. Because performer 2 possesses adequate shoulder flexibility, a fully opened shoulder angle can be achieved. To maintain balance in this scenario, the arched body shape must be realigned to form the desired straight-line relationship. This realization gives rise to an important coaching implication: *Whenever one observes a movement problem in a given skill, what one sees is actually the effect of the problem. The true cause of the problem can be found in the position or movement immediately preceding what one initially observed as the problem.*

Coach the cause, and effect will be your slave!

Performer 2 in figure 3.1 depicts an *ideal model for a technically correct handstand: the entire body is very stretched, very straight, and very tight*. In fact, an imaginary straight line can be drawn longitudinally through the body from hands to feet. The basic idea is to align all the body parts on top of each other so the performer's mass center is positioned precisely at the midline and directly over the hands. Although this straight-line shape appears rather simple and straightforward, its achievement requires a great deal of practice, with attention to proper alignment of each body part. But once the straight-line shape is mastered, considerably less effort is required to maintain the position.

THE HANDSTAND TRAINING TRIAD

Experience has shown that effective learning of a proper handstand is best achieved using a step-by-step approach. First and foremost, it is essential that the performer be physically able to position the total body unit in a straight-line relationship. This is often referred to as "body shaping," the posture of the position, so to speak (*Shape*). Second, it is imperative that the performer possess sufficient muscular control to hold and stabilize the body parts in the desired straight-line shape (*Tension*). The third and final step in the learning sequence requires placing this aligned, locked body shape "on-balance" (*Balance*).

*Practice attaining a properly aligned body shape first,
then provide appropriate tension to the shape,
and finally, work on learning to balance.*

1. Shape

An excellent, proven method for practicing the 1-segment handstand shape while not yet dealing with balancing is to hang from the high rail of the uneven bars, so the body can be fully stretched without the feet touching the ground, as shown in figure 3.2. While offering the opportunity to concentrate solely on correct shape, this *Bar-Hang Method* also uses the pull of gravity to help stretch and thereby guide the total body unit to the desired straight-line relationship. In addition, it requires many of the same muscles to align the body parts in the same way as required in the handstand.

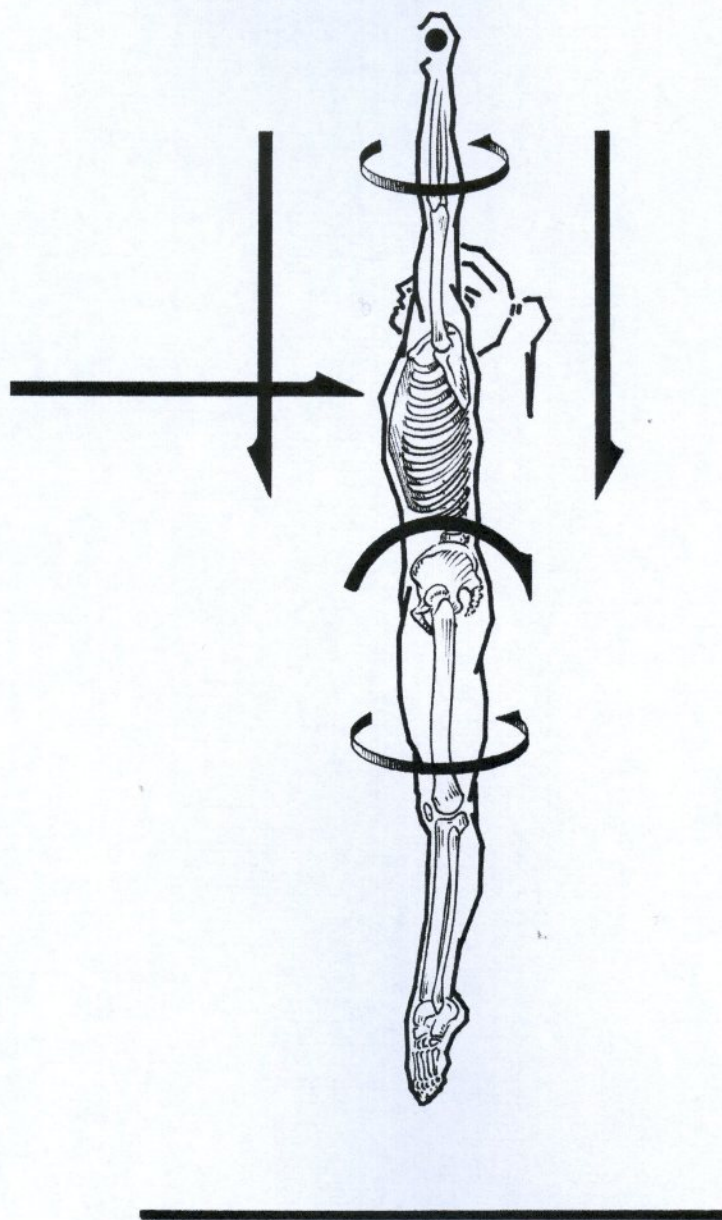


Figure 3.2. The Bar-Hang Method for achieving a straight-line handstand shape.

Although gymnasts generally find it intuitive to maintain straight arms, straight legs, and pointed toes, a close look at the Bar-Hang Method reveals certain key areas require particular attention in mastering the straight-line total-body relationship.

A. Straight-Line Arm-Trunk Angle

Many performers have difficulty positioning the arms completely and directly over the trunk, i.e., fully opening the shoulder joint. A common compensatory technique for inadequate shoulder flexibility is arching the low back, thereby destroying any possibility of a straight-line body shape. In addition to flexibility training for increased range of motion in the shoulders, *rotating the arms inward* (see arrow) *helps line up the arm segments in relation to the trunk*. Achieving a straight-line arm-trunk angle also helps align the head correctly between the arms.

B. Straight-Line Head-Trunk Angle

Another common tendency is to arch the head backward at the neck rather than keeping it in a neutral position between the arms. Again, such a compensatory technique serves only to break the desired straight-line relationship of the total body. Alternatively, *by slightly pivoting the head backward without arching the neck, a small upward tilt of the head can be achieved—allowing the performer to maintain visual contact in the area between the hands*.

C. Fully Elevated Shoulder Girdle

To attain a completely stretched position with the greatest distance possible between the hands and feet, it is necessary to fully “lift” or elevate the shoulder girdle. *Raising the shoulders as high as possible toward the ears* is accomplished by first relaxing fully in the shoulder girdle, to permit the force of gravity to pull the hanging body toward the ground; and then, actually pushing the body farther downward, as far as possible from the bar without actually letting go. Done properly, it feels and looks as if the head and neck “sink-in” between the shoulders, thereby positioning the body’s mass center as far as possible from its base of support. Comparing the examples in figure 3.3, observe in illustration B how *actively elevating the shoulder girdle provides this additional body stretch, a critical ingredient for maximum elongation in the handstand*.

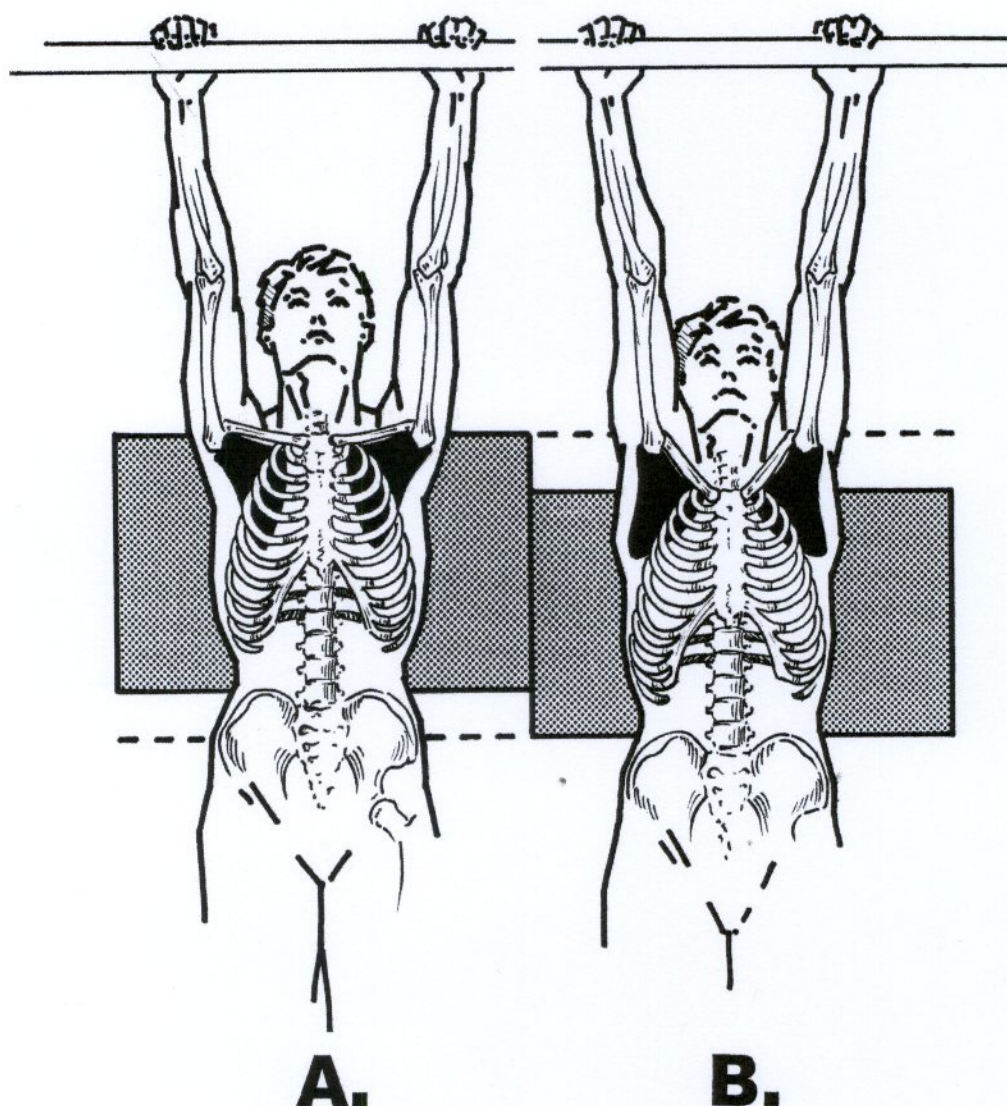


Figure 3.3. Comparative shoulder girdle positions in executing a handstand: (A) incomplete elevation = poor technique; and (B) complete elevation = good technique.

D. Properly Aligned Pelvic Girdle

Lumbar hyperextension, an exaggerated curvature often observed in the low back of many gymnasts, results from a postural misalignment called *anterior pelvic-girdle tilt*. To attain a straight-line relationship with the arms, head, and trunk, the pelvic girdle must be rotated backward (see arrow). Assuming the gymnast has adequate low-back flexibility, this realignment is accomplished by contracting the abdominal muscles so the lower half of the body lines up properly with the upper half. *Posterior pelvic-girdle rotation not only creates a stretched, straight posture but also helps stabilize the center of the body*, which is critical to optimum execution in virtually every advanced skill.

E. Straight-Line Hip-Joint Angle

Some athletes, including many aspiring gymnasts, find it difficult to achieve full 180° extension at the hips. In attempting a straight-line relationship of the legs with the trunk, they often compensate for inadequate hip flexibility by arching the low back (lumbar hyperextension), thereby creating the aesthetically questionable, mechanically inferior anterior pelvic-girdle tilt mentioned above.

In addition to training for increased flexibility specific to hip-joint extension, a wise performer knows *rotating the legs outward improves range of motion in hip extension*. This outward rotation about the longitudinal axes of the hip joints (see arrow) is accomplished while maintaining contact between the heels and balls of the feet (legs pressed firmly together).

*Mastery of correct body shape for the handstand is
a fundamental prerequisite to success at every level!*

2. Tension

Once the straight-line body shape can be readily assumed using the Bar-Hang Method, the next step is developing the muscular tension to maintain it. In the long-hang position, practice contracting the muscles on both the front and back of the body simultaneously. The idea is to *apply an equal level of muscular tension on both sides to retain the desired shape*. This equal, opposite *co-contraction* should be done in such a fashion that the total body acts like a single functional unit ("lock set").

While muscle co-contraction helps maintain the proper total-body relationship, outside forces inherent in the execution of gymnastics skills inevitably bow the straight-line shape. However, *the resulting bend should be slight in terms of degree and as perfectly regular as possible in terms of shape*. Typical examples include long-hang swing skills on the uneven bars as well as layout-somersault skills in tumbling and apparatus dismounts. Consequently, it is wise to simulate the bending effect using a progressive-resistive training format.

The Bar-Hang Method in figure 3.4 illustrates one of many specificity-training exercises for simulating the appropriate body shape under stress. *This technique embraces all the major muscles on the front and the back of the body*. Requiring the relevant muscle groups to work together in an aggregate fashion offers the additional advantage of teaching gymnasts how to coordinate muscle action properly, encompassing the total body unit.

As is quickly realized, the higher the performer is lifted toward the horizontal, the greater the tendency for the body shape to be distorted by the force of gravity. Consequently, as the performer approaches the horizontal, greater muscular force is

required to maintain the straight-line shape. Regardless of degree, *any observed bend should be spread uniformly through the major joints, i.e., shoulders, back, and hips.* Simply put, if the straight-line shape must bend—and bend it will—then:

Spread the curve evenly!

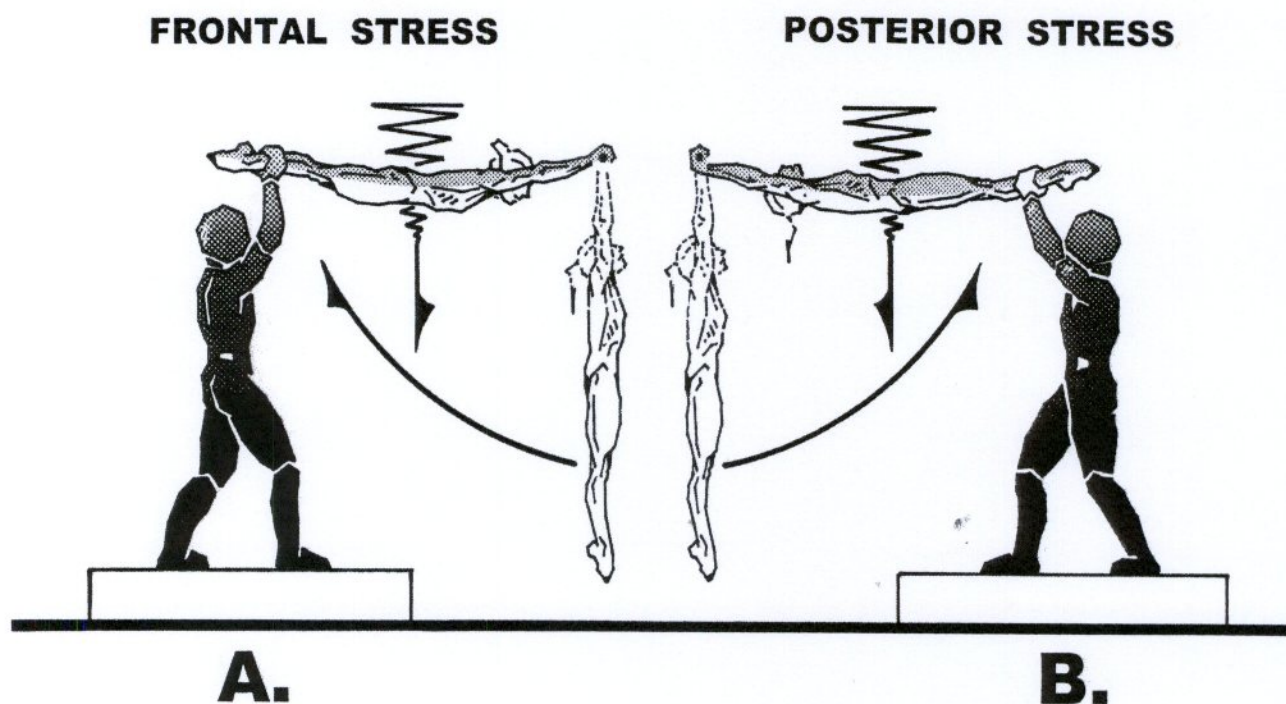


Figure 3.4. The Bar-Hang Method for achieving proper muscular tension in a handstand: (A) frontal muscular tension; and (B) posterior muscular tension.

Of equal importance, *the performer should not be raised to a height that causes a significant bend (failure) in the center of the body—only to a height that does not significantly distort the intended straight-line shape.* As aggregate muscle strength and muscle memory are achieved, the performer can be raised to progressively higher locations. The wise choice is to *start low in the beginning stages of training and progressively build up to regions of higher location.*

*Like an elastic pole, the total body unit should
bend uniformly when an external force is applied, then
return quickly to its straight-line shape absent the external force.*

The performer's ability to maintain a straight-line body shape while being held up at the 9 o'clock and 3 o'clock positions is one litmus test for elite-level readiness. This training technique can be quite rigorous and, as such, requires considerable attention over an extended period. *With sufficient practice, the observed uniform*

bend in the total body unit due to applied forces will become less, and the tendency for the body to return quickly to its original straight-line shape will become more.

3. Balance

Although correctly performing a handstand requires a great deal of practice, keep in mind that mastery of shape and tension makes the final phase—placing the body on-balance—much easier to learn. Once mastered, this triad collectively guarantees a consistency in execution and control the performer would not otherwise enjoy.

Figure 3.5 provides *an ideal model for maintaining correct body shape while proceeding from an upright standing position to a handstand-balance position*. Notice that, except for the support leg, the straight-line shape is preserved throughout the entire movement sequence. The flexing of the hip joint about the support leg is the only observable shape change. The performer starts with arms extended directly overhead (illustration 1) and proceeds through a front scale (2) to an inverted hand-support position (3). Because the hands are placed relatively close to the support foot, the body weight can be readily shifted onto and over the hands, so the leg can then be raised overhead (4). As the legs come together (5), forming a straight line with the body, the weight is centered directly between the hands. This handstand-balance position has *the exact same body shape as in the Bar-Hang Method—except, of course, upside-down*.

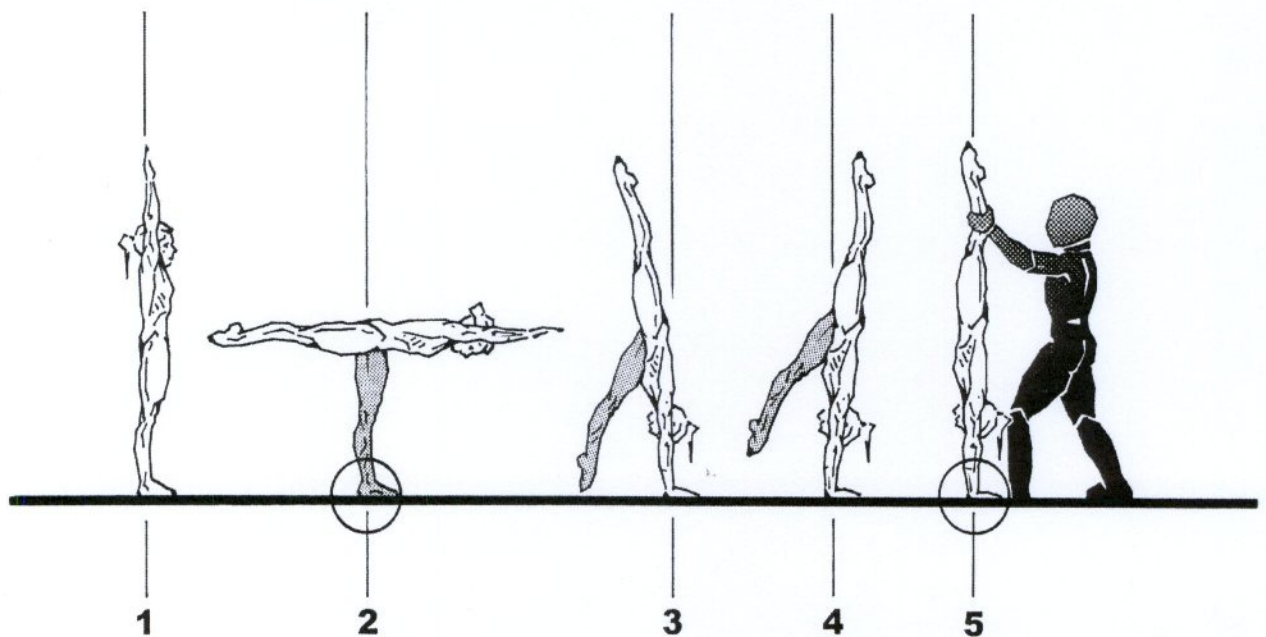


Figure 3.5. An ideal model for a Step-Up to Handstand.

Careful attention to maintaining a straight-line body shape while proceeding to the handstand-balance position not only helps provide more consistent balancing

but also carries over into many other gymnastics movements. Learning fundamental skills such as handsprings, walkovers, cartwheels, and Round-Offs will depend on the performer's ability to step-up (kick) properly to a correct handstand-balance position. So it makes sense to take the time and effort to master this technique in its entirety. Persistence and tedious attention to detail always pay high dividends.

It's not that I'm so smart, it's just that I stay with problems longer.
—Albert Einstein

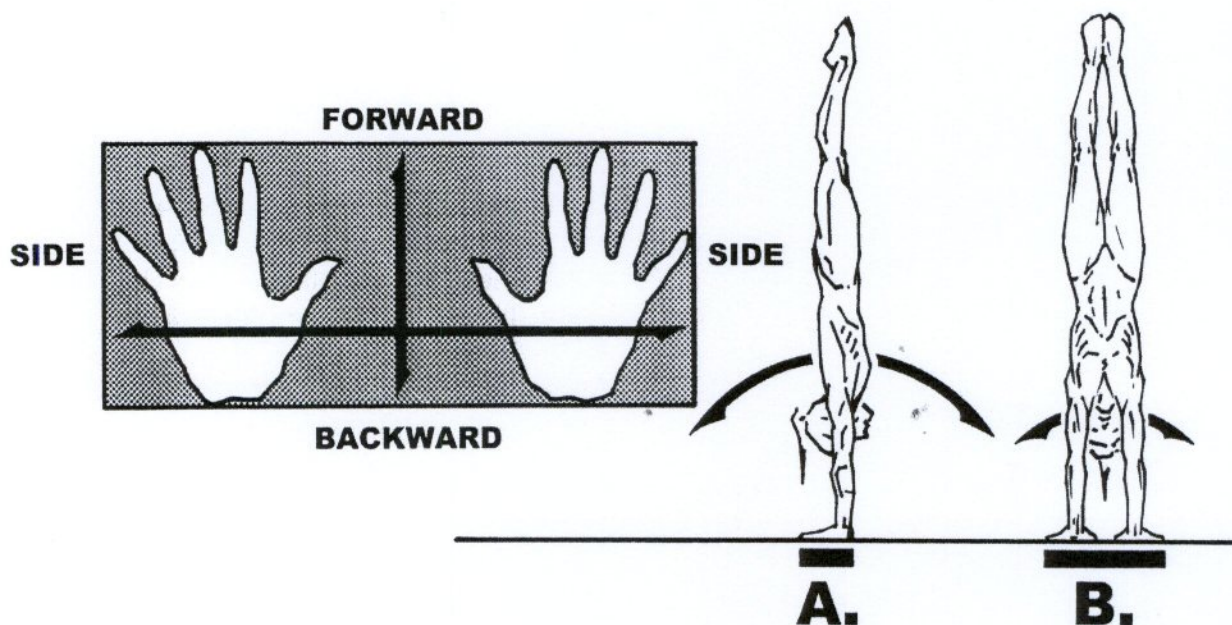


Figure 3.6. Proper hand placement in executing a handstand: (A) forward/backward balance is harder to maintain; and (B) side-to-side balance is easier to maintain.

*Balancing in a handstand is basically a matter of maintaining the effective weight of the body directly over and between the hands. Figure 3.6 depicts a top view of proper hand placement. Notice the fingers are spread apart, facing forward, and the hands are flat, about shoulder-width apart. This hand placement establishes a rectangular base of support. Because a rectangular base is wider side-to-side, the major challenge in balance control is forward/backward—there is usually little or no difficulty in side-to-side balance. Consequently, it is wise to *focus primary attention on learning to control even the slightest forward/backward body sway*. Keep in mind:*

The technique for balancing on one's hands is essentially the same as for balancing on one's feet!

Consider again illustration 2 in figure 3.5. *If the performer were to "hold" this front-scale position "on balance,"* what would be used to control and maintain the position of the body over the support foot? The first attempt reveals *the ankle joint of the support leg is the most important "control center" for upright balance.* The muscles about this ankle work constantly to check and countercheck minute body sways in maintaining balance over the foot. *Since inverted balancing requires that the hands serve as the base of support, then it must be the wrist joints that become the major "control centers" constantly working to maintain the inverted body on-balance!*

A. The Sixth Sense

Ability to balance depends on the close interaction of three sensory systems. The first component, the inner-ear *vestibular system*, provides continuous sensory feedback to the brain regarding gravity, including both straight and curved movement. The second, the *proprioceptive system*, detects gravity and joint position through pressure sensors in the muscles, tendons, and joints. The third, the *ocular system* (eyes), gives visual feedback specific to body position relative to the ground/apparatus and to movement through space. *These systems cooperate interdependently, using their strengths to the gymnast's advantage.*

Although the vestibular and proprioceptive systems respond automatically within a given set of physical constraints, the ocular system is free to select any number of visual targets. This is why it is so important for the gymnast, when learning or performing any maneuver, to employ her eyes actively in focusing on the proper target. *To maximize the proper conditions for learning to balance a handstand, the eyes should "zero-in" on a fixed point directly between the hands (base of support).* The visual feedback from focusing at this point further clarifies minute changes in body position. It's like having a sixth sense:

Feel the balance point with your eyes!

B. Counterbalancing versus On-Line Balancing

Figure 3.7 illustrates two common techniques for balancing a handstand. Example 1, *counterbalancing*, *requires the wrists, shoulders, back, and hips to control large body-sway motions.* Often used in the beginning stages of learning, this gross balancing technique is similar in mechanics to what a young child does when first learning to stand upright.

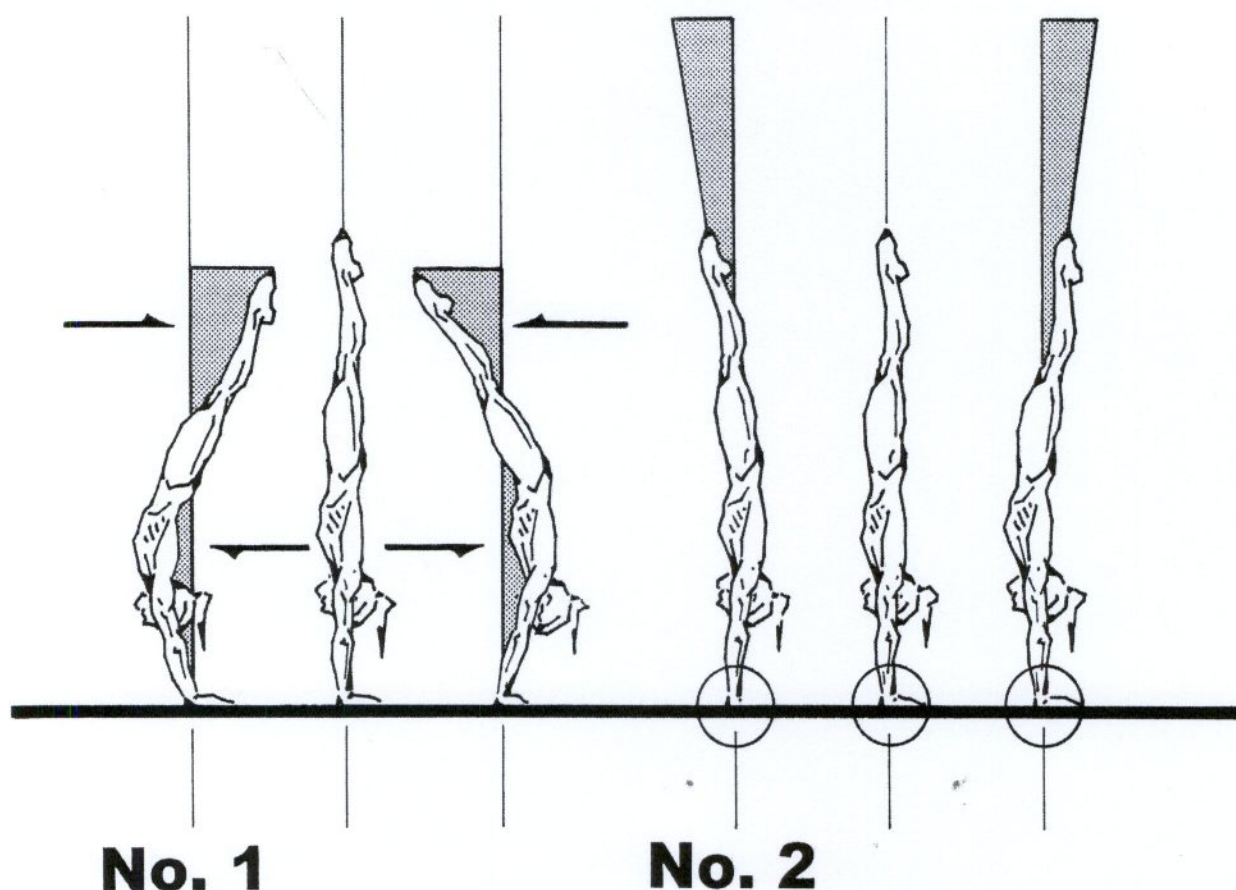


Figure 3.7. Comparison of two techniques used in balancing a handstand: (1) counterbalancing = less desirable; and (2) on-line balancing = more desirable.

However, as the gymnast gains greater command of the act of balancing, body-sway motions become less and less apparent. *The second and more desirable technique is called on-line balancing, and requires only the use of the wrists to control these small body-sway deviations.* Notice the total body unit remains locked in its straight-line shape while the wrists check and countercheck balance.

On-line balancing is the ultimate technique in handstand mastery.

C. Stability, Equilibrium, and Balance

All other things being equal, taller shapes have a higher center of mass than shorter shapes and thus are less stable. Normally, this would lead one to believe it is therefore more difficult to maintain equilibrium in a fully extended handstand shape than in a less fully extended shape. After all, *the lower a performer's center of mass is to its base of support, the greater its stability—however, when striving to balance in a handstand, this is not the case.*

Maintaining balance in a handstand requires more than merely placing the body onto a stable base of support. It also requires that the gymnast continually check and countercheck the minute sway motions inherent in the living body. By assuming the longest possible body shape (with its higher center of mass), the gymnast creates a maximum "moment of inertia." Due to its greater moment of inertia, this longer shape possesses a greater reluctance to fall off top-dead-center than a less-extended shape (with its smaller moment of inertia). As a result, *the longer and therefore slower-moving body shape affords the gymnast more time to feel and correct the realized swaying motions in the act of balancing.*

The broomstick comparison in figure 3.8 readily demonstrates *taller shapes are easier to balance than shorter shapes.* The first attempt at balancing these sticks reveals the longer one is significantly easier to control. This is because the longer stick (greater moment of inertia) falls off its balance point more slowly than the shorter one—consequently, *there is more time for the necessary corrections to keep the longer stick on-balance.* The same concept applies to balancing a handstand, for the same reasons. All other things being equal:

A longer body shape makes handstand balance easier to control.

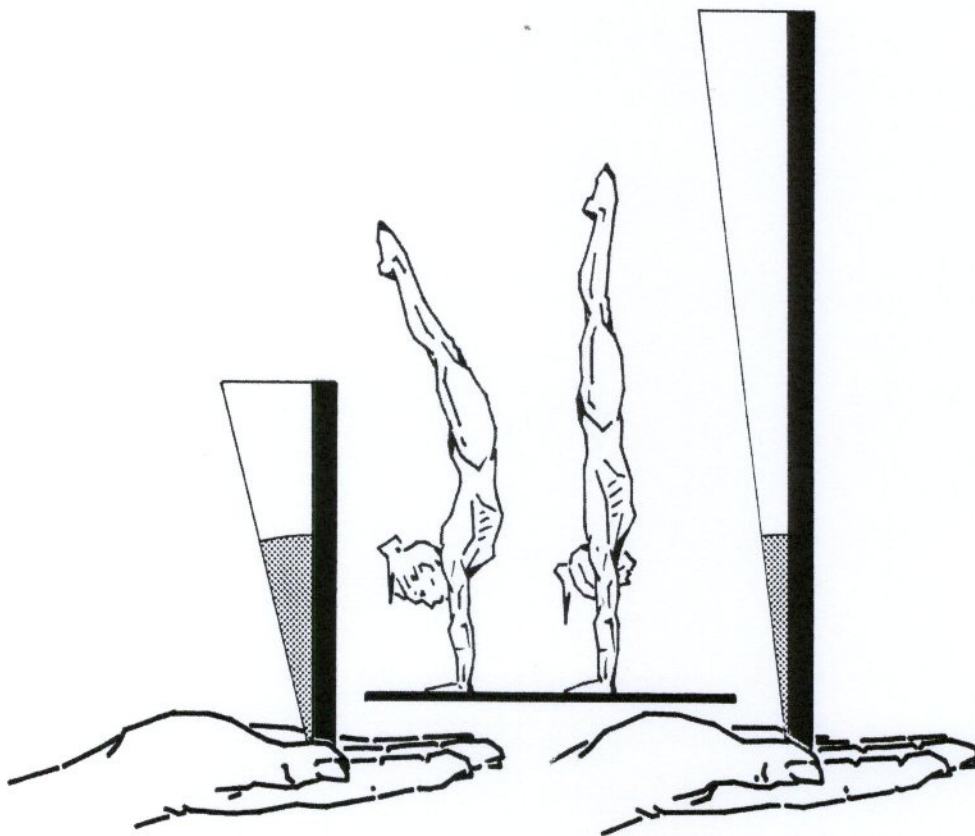


Figure 3.8. Comparing the ease of balancing a long stick versus a short stick: (1) shorter shape = harder to balance; and (2) longer shape = easier to balance.

D. Hollowing the Shoulder Girdle

Hollowing, or protracting, the shoulder girdle about the trunk is an important and effective technique used to stabilize the body for on-line balancing. The underlying concept is demonstrated by the shapes in figure 3.9. When held upright, a flat sheet of paper tends to collapse (illustration 1), but when slightly hollowed (rounded) about its long axis, it has greater structural integrity (2). Just as a slightly hollowed configuration improves the paper's longitudinal shape retention, a slightly protracted shoulder girdle enhances the gymnast's ability to maintain the desired straight-line body shape in a handstand.

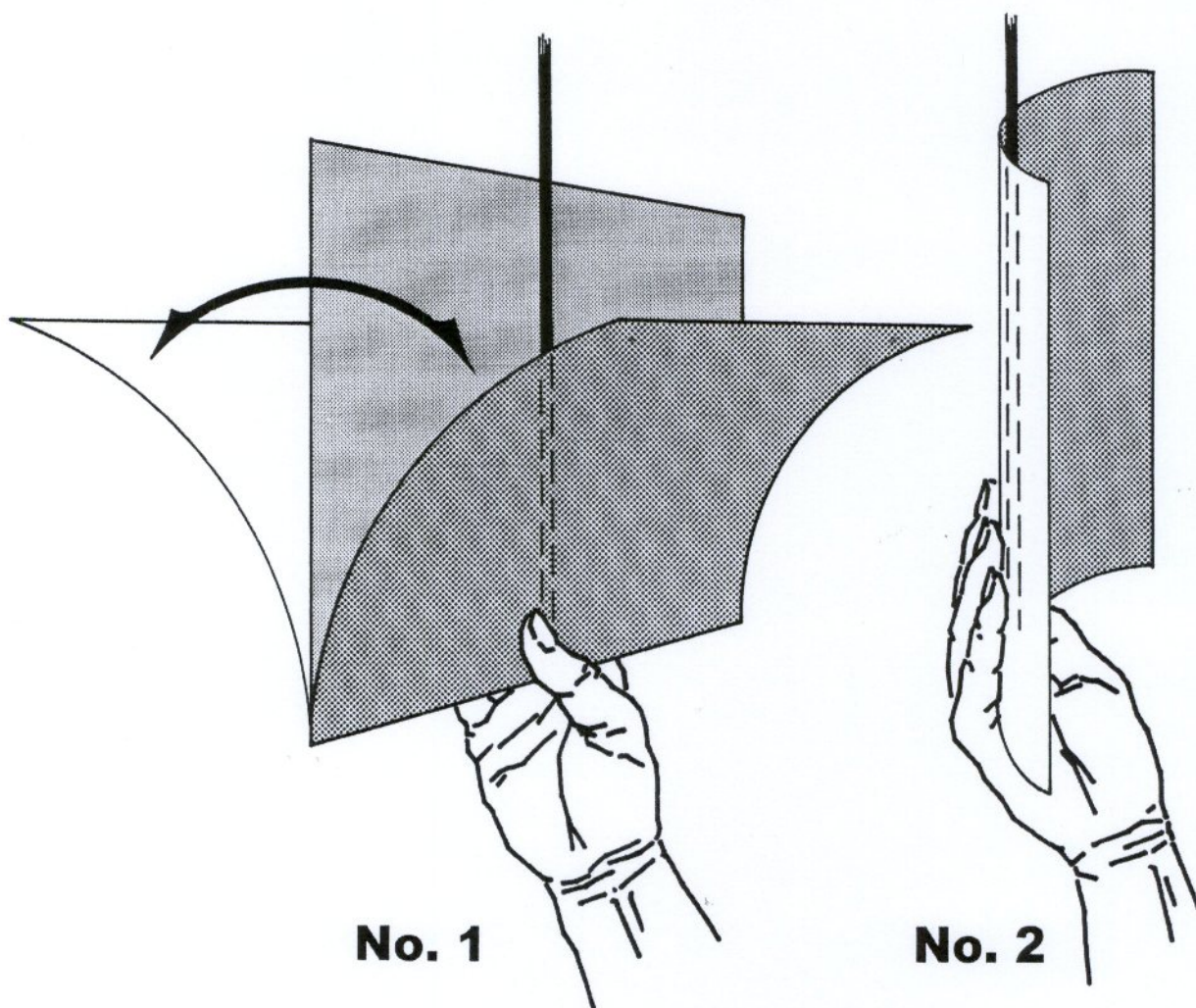


Figure 3.9. Paper comparison of structural integrity in a flat versus a hollowed shape: (1) flat shape = poor structural integrity; and (2) hollowed shape = good structural integrity.

Figure 3.10 depicts the application of this concept to attaining greater functional stability in the upper body. Notice the shoulder girdle of performer 1 is positioned similarly to the flat paper in figure 3.9—undoubtedly a disadvantage in stabilizing the upper body (arm-trunk region). For performer 2, *moving the shoulder girdle forward about the trunk to form a hollowed shape improves structural integrity in the upper body*. This shoulder girdle position enhances on-line balancing for better stabilization, not only of the handstand but also of related gymnastics skills that depend on retaining a straight-line body shape under stress.

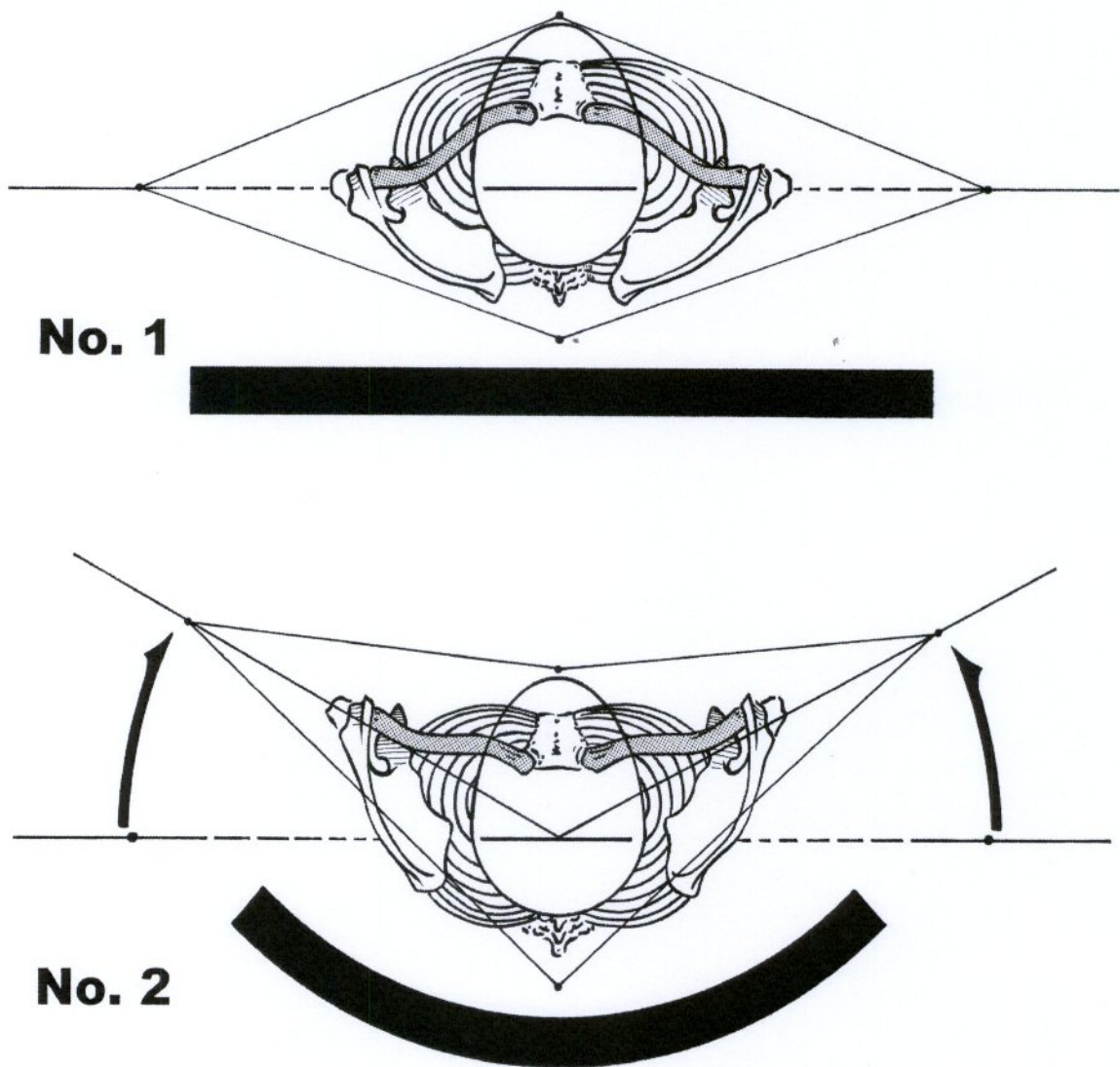


Figure 3.10. Comparative effects of shoulder girdle shape on handstand stability: (1) flat shape = less functional stability; and (2) hollowed shape = more functional stability.

E. Body-Tilt Training Technique

The Body-Tilt Training Technique is effective at strengthening the muscles involved in maintaining correct body shape for on-line handstand balancing. Essentially, as shown in figure 3.11, a spotter tilts the performer off-balance in the forward/backward directions while the performer steadfastly attempts to maintain a straight-line body shape. Remember: the farther or faster the body is tilted from top-dead-center, the more difficult maintaining correct body shape becomes. The performer must be tilted slowly during the initial sessions, and only to the extent that the straight-line shape can be reasonably maintained. As her muscles become better trained and strengthened to withstand the force, progressively greater rates and degrees of body tilt can be applied. Ultimately, the performer should be able to maintain correct body shape while being tilted from a handstand-balance position to a full laid-out position on the floor in both the forward and backward directions!

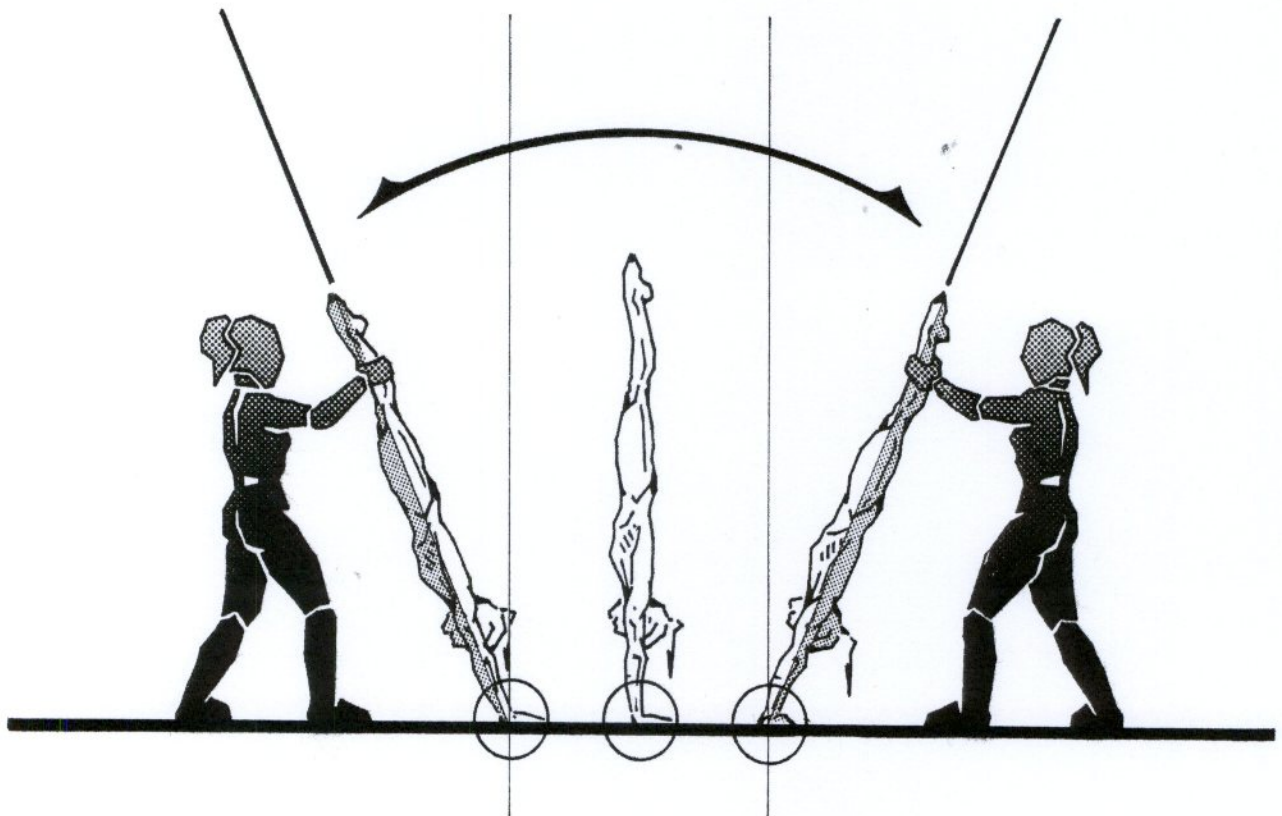


Figure 3.11. The Body-Tilt Training Technique for maintaining correct body shape in on-line balancing. (To facilitate training, hands should be rotated outward 90° when practicing in the forward-tilt mode.)

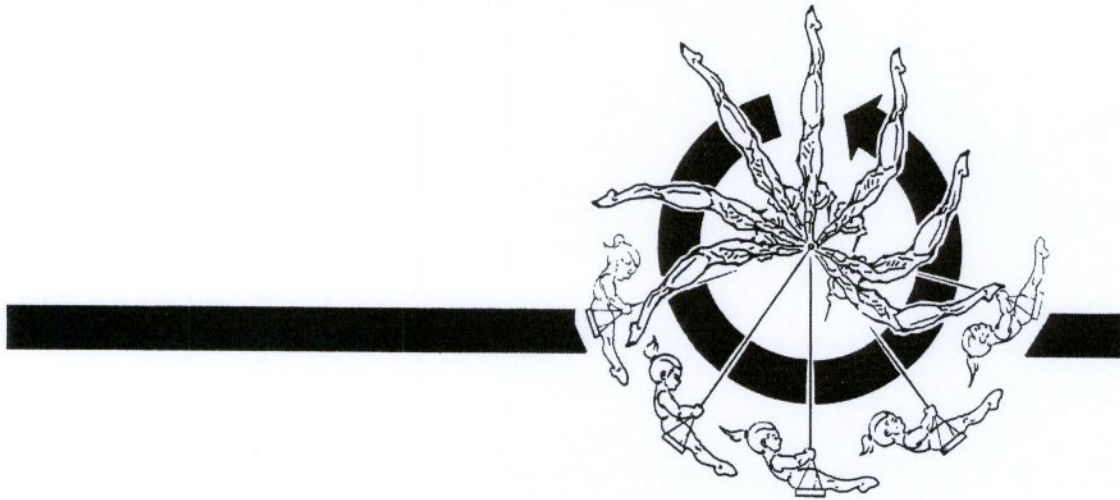
A fundamental litmus test is the ability to balance an ideal-model handstand for a minimum of 60 seconds!

TRAINING SUMMARY FOR THE HANDSTAND

1. A straight-line total body shape is the ideal model for a handstand.
2. Practice attaining correct body shape first; then provide appropriate muscular tension to the shape; and finally, work on learning to balance.
3. The Bar-Hang Method is an excellent training technique for learning to assume a very stretched, very straight, very elongated shape.
4. Proper hand placement is an important prerequisite to achieving balance in a handstand: hands flat on the ground, positioned shoulder-width apart, with fingers spread and facing forward.
5. Maintaining a straight-line body shape while learning to step-up or kick to a handstand improves control and performance consistency.
6. The basic objective in handstand balancing is to maintain body weight directly over and between the hands. Focus with your eyes to feel the balance point.
7. Although learning to counterbalance is an important first step, the ultimately desirable technique is on-line balancing.
8. The wrist joints are the control centers for handstand balancing.
9. The longer the body shape, the easier it is to control balance. Hollowing the shoulder girdle enhances stability.
10. Practice the Bar-Hang Method and the Body-Tilt Training Technique to train and strengthen the muscles involved in maintaining the correct body shape under conditions of stress.

CHAPTER FOUR

THE MECHANICS OF SWING



*Everyone likes to swing. Those who train for excellence love it.
Those who border the lunatic fringe of exacting execution live it...
And that's the simple truth!*

From a mechanical standpoint, *swing is essentially a form of rotary or angular motion.* It can be defined as circular movement of an object about an axial line in a fashion such that all parts of the object travel through the same angle, in the same direction, in the same amount of time. This line, often referred to as the "*axis of rotation*," always lies at a right angle to the object's plane of motion.

The human anatomy, with its numerous joints and segments, can be thought of as an articulated system of swinging levers that circle about one another in a properly coordinated sequence to produce a desired movement. To qualify as swing, the movement need not necessarily be complex. *Any joint of motion of one body segment about another can be considered an elementary form of swing.*

INTERNAL AND EXTERNAL SWING

Notice in figure 4.1 how the shoulder joint serves as the axis of rotation for swinging the arm above the head. *Because this type of rotary motion occurs within the physical limits of the body, it is called "internal swing."*

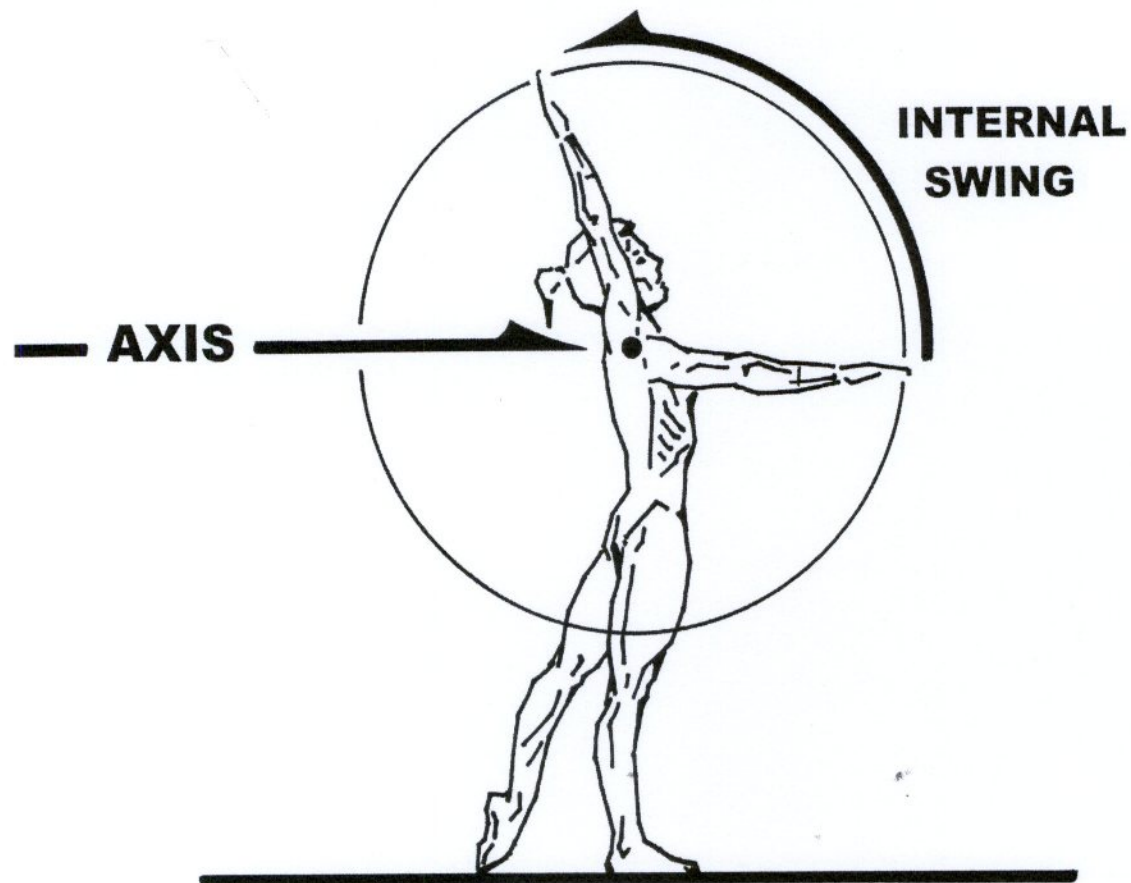


Figure 4.1. Internal swing at the shoulder joint.

In the performance of many skills on the uneven bars, the gymnast often undergoes a different form of swing. It is different in that the axis of rotation lies outside rather than within the body's physical limits. As shown in figure 4.2, the upper rail serves as the axis of rotation for a Backward Hip Circle to Handstand. *Whenever the entire body unit is attached to and circles about a fixed axis, the realized movement is called "external swing."*

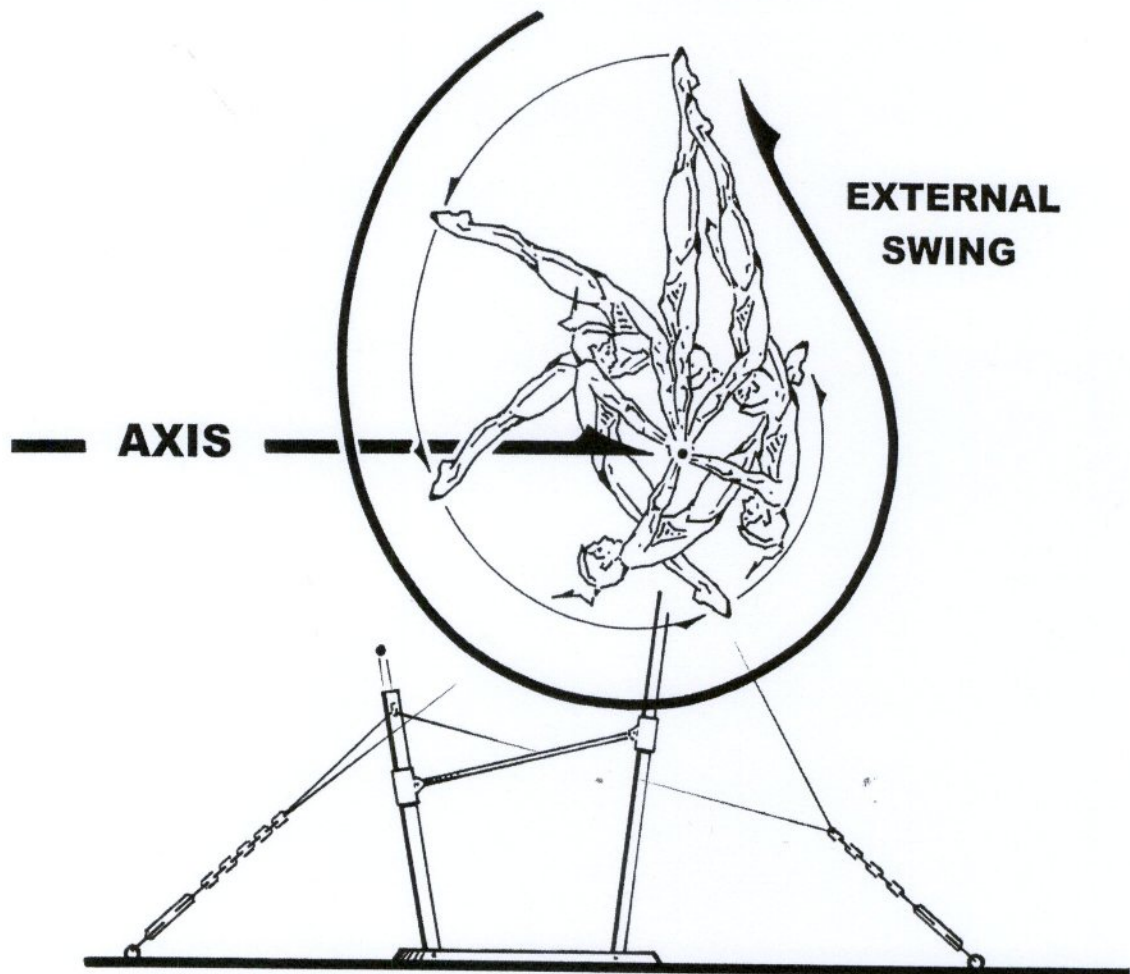


Figure 4.2. The relationship between internal and external swing in executing a Backward Hip Circle to Handstand on the uneven bars.

It is both interesting and important to understand the close relationship between these two fundamental types of swing. In the hip circle, for example, observe how the internal rotary motions—first of the trunk about the shoulder joints, and then of the legs about the hip joints—serve to control, guide and regulate the extent of total body motion, or external swing, about the bar. The timely interplay of these rotary motions, together with use of the bar's inherent elasticity, determines the quality of this and, in fact, all swing-oriented skills. In this light, *it would be wise to consider carefully how to take maximum advantage of internal-swing mechanics.*

*The mechanics of internal swing
serve as the catalyst for
maximizing external swing.*

1. Internal Swing

It is a well-known fact that although force can be present without motion, motion can never be realized without force. Also, the greater the force applied, the greater its effect. Consequently, to produce a desired internal swinging motion, an appropriate amount of muscular force must be exerted by one body part on another. *Whenever such an action occurs, an equal reaction simultaneously occurs and in the exact opposite direction!*

Consider the first example in figure 4.3, and assume the performer is *free of all outside influences*. In swinging from a piked to an extended body shape (hip-joint extension), notice how, as the legs and feet circle clockwise, the head, arms, and trunk simultaneously circle counterclockwise. Because the body mass above and below the performer's pelvic girdle is approximately equal, *the observed effect of the applied force is motion of the two halves in opposite directions.*

As this piked body shape moves rapidly into full extension, *the performer's midsection (abdominal area) also moves in a direction opposite that of her extremities (lower and upper body)*. Notice how the lower body circles *downward* clockwise and the upper body circles *downward* counterclockwise, while the midsection *simultaneously rises* in the opposite, or *upward*, direction. This shifting of the body occurs because, under the prevailing conditions, *any change in shape causes an automatic repositioning of the total body unit about its center of mass.*

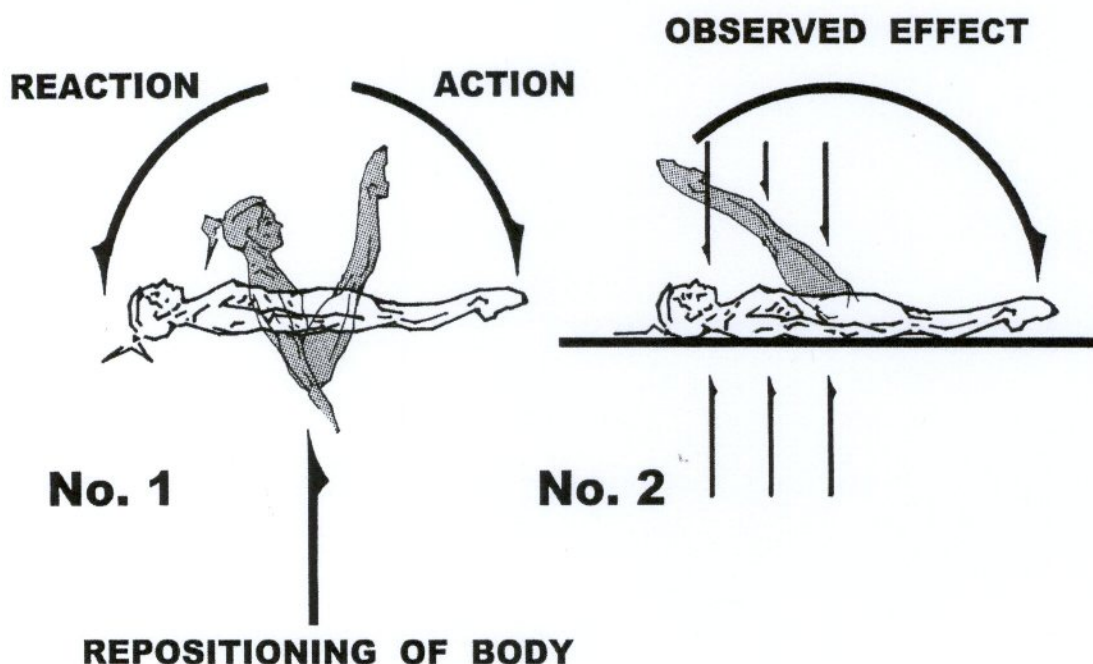


Figure 4.3. Comparative action-reaction effects of internal swing: (1) when the performer is free of all outside influences; and (2) when the performer is in contact with the mat.

The very same movement principle is demonstrated in the second example, and yet the observed effect of the applied force is decidedly different. In this instance, because the performer's upper body is *in contact with the mat*, the lower body is free to swing (extend) about the hip joints. The reaction force exerted through the upper body against the enormous mass of the earth is, to say the least, of insufficient magnitude to produce motion in this direction! As a result, *the net effect of the applied force is realized by the freely swinging lower half of the body, with motion observed in one direction only, i.e., clockwise rotation of the legs and feet.*

A. Transfer of Momentum

Once an internal-swing motion develops in one body part off a stable base, its momentum can then be transferred into other body parts. Take, for example, the *kip-action sequence* presented in figure 4.4, and assume the ultimate objective is to proceed from positions A to D most effectively. Notice the *hip-joint angle is initially fully closed in a deep pike*. This body shape is most advantageous, as it provides the greatest possible distance through which the gymnast's force can be applied. To ensure a large quantity of internal swing (angular momentum), *the hips are then forcibly extended throughout their range to a point just above the mat*. The idea is to generate the fastest possible swing (A, B) so a greater quantity of motion can ultimately be transferred into the upper body.

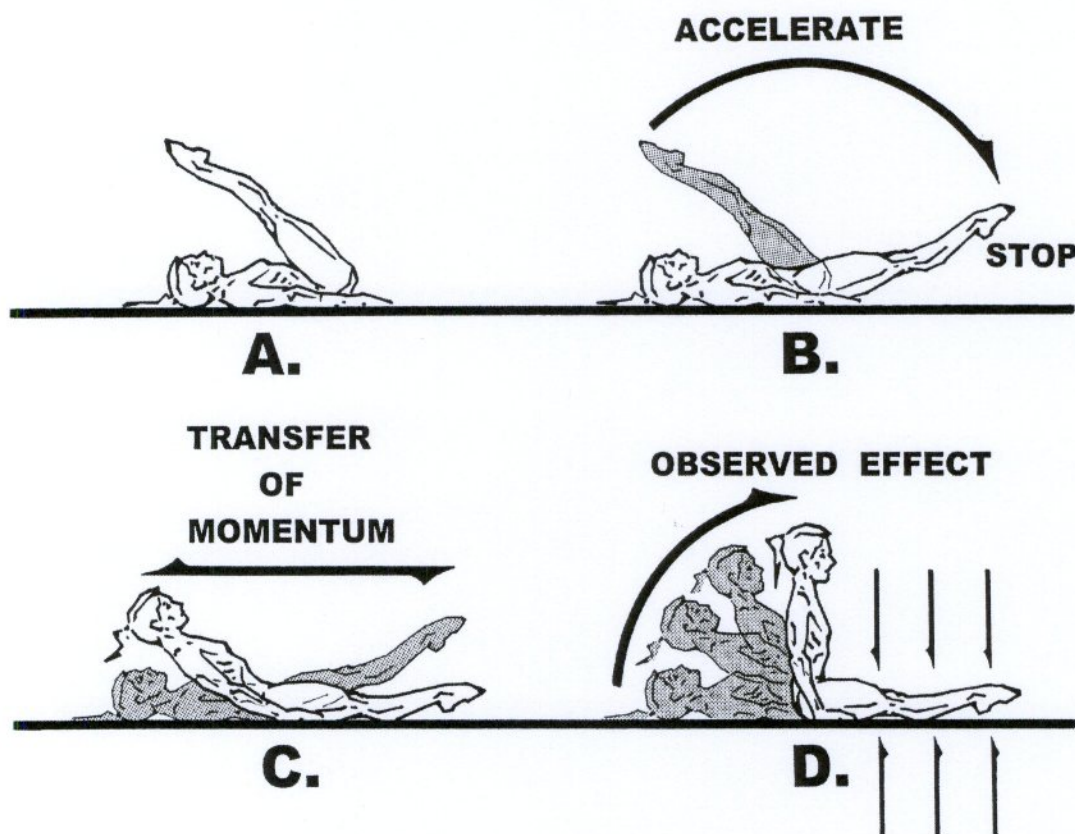


Figure 4.4. Maximizing transfer of momentum for a more effective kip action.

Just prior to contacting the mat, *the rapid extension of the legs and feet is abruptly stopped* (B). This instantaneous stopping of the lower body's motion *results in a large portion of its momentum being simultaneously transferred into the upper body* (B, C). The *observed effect* of this transfer is the gymnast's *ability to rise quickly and effectively* to the desired upright sitting position (C, D).

A close look at this kip-action sequence provides insight not only into what a transfer of momentum actually involves, but more importantly, how to maximize its effect. In skills of this nature, the gymnast is often given fragmented coaching advice such as, "extend vigorously at the hips," or in more mundane terms, "kick harder with your legs and feet." *Yet the wise coach becomes well aware that it is not simply a matter of how hard one kicks. Rather, it is a matter of how quickly one stops how hard one kicks!* Herein lies the hidden component to attaining effective momentum transfer in all power-oriented gymnastics skills.

*Attaining maximum momentum transfer
is not simply a matter of rate of movement,
but rather how quickly one can "stop"
the rate of movement.*

B. Kinetic Chain

Careful study reveals that even complex movements can be viewed as an integrated series of individual momentum transfers, which, when properly executed, occurs in a specific sequence to produce the desired outcome. This sequence of momentum transfers, referred to as the "*kinetic chain*," establishes the *actual pattern of movement* and—when timed properly—renders to the gymnast a level of power, grace, and control she would not otherwise enjoy.

To demonstrate, figure 4.5 compares the mechanical model of a sprocket wheel with the skill model of a Cast to Handstand on the uneven bars. Just as each successive link in the chain progressively unfolds in a 1-2-3 sequence, allowing the turning wheel's momentum to transfer ultimately into the entire assemblage (wheel *plus* chain), so too does the gymnast undergo a similar set of motion transfers.

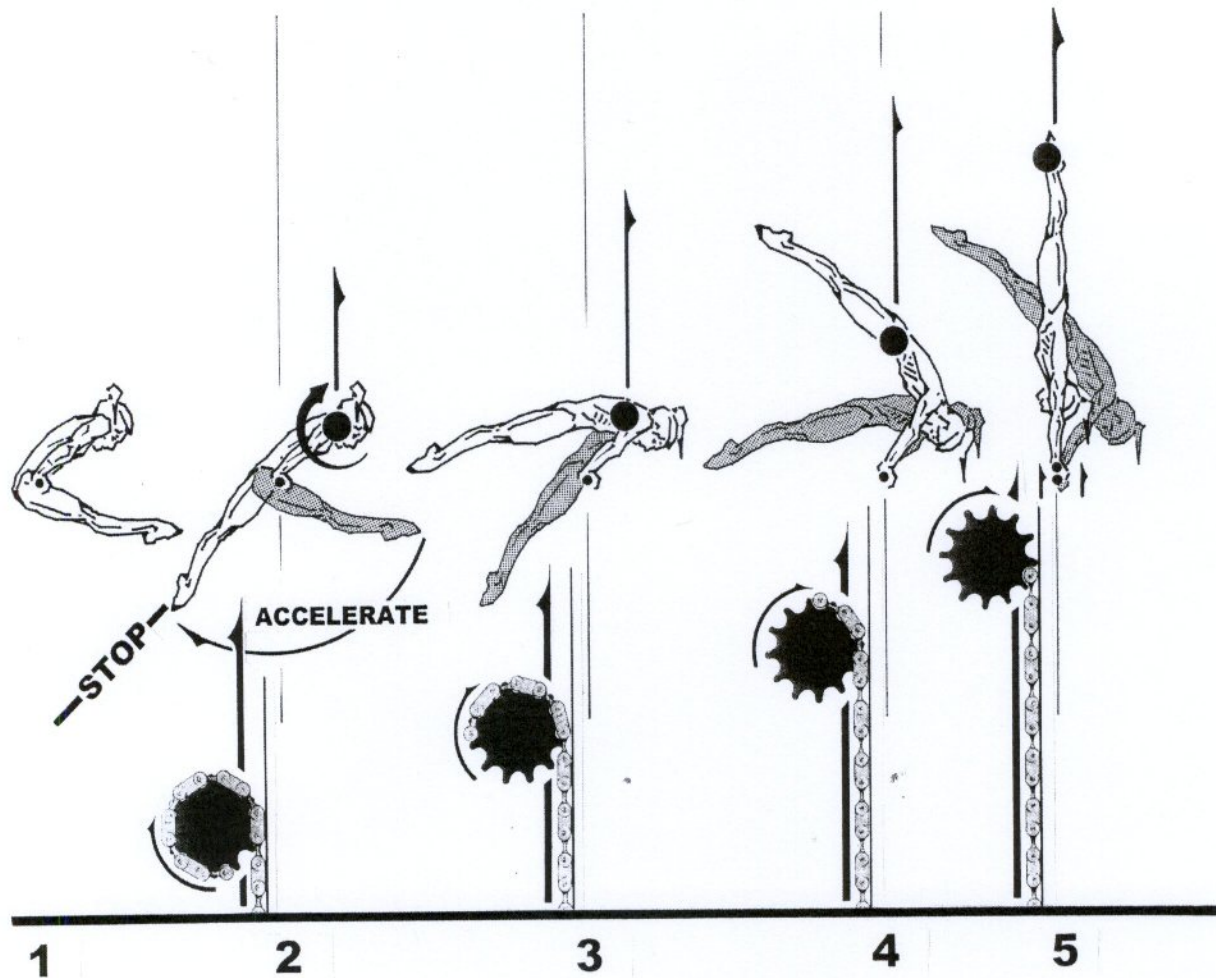


Figure 4.5. Comparison of progressive, sequential momentum transfers in a skill model (Cast to Handstand) and a mechanical model (sprocket wheel).

Figure 4.5 initially depicts the gymnast in a loaded front-support position in preparation for the Cast to Handstand on the uneven bars. Notice the body is deeply piked about the bar, with the legs and feet forming a straight-line segment and the arms, head, and trunk forming a slightly curved or hollowed segment.¹

This loaded body shape affords the gymnast a maximum distance through which to accelerate her legs and feet, and thereby helps ensure a most effective cast (illustrations 1, 2). As in figure 4.4, the rapid extension of the legs and feet is abruptly stopped (2). *This instantaneous stopping action (deceleration) of the lower body's motion immediately prior to full (180°) hip-joint extension results in a large portion of its momentum being transferred into the total body.*

¹ In the initial learning stages, this skill and any of its variations should be initiated from a stationary, front-support cast. However, for maximum cast action, a sequentially related lead-in skill, i.e., Long-Hang Kip, Glide Kip, or Forward Hip Circle, should ultimately be employed.

Consequently, the gymnast can capitalize on the transfer by initiating the arm-push phase of the cast (3, 4, 5).

*The instantaneous stopping action of the legs and feet
serves as the cue
to begin the arm-push phase of the cast.*

Notice that the sprocket wheel has been inserted into the arm-push to magnify the mechanics of how *the gymnast's upper body progressively unfolds to the ultimate handstand position*. As each successive internal-swing motion builds on the immediately preceding motion, a sort of *kinetic chain* is established.

This coordinated series of momentum transfers allows the gymnast to summate optimal force in a particular direction (*upward*) to unfold progressively into a handstand. At the precise moment the gymnast has completely unfolded into a straight-line shape (5), *notice the total body unit is still rising, causing an upward bow in the bar!* The more critical judges are surely aware:

*The litmus test for excellence in cast execution
is not simply a matter of observing the handstand position,
but also of observing the resulting upward motion in the bar.*

2. External Swing

In its most elementary form, the mechanics of external swing are quite similar to that of any circular swinging motion. As depicted in figure 4.6, the circular motion of a body speeds up through the entire descent phase, with the greatest velocity attained at the exact bottom of the swing. The continuous downward pull of gravity is responsible for this increase in velocity (acceleration) during the descent phase and equally responsible for the decrease in velocity (deceleration) during the ascent phase.

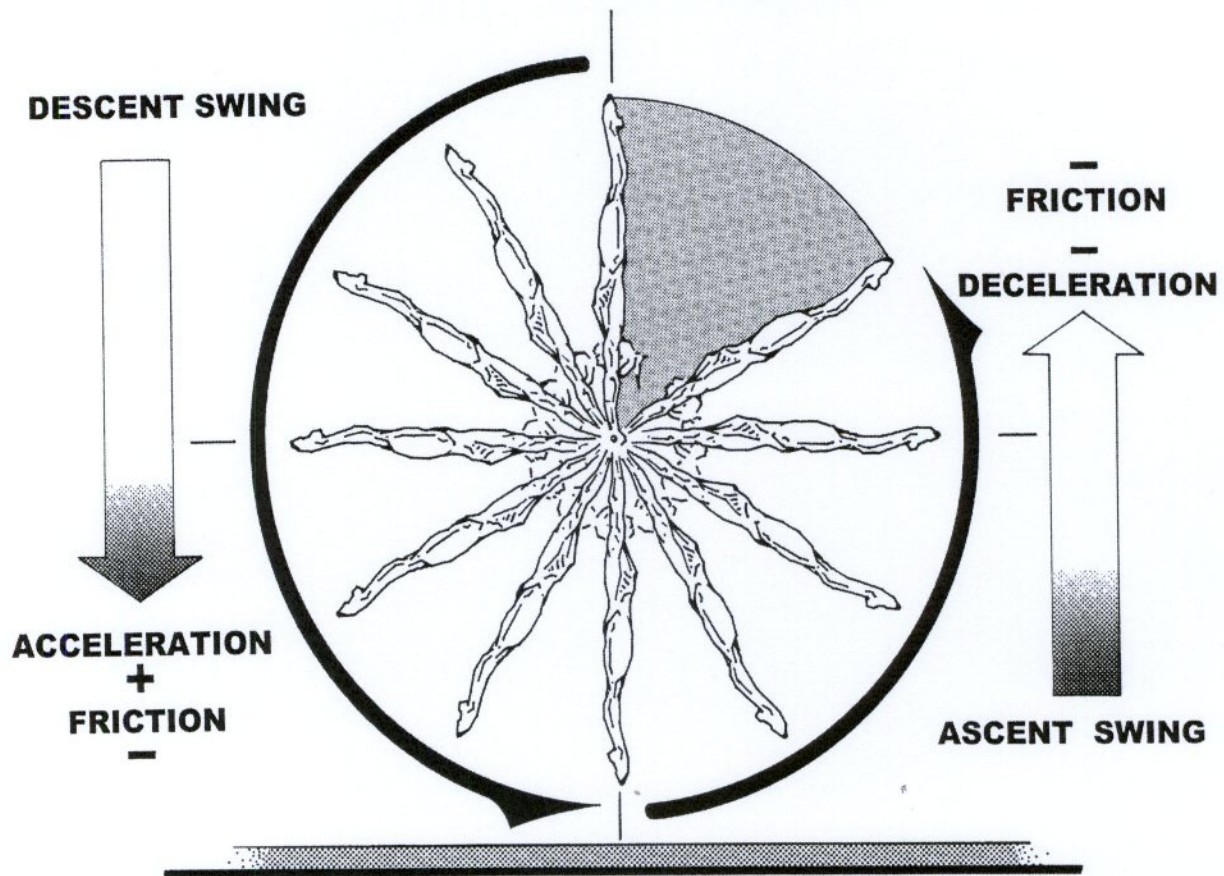


Figure 4.6. External swing about the upper rail of the uneven bars. (Ascent swing amplitude is always somewhat less than descent swing amplitude.)

However, *the amount of external swing realized in the ascent phase is always somewhat less than the amount in the descent phase*. This is because friction, created mainly by the hands encircling the bar (axis of rotation) and by the elastic property of the bar itself, reduces the upswing that otherwise (with a friction-free state and a perfectly elastic bar—both impossible!) might be attained. *In spite of this relative difference in swing amplitude between the descent and ascent phases, there exists an important relationship between the two:*

*The greater the amplitude in the descent phase,
the greater the potential for
increased amplitude in the resulting ascent phase.*

This relationship holds particular implication for all skills characterized by external swing, as much of what happens to optimize skill execution depends directly on the nature of the descent phase—simply put, it sets the stage for all that is to follow. To a large extent, the degree of refinement for any swing-oriented skill inevitably depends on the amount of swing amplitude the performer can effectively

achieve and control in the descent phase. From the ideal-model perspective, *strive for maximum controllable amplitude in the descent phase of every swing skill.*

A. Descent Swing Amplitude

Two important mechanical factors serve to regulate and ultimately maximize descent swing amplitude. The first and perhaps more obvious is the *starting height of the swing*. As shown in figure 4.7, performer 2 initiates the mount phase of the Glide Kip from a region of higher location (relative to the bar) than does performer 1. A higher start position allows a greater distance (more external amplitude) to be covered in the descent—a distinct advantage, as acceleration due to gravity can act on the body for a longer duration, and thus a greater quantity of motion can be made available to maximize amplitude in the oncoming ascent.

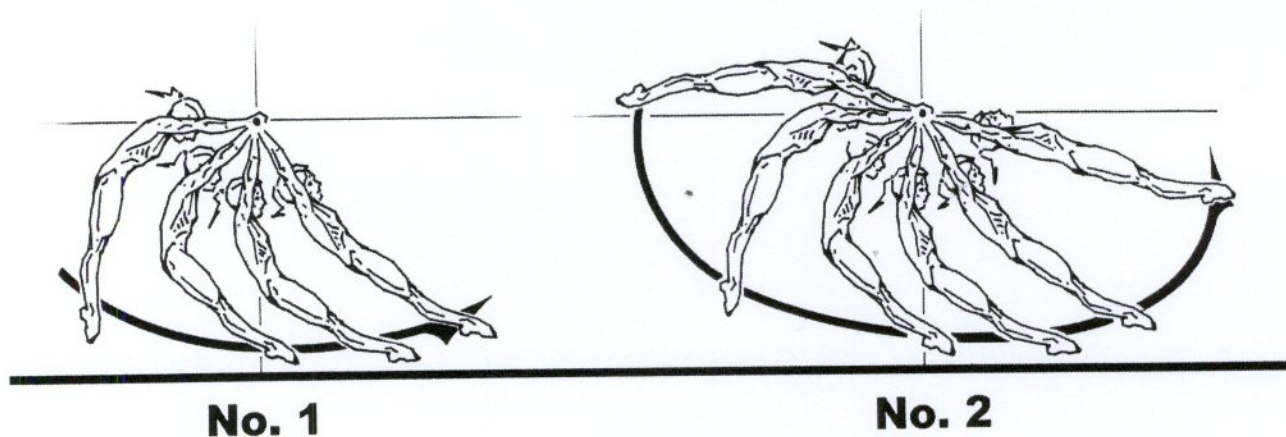


Figure 4.7. Comparative effects of "starting height" on external swing amplitude in the mount phase of a Glide Kip on the uneven bars: (1) low start height = less amplitude; and (2) high start height = more amplitude.

A second and equally important consideration in maximizing descent swing amplitude is *distance*, i.e., the distance from the body's center of mass (at or near the waist) to the axis of rotation (bar). This distance—the body's *radius of rotation*—*should be as large as mechanically possible throughout the descent phase*. Compare, for example, the effect of long versus short radius of rotation in executing a Stalder on the uneven bars, seen in figure 4.8.

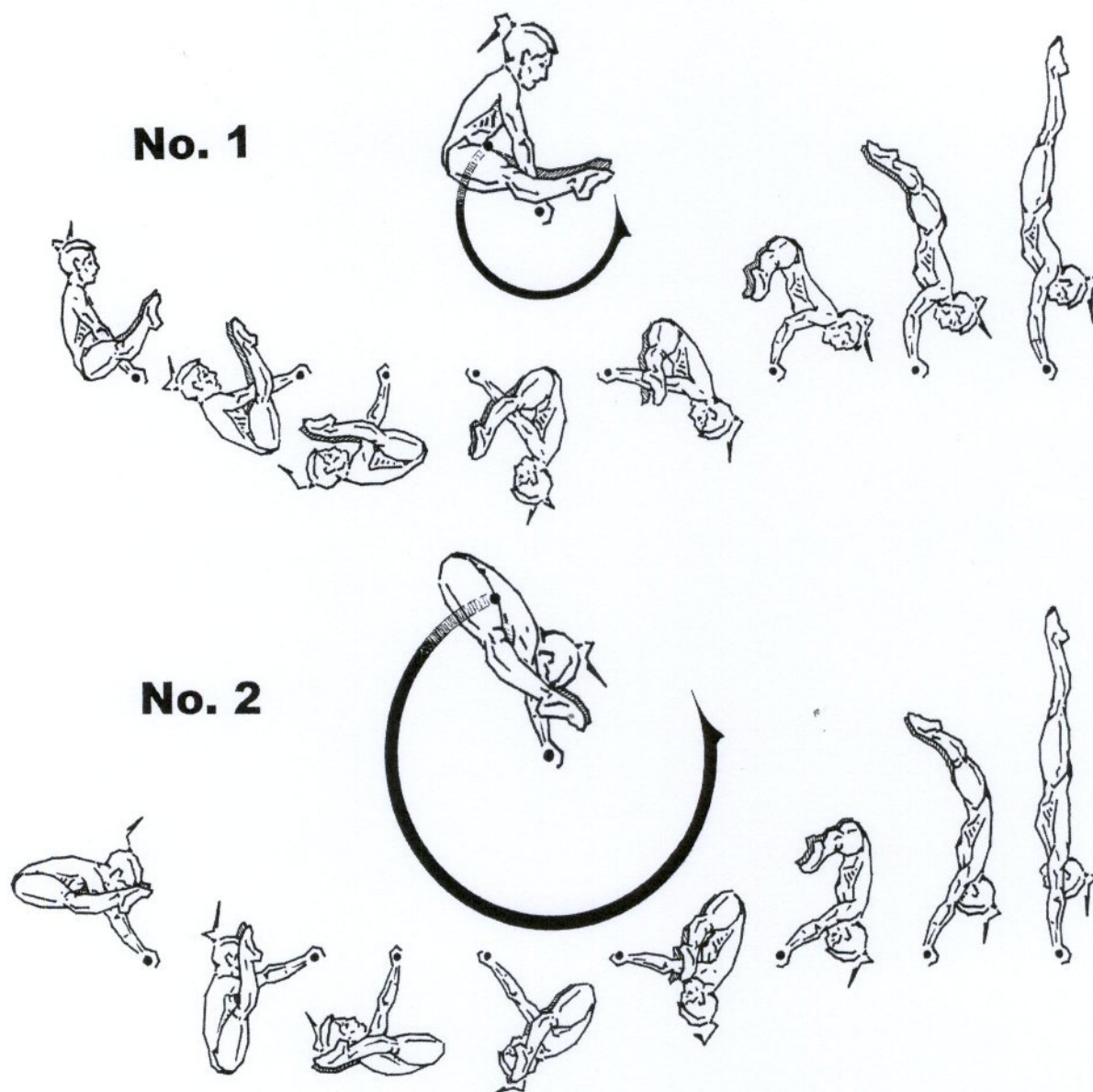


Figure 4.8. Comparative effects of radius distance on external swing amplitude in executing a Stalder on the uneven bars: (1) short radius of rotation = less amplitude; and (2) long radius of rotation = more amplitude.

Because performer 2 assumes a body shape that positions her mass center farther from the bar, her effective radius of rotation is significantly longer than that of performer 1. This increased distance (*cause*) not only provides for greater descent swing amplitude but also ensures a smoother transition into the ascent phase. As can be readily observed, the end product (*effect*) is a greater quantity of motion available for the upswing portion of the Stalder.

B. Conservation of Angular Momentum

When the radius distance of a rotating body is decreased, its angular momentum (rotation velocity) is proportionately and simultaneously increased, and vice versa. For example, if greater speed of rotation is desired at a particular point in the swing, the performer need only alter her body shape (within the context of the skill) to shorten the radius distance appropriately. Conversely, by lengthening the radius, rotation speed is decreased.

*The nature of swing mechanics
involves
robbing Peter to pay Paul...*

Although understanding this principle of rotary motion is particularly useful in regulating external swing, *its true effectiveness inevitably depends on the quantity of rotary motion already existing in the swing.* This is why attaining a maximum starting height and positioning the body's mass center as far as possible from the bar during the descent phase of every swing are critical prerequisites to full use of the Angular Momentum Principle. Consequently, *it is not simply a matter of knowing when and how much to shorten or lengthen one's radius of rotation*—these aspects of swing mechanics are comparatively easy to master. *Rather, it is a matter of knowing how to obtain a sufficient quantity of rotary motion in the first place!*

3. Optimizing Swing Mechanics

By collectively employing the above-discussed principles, the stage can be set to border the maximum execution tolerance limits of almost any skill. For example, if performer 2 in figure 4.8 wants to optimize execution of a Stalder, she needs to maximize her starting height and her radius of rotation throughout the descent phase (**Amplitude Principle**); delay the full Stalder action until the latter stages of the descent (**Peaking Principle**), then Stalder-in very quickly at the last moment (**Closure Principle**); execute the Stalder-in with minimal body-shape changes (**Segmentation Principle**); and employ a 1-2-3 sequence (**Kinetic Chain**) first in the hips, then the lumbar area/trunk, and finally the shoulders for the actual Stalder-in action.

These actions, though somewhat advanced from a technical perspective, render maximum swing amplitude to work with in the oncoming ascent phase. In figure 4.9, notice how the performer maintains a fully extended body shape as long as possible during the descent phase (illustrations A, B, C), waits as long as possible to execute the Stalder-in (D, E, F), and then does so very quickly and completely by closing the hips, lumbar/trunk area, and (to a lesser extent) the shoulders (F, G, H), using the proper 1-2-3 kinetic chain sequence.

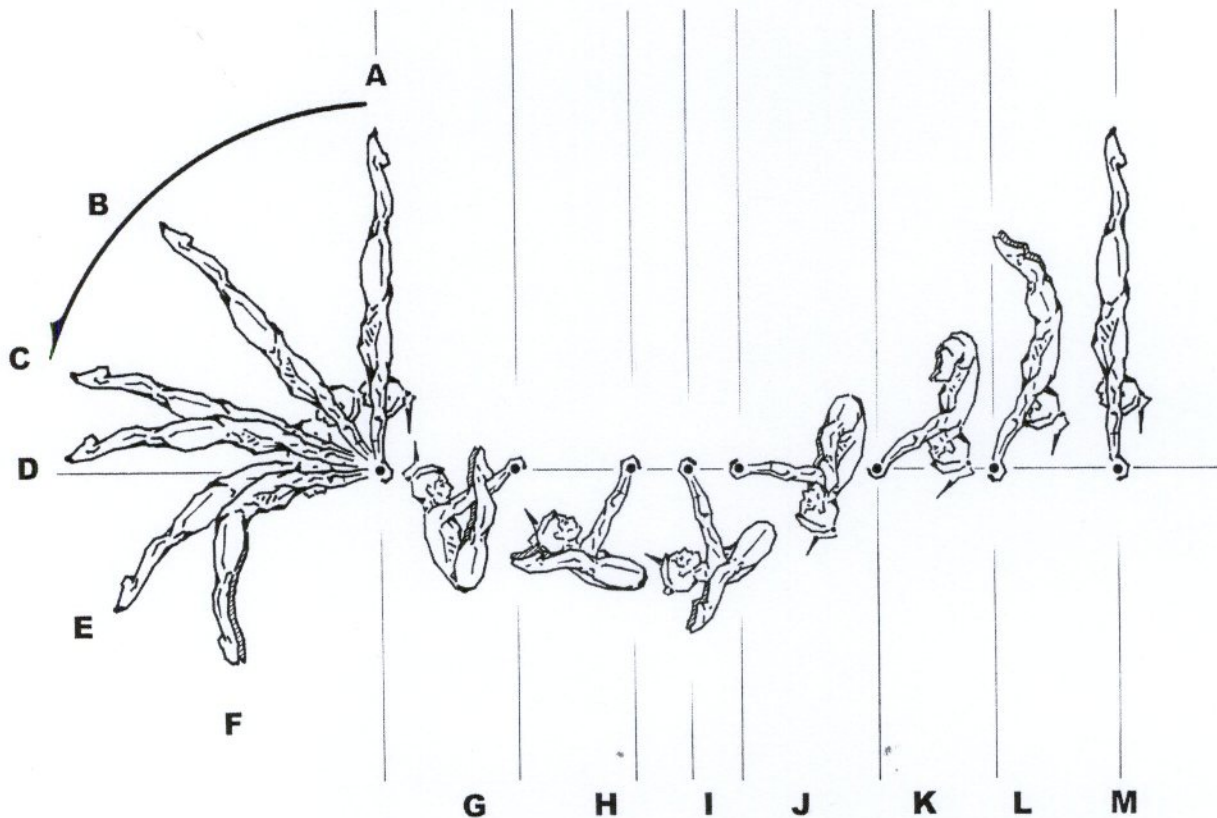


Figure 4.9. An ideal model for a Stalder on the uneven bars.

These timely movement patterns ensure the performer can now execute the entire Stalder-out using the reverse 3-2-1 sequence of progressively unfolding the total body unit into the handstand position (I, J, K, L, M). Notice all body parts line up with one another and the upper vertical line at precisely the same time (**Peaking Principle**).

*Bordering the lunatic fringe of exacting execution
is indeed
the Michelangelo of gymnastics.*

A. Body Shape and Radius of Swing Rotation

At this point, it is important to *consider how body-shape changes affect the radius of rotation while circling the bar*. Obviously, the longest possible radius is achieved whenever the gymnast assumes a fully extended total body shape. Any change in this elongated shape (whether at the shoulders, trunk, lumbar region, hips, or knees) decreases her radius distance from the bar. *However, the degree to which the performer's radius of rotation is actually affected depends*

directly on which specific changes in body shape are employed, to what extent, and in which sequence. Not only is understanding and applying this concept to swing skills essential for correct technique, but also it renders to the judges' eyes an unforgettable impression of undeniable excellence. Keep in mind:

*Swing mechanics is a science...
rendering the science
is an art.*

For example, when executing an Overgrip Giant Swing, every effort should be made to circle the upper rail in as fully extended a body shape as possible. However, *the precarious (yet necessary) proximity between the upper and lower rails poses a unique physical constraint on maximizing the descent swing*. This constraint leads many gymnasts to employ less-than-advantageous techniques to clear the lower rail, thereby reducing their potential descent swing amplitude. As a result, they compensate by unduly altering or misaligning body shape for a marginal ascent—or suffer the consequences lay hidden for a failure to complete!

It should also be obvious that a key consideration in a successful Overgrip Giant Swing is *maximizing descent swing-swing amplitude while avoiding contact with the lower rail*. It should be equally obvious that, by sufficiently decreasing one or a series of joint angles at the proper time, the performer can avoid striking the rail. What is perhaps not quite so obvious is *how to avoid contact with the rail while still ensuring the largest possible radius of rotation throughout every point in the descent swing*.

Figure 4.10 provides an interesting demonstration of “the best of both worlds.” In both examples, a selected joint angle is decreased sufficiently to allow only minimal clearance of the lower rail. But rather than bend at the shoulder, performer 2 bends at the hip, pulling a comparatively smaller percentage of body weight inward toward the axis of rotation (upper rail). *Although the straight-line distance between the feet and the axis of rotation remains the same, a comparatively longer radius of rotation is achieved by performer 2*. This longer radius results in greater descent swing amplitude, with the net effect of ensuring greater ascent swing amplitude!

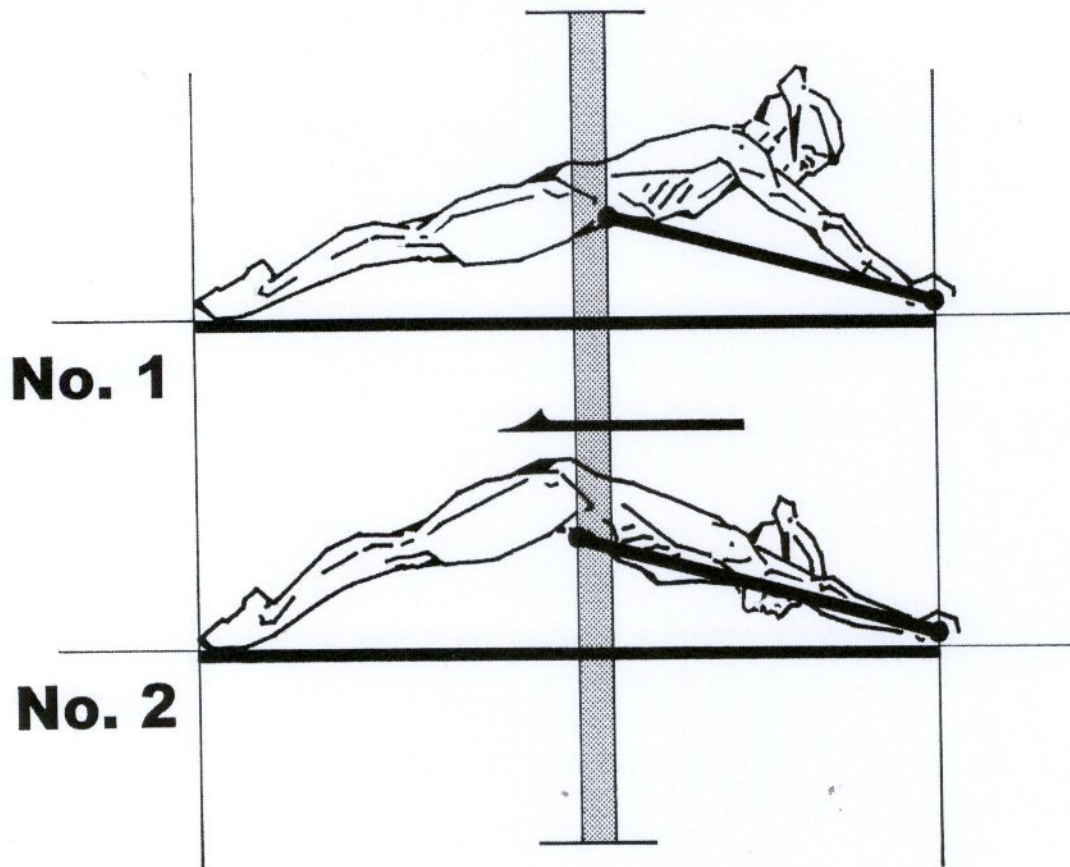


Figure 4.10. Comparative effects of body-shape changes on radius of rotation in executing an Overgrip Giant Swing: (1) bending in the shoulders = shorter radius; and (2) bending in the hips = longer radius.

Figure 4.11 depicts the application of these concepts to maximizing descent swing-swing amplitude in light of the constraint imposed by the lower rail. An Overgrip Giant Swing is initiated from a fully extended vertical handstand (illustration A). *Every attempt should be made to retain the fully extended total body shape for as long as possible during the initial aspect of the descent* (A, B, C). In addition, notice how both a straight arm-trunk angle and a fully elevated, protracted shoulder girdle are steadfastly maintained through the entire descent phase.

As the performer begins to bend in preparation to clear the lower rail, notice *the body-shape changes are sequential and are initiated at a point of greatest distance from the axis of rotation*. Decreasing the angle first in the hips is the cue to begin decreasing in the lumbar region, in turn the cue to decrease in the thoracic region (C, D, E). Each body-shape change builds sufficiently on the previous one to permit minimal rail clearance (E). Upon clearing the rail, the feet drive downward as the performer rapidly unfolds from this hollowed shape into a fully extended shape well before the exact bottom of the swing (F, G). These

timely actions help ensure a maximum quantity of descent swing-swing amplitude, which is essential to proper execution of an Overgrip Giant Swing.

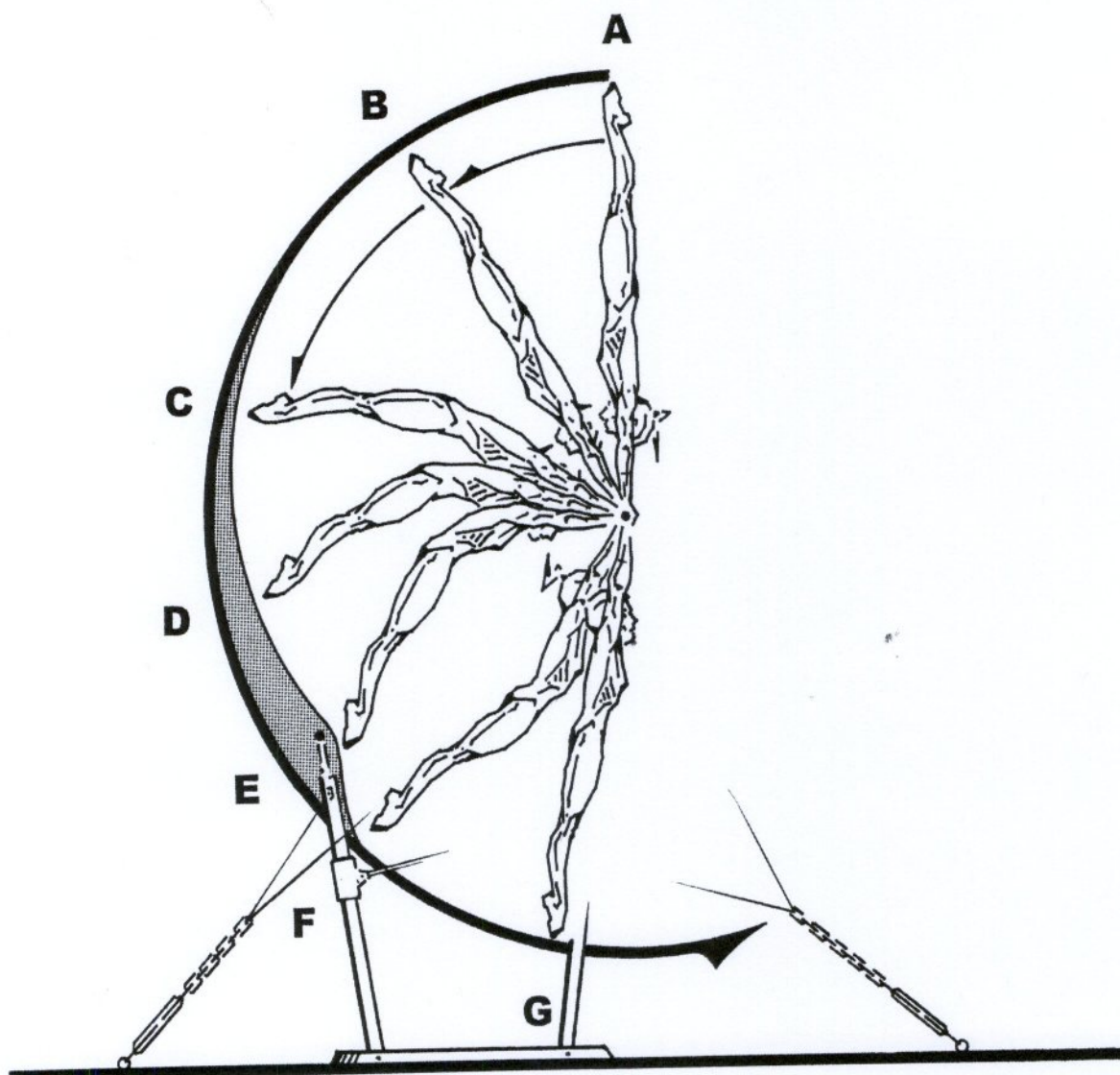


Figure 4.11. Maximizing swing amplitude in the descent phase of an Overgrip Giant Swing.

In executing long-hang swing skills, *the farther the bend in body shape is from the bar, the smaller its effect (fine-motor tuners) on radius of rotation.* By comparison, *the closer the bend is to the bar, the greater its effect (gross-motor tuners) on radius of rotation.* As we have just seen, bending at the shoulders rather than the hips to decrease the radius of swing rotation pulls a larger percentage of body mass inward toward the bar. From a technical perspective, it is important to recognize that *significantly greater control, grace, and precision can be achieved in any swing pattern wherein the performer can employ her "fine-motor tuners" to execute the skill.*

Because the descent phase mechanics set the stage for all that is to follow, it should begin to become somewhat more clear that seemingly minor differences in descent swing-swing technique—more often than not—result in major differences in total performance. *Look carefully at the performance characteristics of the descent phase, for therein lies the catalyst to every successful swing-oriented gymnastics skill.*

*The margin of excellence
always comes down to
least discernible differences!*

B. Ascent Swing Amplitude

Although the amount of potential amplitude available in the ascent swing phase depends directly on the amplitude generated in the preceding descent phase, it is also true that regardless of the amount of potential upswing amplitude made available, *the performer is still required to shorten her radius of rotation sufficiently if she expects to complete a 360° circle.* Merely shortening the radius of rotation during the upswing phase of the skill, however, is but a story half-told. *The axiomatic consideration here is how best to achieve this!*

*Shortening the radius of rotation is not the litmus test—
rather it is
the way in which the radius of rotation is shortened.*

To demonstrate the principle, look carefully at the upswing phase of the Overgrip Giant Swing presented in figure 4.12. It should be apparent that the performer not only shortens her radius of rotation to ensure completion of the skill, but more importantly, does so in a particular way. For example, notice *the performer bends first in the area of the body farthest from the bar, i.e., hip-joint flexion.*² This forceful *foot-lead action* directly off the exact bottom of the swing serves as the catalyst for lumbar flexion, which in turn serves as the catalyst for thoracic flexion. Notice these movements occur in a *progressive 1-2-3 sequence* (illustrations H, I, J). Observe how *the performer, rather than bending deeply in a single body part, progressively spreads the bend over a series of joint sites located well away from the bar (axis of rotation).*

² Although the knees and ankles are even farther from the bar than the performer's hips, bending in either of these areas constitutes a form break and, as such, is not advisable.

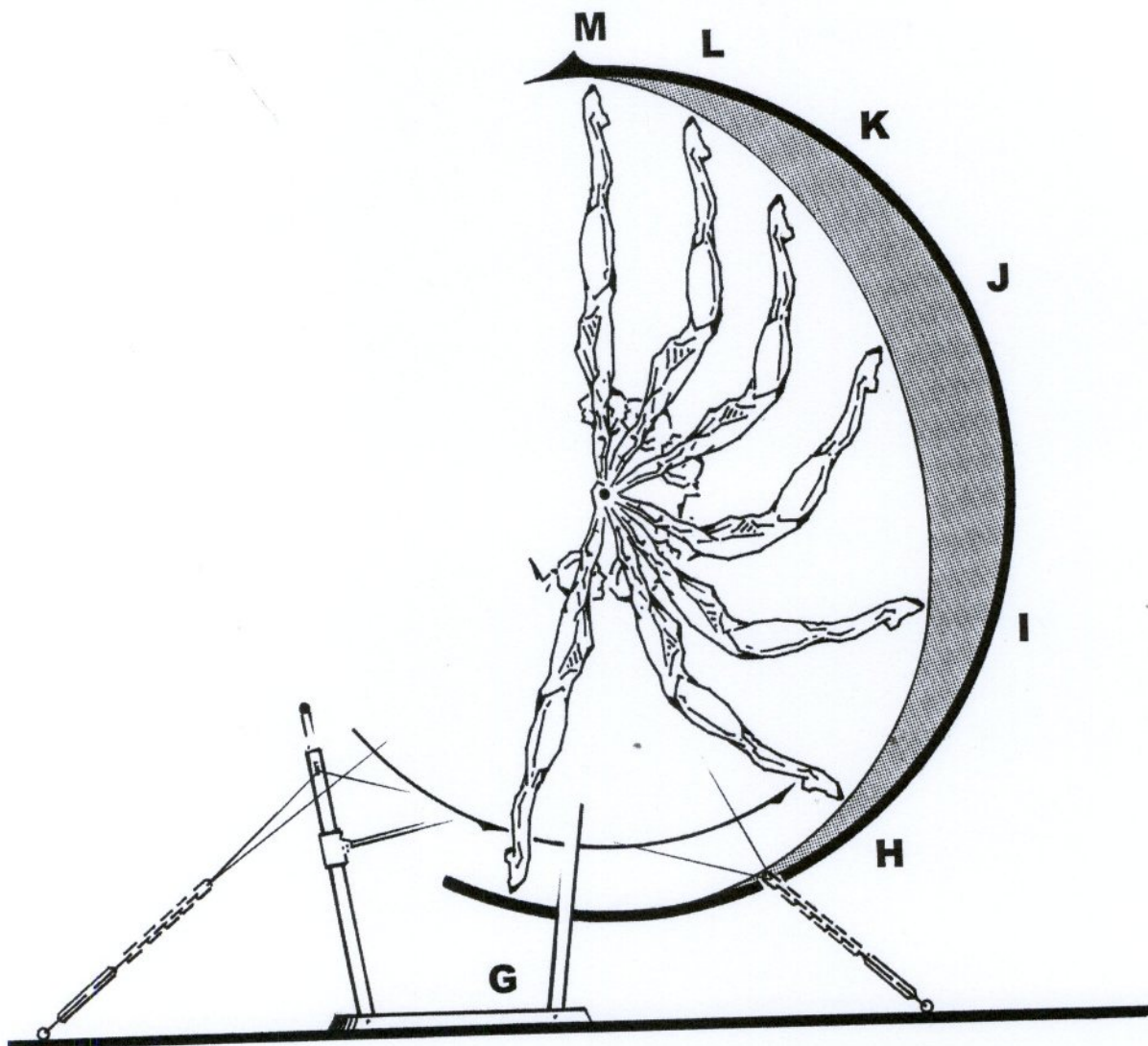


Figure 4.12. Shortening the radius of rotation in the ascent phase of an Overgrip Giant Swing.

In the final upswing phase of the giant swing, the precise opposite action occurs in a 3-2-1 sequence. The performer first opens her thoracic angle, and this extension of the thorax is the catalyst for lumbar extension, which in turn is the catalyst for hip-joint extension (K, L, M). The litmus test for exacting execution can be found in the realization that all body parts have lined up with one another and with the upper vertical line at precisely the same time! Without these properly timed patterns of internal-swing motions, maximum execution of the giant swing remains but a hope in the mind of a dreamer...

*Just as the curl of a giant wave intrigues the eye,
so does the flow pattern of exacting human movement
hold captive the eye of the beholder.*

C. The Tangent-Release Principle

Force always acts in the precise straight-line direction in which it is applied. Consequently, any body in motion as a result of applied force tends to travel its same straight-line path, and speeds up (*accelerates*) at a rate proportional to that force's magnitude. The only factor which can alter this state of affairs is the introduction of one or more additional forces. If, for example, force is applied in a direction opposite the already-existing motion, the body slows down (*decelerates*). *The relationship between the magnitude of force and the direction of the applied force determines whether the body will move, and if so, at what rate of speed and in which direction.*

For example, during the descent phase of the Overgrip Giant Swing, the force of gravity tends to accelerate the performer's mass downward in a straight line. The body's mass center, however, does not travel straight downward. Rather, it continuously changes direction, circling relative to its fixed axis of rotation (bar). Because the performer's hands are firmly anchored to the apparatus, the body tends to follow a circular path equal in length to its radius of rotation.

This circular movement pattern is due to the mutual force relationship between the gymnast and the bar. *The action of the performer pulling against the bar causes a simultaneous reaction of the bar pulling against the performer.* Because this action-reaction relationship is equal in magnitude and opposite in direction, the effects would seem to cancel out. Yet this is not the case, for the action of the performer pulling against the bar cannot possibly move the apparatus, as it is firmly attached to the colossal mass of the earth!³ However, the reaction of the bar pulling against the performer does possess sufficient magnitude to produce a continuous change in direction of the performer's light mass. The observed effect of this action-reaction scenario is a circular pattern of the total body unit about the bar. *As long as this mutual force relationship is maintained, the performer's external swing motion is preserved.*

However, *if the performer were to release her hand-grasp at any time while circling about the bar*, this mutual force relationship would cease to exist, and *her body would be projected away from the bar in a straight-line at an angle perpendicular to its radius of rotation.* Once airborne, the body's mass center would then travel a perfectly regular, curved path (*parabolic trajectory*).⁴ This is precisely what occurs in the Double Backward Somersault Dismount presented in

³The performer's pulling does bend the bar in the direction of the pull. For additional information specific to "rail action," refer to *The Bottoming Effect* and *The Slingshot Technique* in chapter 12.

⁴The only exception to the parabolic trajectory outcome would be if the performer's center of mass were at either the 3 o'clock or 9 o'clock position when the hand-release occurred, in which case her body would be projected either straight up or straight down.

in figure 4.13! At the instant of release, notice how the performer's body is projected in a straight line at a 90° angle to its radius of rotation, and how, once airborne, her center of mass follows its predetermined parabolic trajectory.

*Every release from any external-swing movement
always results in
the center of mass being projected at a right angle to its radius.*

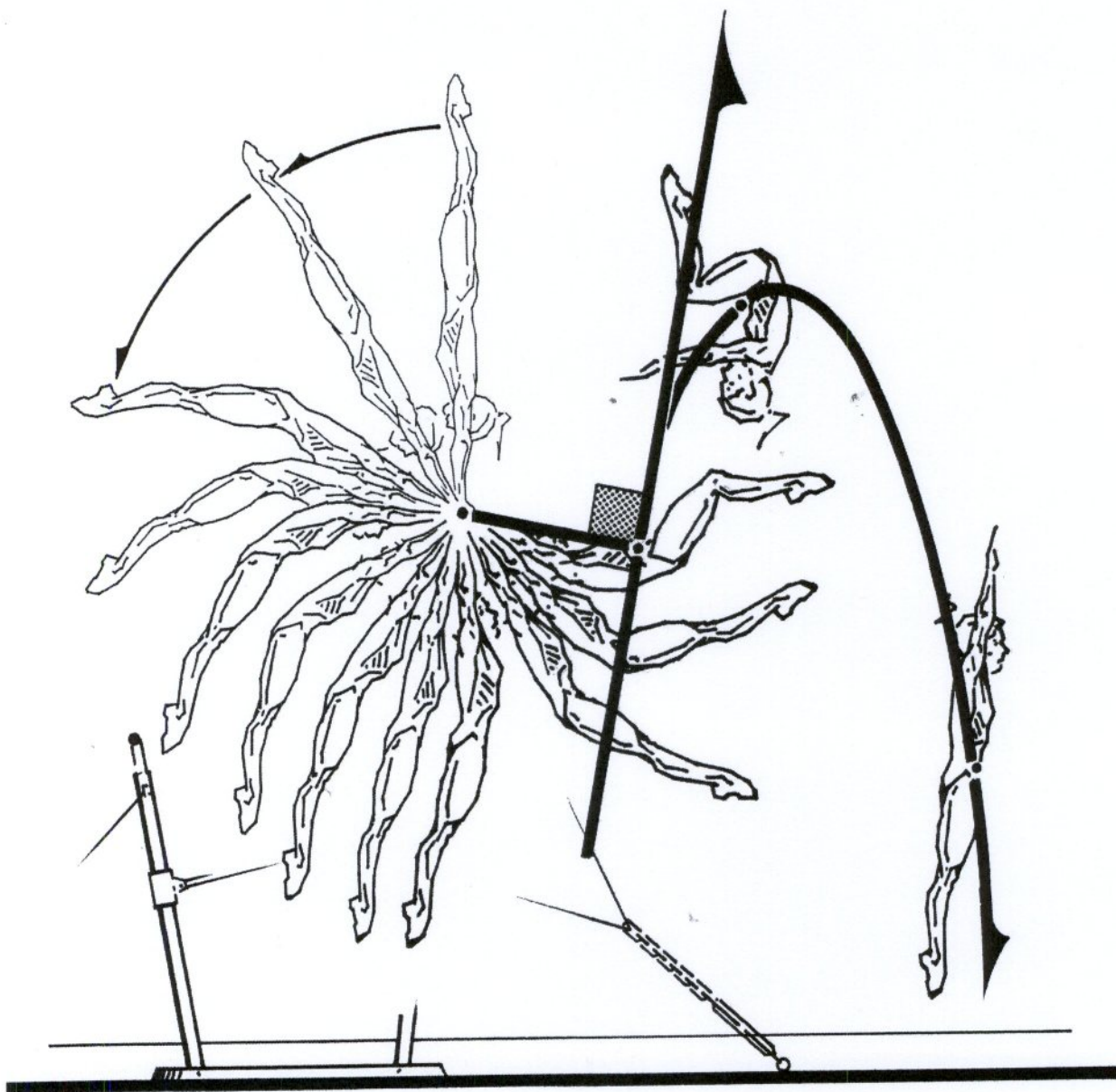


Figure 4.13. The Tangent-Release Principle in executing a Double Backward Somersault Dismount from the uneven bars.

Because the body's mass center exits from any external swing at a 90° angle to its radius of rotation (tangent to the swing), *the gymnast can confidently take advantage of the Tangent-Release Principle to direct the flight pattern properly for any dismount or release-grip skill on the uneven bars.* Effective use of this principle, however, requires a clear understanding of the intended direction and objective of the skill's airborne phase, so the release phase can be timed accordingly. Simply put, *proper timing of the release is critical to success in all airborne movements generated by external swing.* The wise gymnast becomes well aware that:

*Just as the archer's bow establishes the flight direction of the arrow,
so too
does the tangent release establish the flight direction of the gymnast.*

FUNDAMENTAL CONCEPTS OF SWING

1. You are the "*giant*" executing the *swing*! Strive for maximum controllable swing amplitude.
2. Stay as far away from the bar as possible throughout the swing phase of every skill.
3. The amplitude achieved in the descent phase of the swing determines the potential amplitude available for the ascent phase.
4. Maximum descent swing amplitude is achieved by employing a maximum starting height while maintaining as large a radius of rotation as possible.
5. Throughout the swing phase of every skill, strive to push as far as possible away from the bar prior to bending, i.e., spreading the bend.
6. Always keep in mind that the quality of internal swing serves as "the great regulator" of external swing.
7. All changes in body shape should be initiated from a point of greatest distance from the axis of rotation (bar). Wherever possible, employ your "fine motor tuners" to regulate the quality of swing.
8. Changes in total body shape should always occur in a progressive, 1-2-3 sequential pattern.
9. The quickness with which a moving body part can be stopped determines the effectiveness of its momentum transfer.
10. For all release-grip skills and dismounts, employ the Tangent-Release Principle to help control, guide and regulate the airborne trajectory.

CHAPTER FIVE

THE MECHANICS OF IMPACT



*Ninety-five thousand pounds of effective thrust
screams its menacing reply to Newton's third law,
and you're off into the friendly skies of United...*

The term "*impact*" generally refers to the interaction between one object colliding with another, and to the effects of such a collision. Objects often possess some degree of *elasticity*, a property which causes them to return to their original shapes (*restitution*) once they have been deformed (*deflection*) by a collision. All other factors being equal, the quickness with which their original shapes are restored (expressed mathematically as the *coefficient of restitution*) largely determines the net effect of their interaction.

Although the human body is considered quasi-rigid rather than elastic in nature, many concepts dealing with elastic properties can still be usefully applied. Just as elastic objects (such as vault boards, spring floors, and uneven bar rails), develop a potential energy for immediate use upon being compressed, so does the human body, with its internal muscular and connective network, possess a similar capacity to develop and expend an instantaneous working energy. This is particularly apparent in the impact phases associated with virtually every airborne gymnastics skill.

In fact, impacts such as those observed in *take-offs, arm-repulsions, and even landings serve to control, guide, and regulate the ultimate quality of virtually all aerial gymnastics skills*. With this in mind, let us take a closer look not only at the mechanics involved in each of these critical impact phases but also at how these impact phases can maximize the quality of skill execution.

LEG IMPACT AND TAKE-OFF

The effectiveness of the take-off sets the uppermost limits of what the gymnast can hope to obtain during the airborne phase of any skill. During this moment, the path (trajectory) followed by the performer's center of gravity, as well as the quantity of rotary motion (angular momentum) available for skill execution, are irrevocably established. Because both of these variables are, without question, of utmost importance to success, we need to consider carefully the nature and function of each, and to examine their inherent interrelationships to the take-off itself.

*Once the gun has been fired, there is no turning back...
for the trajectory and momentum of its bullet
are irrevocably established!*

1. Trajectory

The term "trajectory" simply refers to the predetermined path taken by an airborne body as a direct result of its take-off. The horizontal and vertical velocities derived from impact give a trajectory its particular shape. Depending on the specific conditions existing during the take-off phase, an airborne body will follow either a direct vertical trajectory (straight up-and-down) or some parabolic trajectory.

A direct vertical trajectory occurs whenever only vertical velocity is involved—or to put it another way, it can only be realized in the absence of horizontal velocity. In these instances, the body's mass center simply rises and falls through the same vertical pathway. For example, if a performer were to execute a Standing Tucked Backward Somersault in a fashion that projected her directly upward (at a 90° angle to the horizontal), her center of mass would follow a direct vertical trajectory. Regardless of any rotational component in the somersault, a body projected straight up into the air will always return to the earth along the very same path. This is because, once airborne, the only significant variable affecting the path of the trajectory is acceleration due to gravity, and gravity, although ever present, acts only in one direction, i.e., vertically. Remember:

*Gravity,
that inevitably nagging fly,
has neither emotion nor conscience, only memory.*

Most airborne gymnastics skills involve the use of both vertical and horizontal velocities at take-off. In these common situations, the performer's center of mass is projected (takes-off) at an angle to the vertical and then follows a perfectly regular curved path called a parabola. The actual shape of the trajectory depends on the relative amounts of vertical and horizontal velocities realized as a direct result of the take-off. As shown in figure 5.1, whenever the vertical velocity at take-off is greater

than the horizontal velocity, the resultant trajectory's shape is comparatively high and short (example A). If the horizontal velocity is greater than the vertical, the trajectory is comparatively low and long (B). And if the horizontal and vertical velocities are equal, the performer's mass center will lift-off from (and return to) level ground at a 45° angle (C). In every case, however, notice *all trajectories are perfectly regular in shape, because their horizontal components remain constant while their vertical component, acceleration due to gravity, is uniform in effect and forever present.*

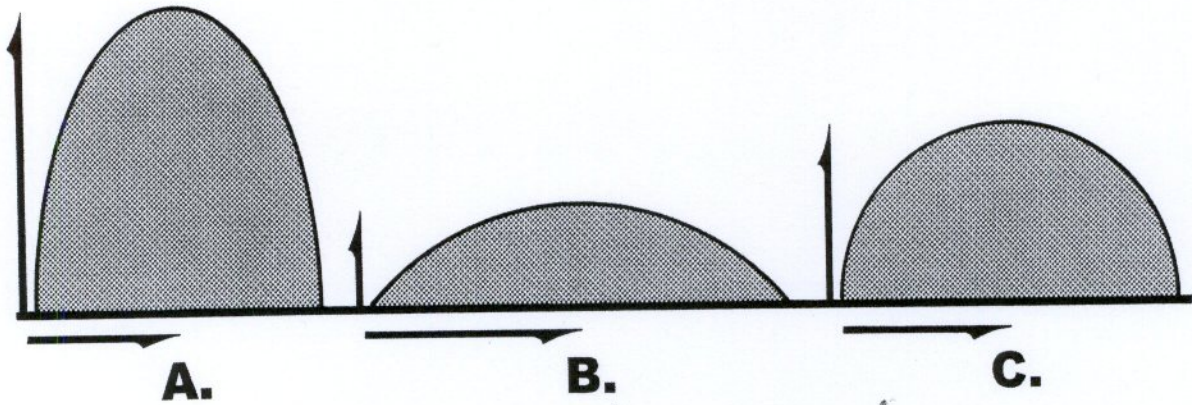


Figure 5.1. Comparative effects of vertical and horizontal velocity on parabolic trajectory: (A) greater vertical velocity = higher, shorter trajectory; (B) greater horizontal velocity = lower, longer trajectory; and (C) equal vertical and horizontal velocities = 45° angles.

In the Forward Handspring Forward Somersault sequence presented in figure 5.2, for example, the handspring trajectory prescribes a comparatively low, long shape (emphasizing horizontal amplitude), whereas the somersault trajectory is higher and shorter (emphasizing vertical amplitude). This is because a comparatively greater amount of horizontal motion is used for the handspring phase, whereas a greater amount of vertical motion is used for the somersault phase.

Although a number of gymnastics movements, such as the post-flight phases in Vaulting, emphasize the attainment of maximum amplitude in both directions, *vertical amplitude or "lift" invariably serves as the essential component to success in the majority of airborne skills.* The fact that it would be impossible to attain any amount of horizontal "travel" without some vertical "lift" substantiates this observation. And the continuous downward pull of gravity also makes the attainment of vertical amplitude noticeably more difficult to achieve than its counterpart, horizontal amplitude. For these reasons, *"lift" is generally considered the more essential factor of the two and, as such, deserves particular attention.*

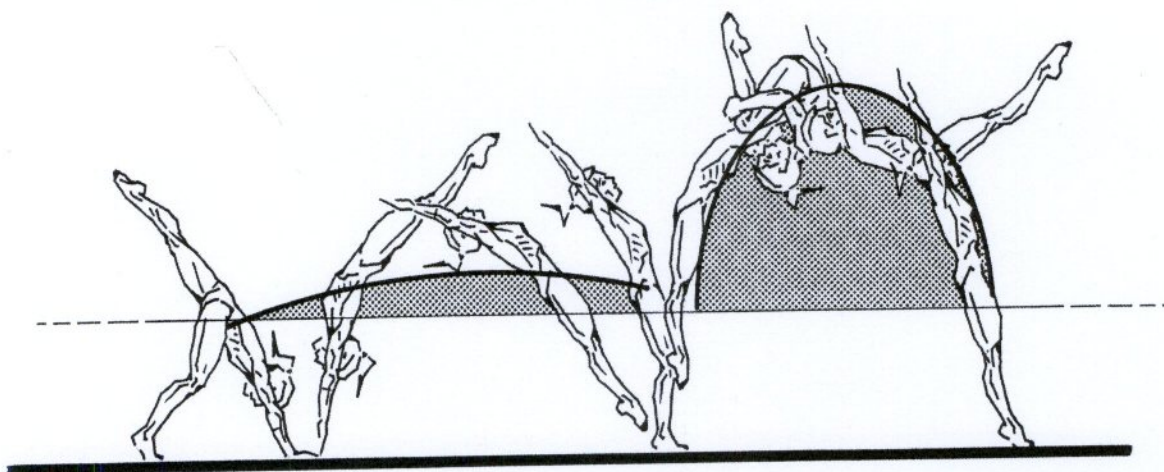


Figure 5.2. Comparative trajectories in executing a Forward Handspring into a Forward Somersault in tumbling.

A. Maximizing Lift

The *Layout Dive Forward Roll* presented in figure 5.3 provides a *basic model of how to maximize lift*. The degree to which maximum lift can be realized depends on the conditions existing at the precise moment of impact as well as on what occurs immediately following impact, i.e., the actual take-off.

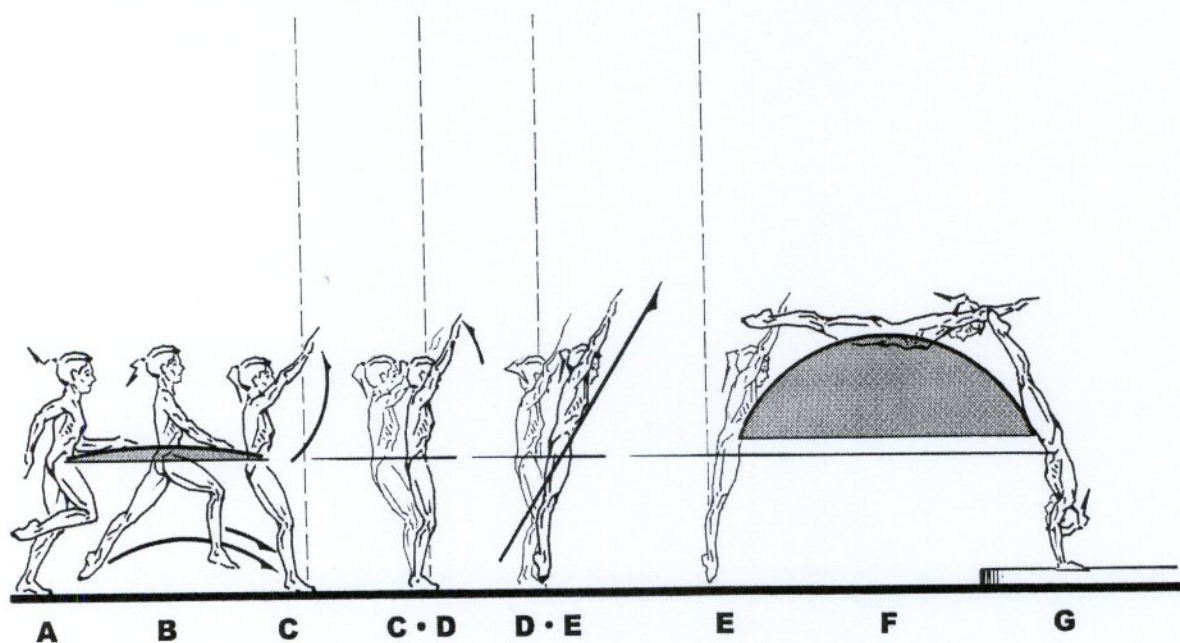


Figure 5.3. A conceptual model of the mechanics for maximizing lift in executing a Layout Dive Forward Roll: (A, B, C) hurdle phase; (C, D) impact phase; (D, E) take-off phase; and (E, F, G) airborne phase.

The nature of the run, and particularly the hurdle, sets the stage for conditions at impact. From a practical viewpoint, it should be obvious to most coaches that the smaller the amount of downward motion experienced as a result of the hurdle, the greater the resulting potential to maximize lift. What is perhaps not quite so obvious centers upon how to accomplish this and why it works. If the hurdle phase can be executed so the body's mass center continues moving forward very quickly (maximum controlled horizontal velocity), has a low, flat flight trajectory, and thus remains airborne for a very brief time, the performer will have little, if any, downward motion to contend with during actual impact. Employing a hurdle trajectory that is short, flat and fast is particularly advantageous in that, rather than wasting effort arresting unwarranted downward motion, the performer can instead use most, if not all, of her available impact force to generate the much-needed lift!

During the airborne phase of the hurdle (illustration B), notice the arms begin to rise rapidly in a fore-upward direction. In the same time frame, also notice the total body unit rotates slightly counterclockwise to a point such that an observable backward-leaning body angle relative to the vertical is formed. *This shift in the total body unit, which allows the feet to make contact with the ground (C) at a point well in front of the body's mass center, is often referred to as "blocking."*

Many gymnasts, as well as coaches and teachers, are as familiar with leg action during the blocking phase as they are unfamiliar with arm and trunk actions. All too often, one observes the aspiring performer, though blocking correctly with the legs and feet, bent over at the hips and shoulders, resulting in a forward-leaning angle of the upper body. This state of affairs not only sorely compromises correct body shape at take-off, but—worse—significantly interferes with the proper timing sequence between the arm drive and the leg impact.

Simply put, *proper execution of a Layout Dive Forward Roll requires that the performer's trunk to remain upright and her arms to rise rapidly overhead at the moment of touch-down.* However, as the legs forcefully impact the ground, this rapid fore-upward arm drive should be instantaneously stopped (C, D). This timely but abrupt deceleration of the arm-swing causes its momentum to be transferred into the total body. *Precise timing specific to the stopping action of the arms with the impact action of the legs, is essential to ensure maximum momentum transfer into the total body unit.*

B. Optimizing the Angle of Input for Take-Off

Selecting the precise blocking angle (*angle of input*) is also an essential ingredient for optimum execution of the skill.¹ *The degree of blocking angle employed by the total body unit at touch-down should be such that the performer can summate her available forces in a precise vertical direction.* Practically speaking, selecting the appropriate amount of total body lean (blocking angle) is determined by the speed and direction of the performer's mass center at touch-down. In other words, *the faster, flatter, and shorter the hurdle trajectory, the greater must be the angle of block if maximum lift is to be achieved.* The ideal situation, of course, would be to attain a maximum controlled horizontal speed during the hurdle and then block quickly in accordance with that speed.

In illustrations C and D of figure 5.3, notice the force of impact causes the ankle, knee, and hip joints to undergo momentary, slight flexion. Although this would appear to contribute to downward motion, such an effect is essentially cancelled out, because at the same moment, the total body unit is also pivoting fore-upward about the feet, which are firmly anchored to the mat. As a result, the performer's center of mass travels horizontally forward during actual impact!

Through the entire movement sequence, it is important to emphasize proper body shape and tension. *Standing as tall as possible, particularly during impact, maximizes the height of the performer's mass center from the start* and thus adds to the potential vertical height that can ultimately be achieved from the ground. In addition, greater downward force can be exerted against the ground in a shorter period of time when the ankle, knee, and hip joints are extending into the impact from a slightly flexed rather than deeply flexed position. Going into the actual impact phase, the wise performer should remind herself to:

*Rise up, stand tall!
Pretend to be a giant!*

Assuming that all these impact conditions are favorably met, the amount of "lift" the performer can ultimately hope to attain now depends on the effectiveness of the take-off itself. More specifically, it is the product of the magnitude of vertical forces exerted against the ground and the length of time during which these forces act. This quantity, known as *vertical impulse*, is defined mathematically as *impulse = force x time*.

¹ "Angle of input," often referred to as "blocking" or "blocking action," can be defined as the angle formed by the total body unit (center of mass) relative to the vertical at the exact moment the performer impacts the ground, board, or other apparatus.

With this in mind, it seems reasonable to suggest that a performer attempting to improve vertical lift from the ground should strive to maximize both force and time—however, this not the case, as *studies of jumping activities have repeatedly shown that a shorter take-off time results in comparatively greater lift from the ground.*

Although this may appear paradoxical at first glance, there exists at least one logical explanation for such a perplexing discovery. Assuming no differences in conditions at impact, suppose that as the time of force application decreased, the magnitude of vertical forces increased, and at a proportionately greater rate than the time decreased! Such an interaction would account for why greater net vertical lift can be attained with a shorter take-off time.

Precisely how the human body accomplishes this feat is not fully understood. From a practical point of view, though, it is more important for us to understand that upon impact, a brief and very slight flexion reaction of the legs followed by *an instantaneous and most forceful extension results in a short take-off time, and a shorter take-off time produces greater lift than a longer one* (D, E, F). Simply put:

*The most effective impacts
are
hard and fast!*

2. Angular Momentum

In gymnastics, *angular momentum is defined as the "quantity" of rotary motion available for skill execution.* Although it can be, and very often is, transferred from one body part to another, the actual initiation of rotary motion inevitably originates from the ground (or the apparatus, which is firmly affixed to the ground). Depending on the nature of the skill in question, *a performer can employ one or a combination of the following techniques to generate the appropriate quantity of rotary motion.*

A. Transferring Momentum from Part to Whole

A number of skills require that the gymnast initiate rotation without benefit of any already-existing motion. For example, consider the mechanics presented in figure 5.4 for initiating a Backward Somersault from a Stand. Starting from a fully extended standing position (illustration A), the performer briefly assumes a semi-squat stance (B) and then immediately pushes against the ground by forcefully extending her legs and feet. At the same moment, the ground pushes against the performer with a force equal in magnitude but opposite in direction (C). It should be obvious that the performer's push force against the ground,

however great, is not of sufficient magnitude to move the colossal mass of the earth! Yet *the equal, opposite, and simultaneous reaction force of the earth is of sufficient magnitude to cause upward motion (lift) of the performer (D).*

As the leg-push against the ground is occurring, notice also that the performer is rapidly throwing her arms, head, and torso in an upward-backward direction (C). This powerful extension action of the upper body in a clockwise direction causes the lower body to want to move simultaneously in the opposite (counter-clockwise) direction. However, the lower body cannot move in the opposite direction, because at this moment, the performer's feet are firmly affixed to the ground. In other words, the previously described forceful leg drive against the ground has established a momentarily "anchored" base of support about which the freely swinging upper half of the body can rotate.

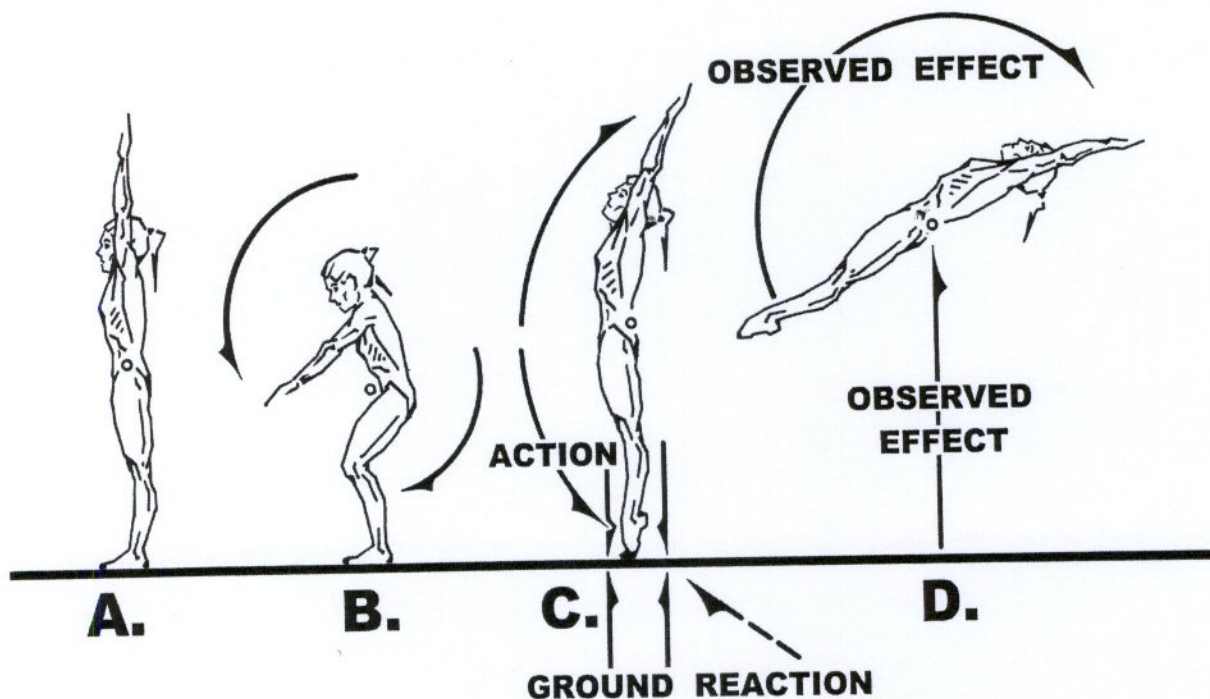


Figure 5.4. The mechanics for initiating a Backward Somersault from a Stand.

Just prior to becoming airborne, the rapid throwing motion of the upper body is abruptly stopped, causing its backward momentum to be transferred into the total body unit.² The speed and direction of the upper-body throw establishes the potential quantity of rotation available for transfer, whereas the quickness with which this throwing action can be stopped largely determines the net effectiveness of this transfer (C). When action-reaction is properly timed, the observed effects of these events are vertical lift of the total body unit off the ground, and backward rotation about the performer's center of mass (D).

² Refer to *Transfer of Momentum* in chapter 4.

You get what you give.
There is perfect justice in the universe.
—Chic Johnson

It is important to emphasize: the amount of lift achieved depends directly on the power generated by the performer relative to her weight. Consequently, it must be recognized that without the capability to generate sufficient power for the given skill in the first place, all the technique in the world will not get her there! *Power-to-weight ratio is specific to the person, and can be significantly improved by any aspiring gymnast through a carefully planned program of power-oriented vertical jumping drills.*

While "technique" may be the "transmission,"
never forget that
"muscular power" is the "engine"!

B. Altering the Direction of Take-Off

Direction of take-off is another important variable affecting the potential quantity of available rotary motion. As depicted in figure 5.5, whenever the performer takes-off in a direction opposite the intended rotation, e.g., traveling forward while attempting to rotate backward—as in a Gainer Backward Somersault (example 1)—a portion of the backward rotary motion must be "spent" accomplishing this change in direction, i.e., forward travel. This is why *rotation becomes increasingly more difficult to generate in all gainer-oriented skills.* On the other hand, when the take-off is in the same direction as the intended rotation, i.e., traveling backward while rotating backward—as in a Backward Handspring (2)—a portion of potential vertical lift can be "traded-off" for increased rotation.

Because almost every advanced tumbling and vault skill requires an extremely large amount of angular momentum, the position of the body's mass center relative to the vertical at actual take-off is observed to be leaning (and thus traveling) in the same direction as the intended rotation. When performing skills involving multiple somersaults, for example, *the wise gymnast is always willing to trade-off a small portion of vertical lift to reap the tremendous dividends in rotation!*

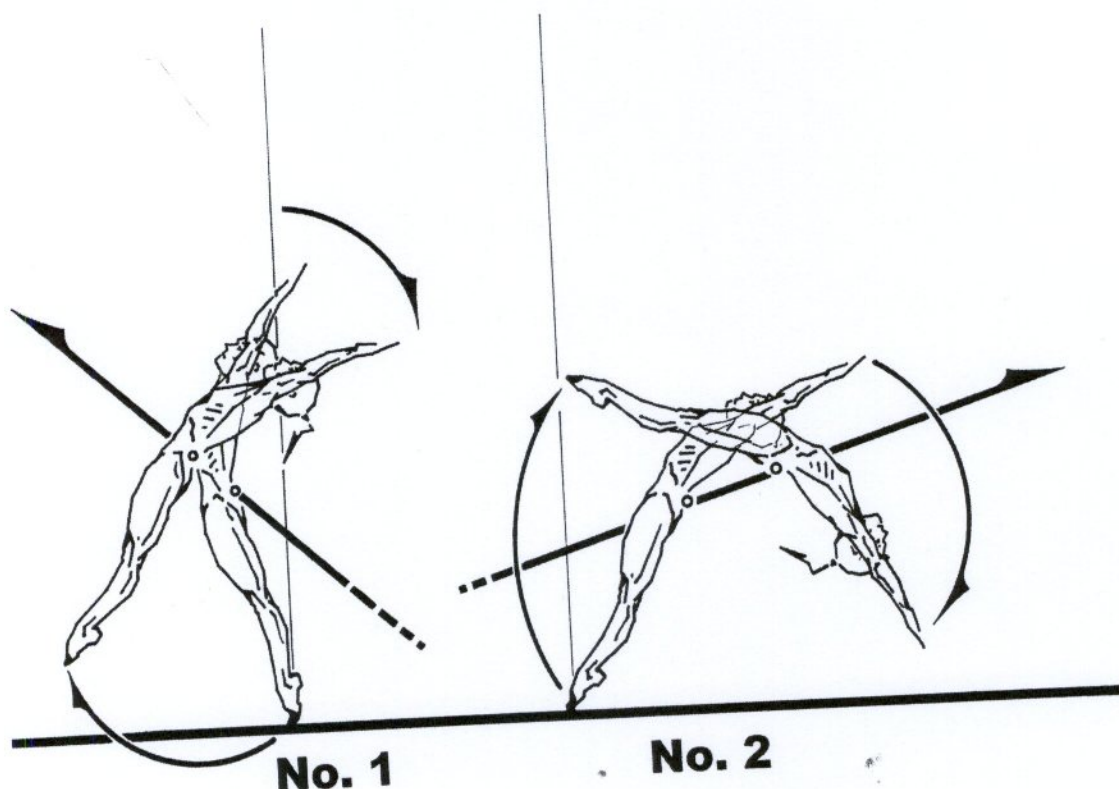


Figure 5.5. Comparative effects of take-off direction on rotary motion: (1) Gainer Somersault take-off inhibits rotation; and (2) Backward Handspring take-off facilitates rotation.

C. Converting Horizontal Motion into Rotary Motion

Imagine what would happen to a basketball after being vertically dropped out of an automobile traveling horizontally forward at a relatively slow rate of speed. After striking the ground in a fore-downward direction, the ball would not only begin to rebound in a fore-upward direction but would also possess a given quantity of rotary motion or spin. This spinning effect occurs because a portion of the ball's horizontal motion is converted into rotary motion upon impact. By comparison, if the auto (and thus the ball) were traveling horizontally forward at a high rate of speed, a significantly greater amount of spin would be imparted to the ball. Consequently, *the amount of horizontal motion an object possesses at impact bears a direct relationship to the amount of resulting rotary motion observed in its rebound.*

The quantity of rotary motion that must be generated to execute advanced tumbling and vault skills successfully is also largely regulated by the amount of horizontal motion the gymnast achieves upon impact. For precisely at this moment, the performer's mass center begins to rotate about her feet, which are

momentarily anchored to the ground. Or in more mundane terms, *if you want to turn double and triple somersaults, you'd better be "movin' on down the road"!*

*The greater the horizontal velocity at impact,
the greater the resulting rotary motion at take-off.*

To gather a maximum quantity of rotary motion, a gymnast is often required to take full advantage of all three techniques. For example, in figure 5.6, consider the rather large amount of angular momentum required to execute a Triple Backward Somersault from a traditional tumbling sequence. By generating as much horizontal motion as mechanically possible during the run, hurdle, Round-Off, and handspring phases, a comparatively greater quantity of this horizontal motion can be converted into the much-needed backward rotary motion, a necessary prerequisite to successful completion of the triple somersault. This is precisely why *the trajectories of these lead-in or set-up skills must be flat in terms of shape, brief in terms of time interval, and most importantly, very, very fast in terms of horizontal velocity.*

In addition, notice the shape of the resultant trajectory for the triple somersault is flatter, longer, and therefore lower than it would normally be for a single somersault. This is because *the performer wisely chooses to alter her direction of take-off* from an essentially upward mode in favor of a more back-upward mode. As mentioned, *trading-off a small measure of lift allows the performer an opportunity to reap significant dividends in much-needed rotation!*

To achieve the necessary vertical lift, the performer's legs and feet must produce an instantaneous, powerful punching action against the ground. Notice that a vigorous and powerful "whip action" of the arms, head, and trunk in a back-upward direction is also occurring. And of equal importance during this same time frame, notice *this forceful upper-body whip action is abruptly stopped, causing its momentum to be transferred into the total body.* Keep in mind:

*Without sufficient angular momentum at one's disposal,
championship performance
remains forever a dream...*

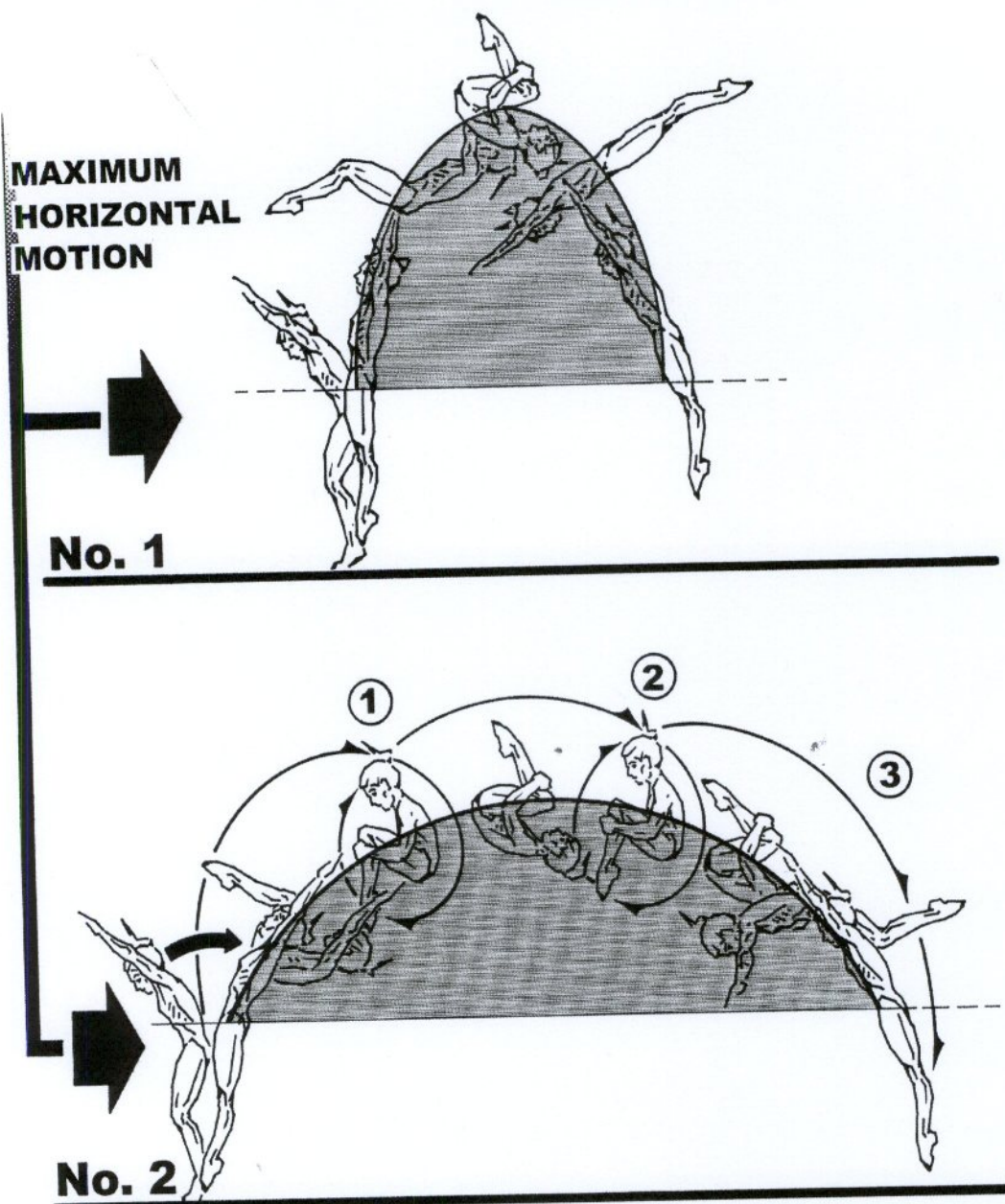


Figure 5.6. Examples of altering take-off direction to facilitate rotary potential in tumbling: (1) Single Backward Somersault; and (2) Triple Backward Somersault.

3. The Trajectory-Angular Momentum Relationship

Although the direction and speed of a performer's mass center during impact and at take-off significantly affect the potential outcome of any performance, they constitute only part of the total picture. The gymnast must also clearly understand exactly what she is trying to accomplish, i.e., the specific airborne objective of the intended skill. In addition to having an accurate conceptual model of the desired

trajectory shape (lift and travel) and knowing how much angular momentum (rotation) is required, the performer must also be critically aware of the effect that each of these variables has upon the others. *For lift, travel, and rotation are mutually interdependent and cannot truly be separated in the practical sense. Any change in one necessarily requires some adjustment or change in the others, i.e., trading off a portion of one for greater emphasis in another.*

In this light, the following principles are provided not only to demonstrate the close interrelationship between these variables but also to serve as important guidelines for ensuring proper mechanics of the take-off:

- As lift is increasingly emphasized, the resulting travel progressively decreases, while the difficulty in attaining rotation progressively increases;
- As rotation is increasingly emphasized, the resulting travel progressively decreases, while the difficulty in attaining lift progressively increases; and
- As travel is increasingly emphasized, the resulting lift progressively decreases, while the difficulty in attaining rotation progressively increases.

In multiple-somersault skills, it is important to note that *travel is the variable that must be spent to achieve greater emphasis in both lift and rotation.* Consequently, it is wise to ensure sufficient horizontal motion (travel) prior to actual impact in virtually all multiple-somersault skills and—as we will discover—particularly those characterized by a twist component!

It must be reemphasized that having *a clear understanding of the nature and function of each skill's airborne objective is essential for proper utilization of these variables.* For example, the performer must know whether the motion emphasis centers on attaining vertical amplitude, as in a single somersault (maximum lift with rotation); horizontal amplitude, as in a Backward Handspring (maximum travel with rotation); or perhaps a combination of all three variables, as in the post-flight phases of elite-level vaulting skills (lift, travel, and rotation).

In every case, however, *the wise performer attempts to maximize the most essential variable(s) to the fullest extent while still directing just enough take-off force to accomplish the variable(s) of lesser importance.*

Championship skill execution is essentially a matter of learning how to strike the most effective balance in lift, travel, and rotation.

4. The Angle of Input

The relative amounts of lift, travel, and rotation required for a given airborne skill are largely determined by the performer's chosen angle of input, or blocking angle, which occurs at actual touch-down. As described earlier, *the angle of input refers to the angle formed by the body's center of mass relative to the vertical at the exact moment the performer impacts the ground, board, or vault table.*

To demonstrate how a chosen angle of input affects the outcome of any tumbling or vaulting skill, compare the three different angles of input that can be employed in the snap-down phase of a Round-Off, presented in figure 5.7. (For purposes of clarity, assume that all other lead-in conditions specific to the Round-Off are the same.)

Because the performer in the first example has a rather large angle of block in a direction opposite the intended motion, the opportunity to emphasize maximum *lift* at the expense of some rotation and travel is made available, i.e., Tucked Backward Somersault. In the second example, because the blocking angle is quite small (approaching zero degrees relative to the vertical), the opportunity to generate maximum *rotation* at the expense of some lift and travel is made available, i.e., Double Backward Somersault. The angle of block in the third example is in the same direction as the intended rotation, so the opportunity to emphasize *travel* at the expense of some rotation and lift becomes readily apparent, i.e., Backward Handspring. *The angle of input can therefore be considered a major source, a causative factor, a controllable variable that significantly influences the nature of the trade-off between a performer's trajectory and her available angular momentum.*

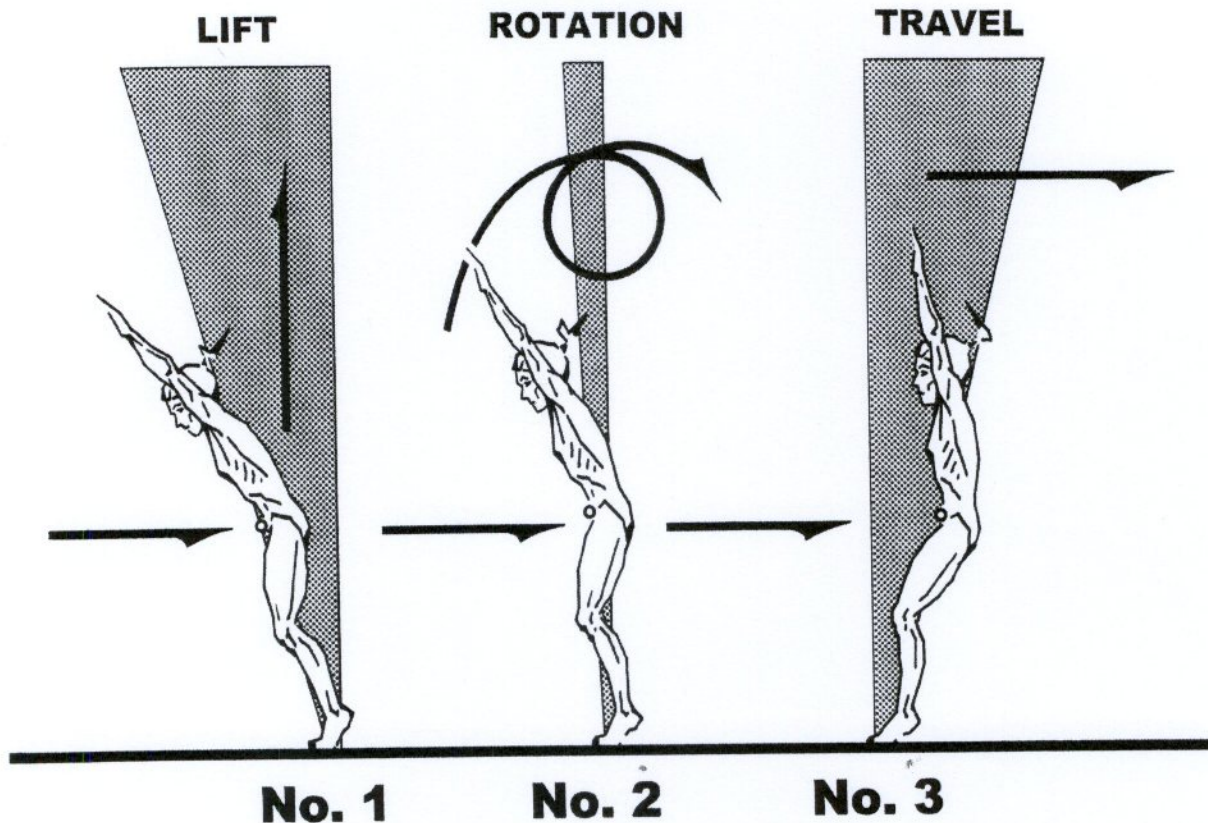


Figure 5.7. Comparative angles of input out of a Round-Off in executing specific airborne skills: (1) emphasizes lift, as in a Tucked Backward Somersault; (2) emphasizes rotation, as in a Double Backward Somersault; and (3) emphasizes travel, as in a Backward Handspring.

It is a common misconception that, because gymnastics skills differ in terms of their objectives, different mechanical techniques must therefore be employed. However careful observation reveals that *the vast majority of such differences in mechanical technique exist more in terms of degree than in kind!* For example, the body shapes presented in figure 5.8 are exactly the same as those in figure 5.7, except their reference planes have been rotated so the angles of input (body lean) at touch-down are identical. *Because no change has been made in terms of actual body shape, a striking degree of mechanical similarity becomes quite obvious!* This is but one of innumerable instances which can be cited in support of the premise that *there are basic movement principles which have relevant, universal application to gymnastics technique* and serve to clarify correct technical execution for a broad category of skills.

*The pieces to the puzzle are easiest to resolve
when viewed in terms of relationships.*

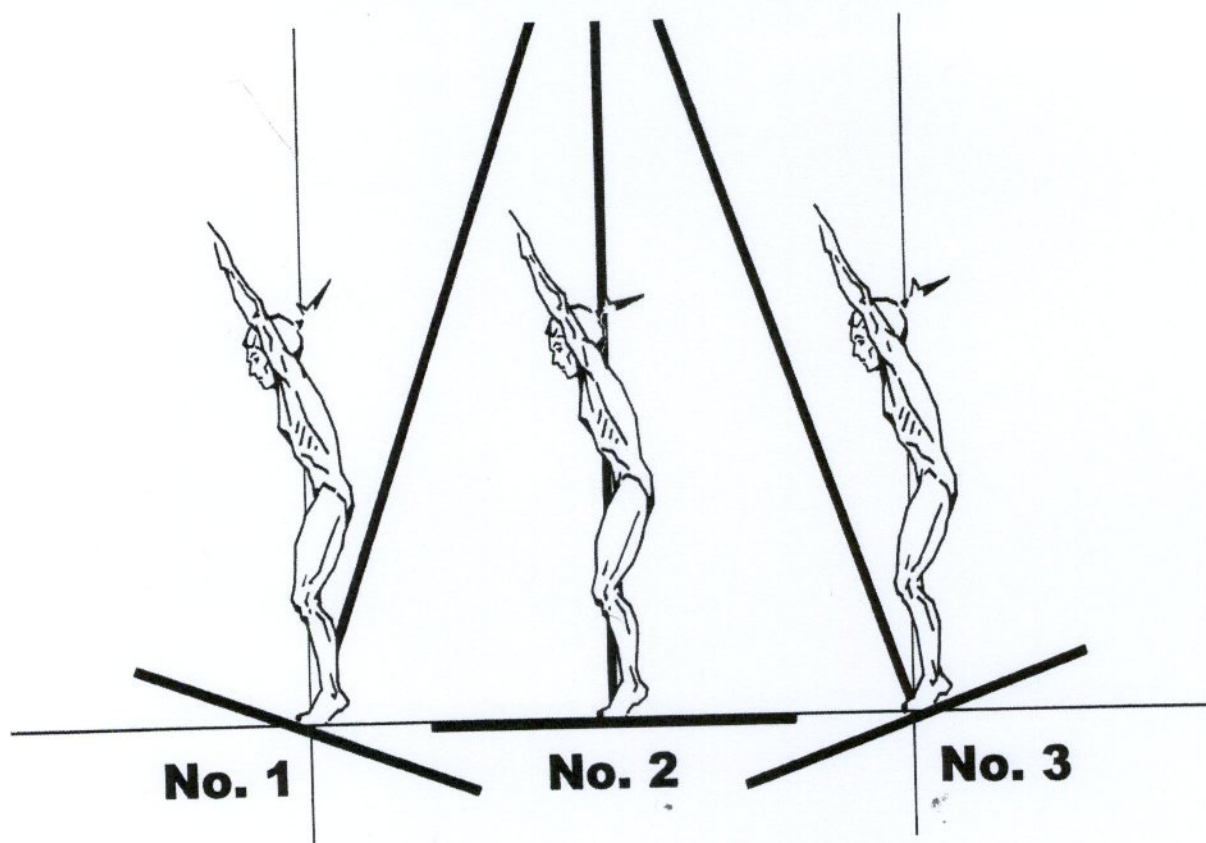


Figure 5.8. Rotating the reference planes to match their respective angles of input reveals a high degree of mechanical similarity among all leg-impact skills.

HAND IMPACT AND REPULSION

Most vault and tumbling sequences can be described as a precisely timed series of impacts alternating "feet-then-hands-then-feet" in a reciprocating fashion. *Although the hands, arms, and shoulder girdle serve as the body's prime repulsion mechanisms during the inverted-support phase of any skill, the actual principles involved in generating continued lift, travel, and rotation are identical to those already presented for leg-oriented take-offs.*

For example, figure 5.9 shows the three critical phases in a Handspring Piked Forward Somersault Vault: hurdle trajectory (A), pre-flight trajectory (B), and post-flight trajectory (C). Just as the run, hurdle, and board impact collectively set the stage for the take-off, so too does the take-off, pre-flight, and vault table impact set the stage for the repulsion. In light of this "sequential cumulative effect," let us consider how each trajectory builds on the preceding trajectory to generate optimum execution of the vault.

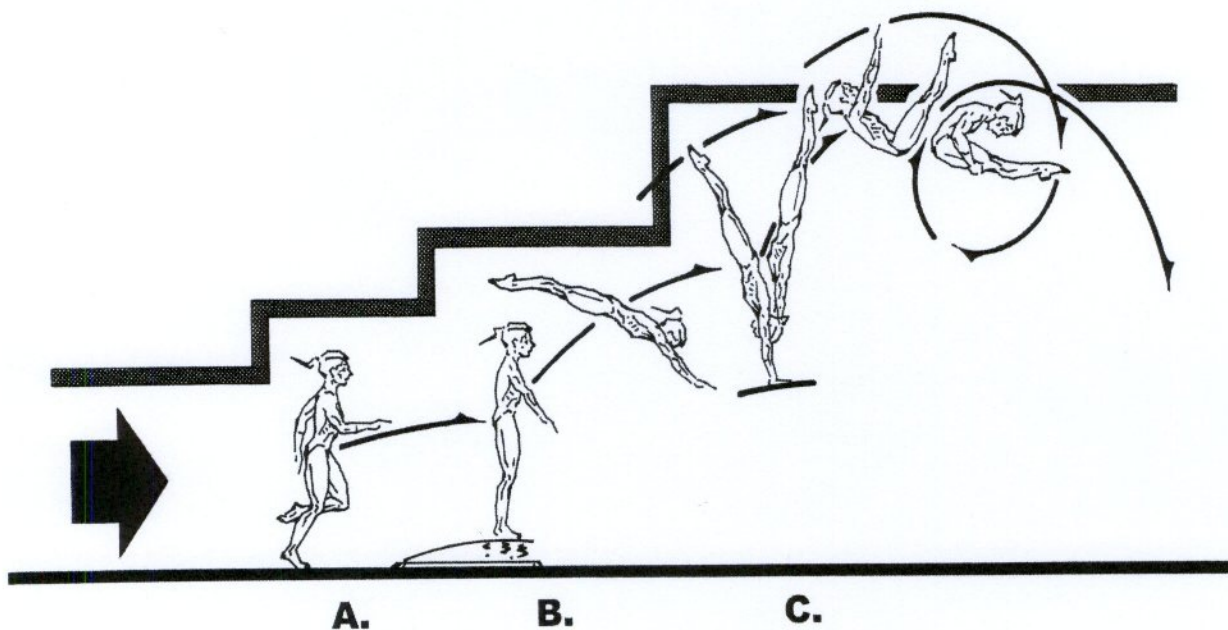


Figure 5.9. Critical phases in executing a Handspring Piked Forward Somersault Vault: (A) hurdle trajectory; (B) pre-flight trajectory; (C) post-flight trajectory.

Because attaining increased vertical amplitude off the vault table is an important objective of the arm-repulsion phase, *the performer should make hand contact with the table as soon as possible during the ascent phase of the pre-flight trajectory.* For this to be possible, the pre-flight trajectory must possess the same characteristics as its preceding hurdle trajectory, i.e., be short, flat, and very fast. Notice also that *the hands travel directly to the table in the pre-flight phase.* Such a consideration minimizes the downward motion at impact and allows for a quicker, more forceful repulsion from the vault table, thereby increasing vertical lift.

In addition to maximizing the lift component, a rather large amount of rotary motion is required in this skill's post-flight phase, which is a $1\frac{1}{2}$ Forward Somersault from hands to feet in the piked position. *The performer must trade-off a small portion of horizontal velocity (travel) to reap tremendous dividends in rotation.* And only through a short, flat, very fast hurdle trajectory, an instantaneous take-off, and a short, flat, very fast pre-flight trajectory can enough horizontal motion be made available to accomplish all three post-flight objectives: attaining maximum *lift* with sufficient *rotation* for the somersault while still achieving adequate *travel* from the vault table.

Along with capitalizing on the already-existing horizontal motion of the pre-flight phase, the performer should employ an additional technique during the arm-repulsion phase to enhance that much needed rotation. As shown in figure 5.9, the short, flat, very

fast hurdle trajectory followed by a comparatively small angle of input at touch-down greatly increases the forward rotary motion of the take-off.

This state of affairs helps establish a pre-flight trajectory very similar to the hurdle trajectory but with *an important addition: a large quantity of forward rotary motion, which is essential to maximizing the post-flight phase.* As a result the performer can capitalize on this increased forward rotary motion in pre-flight by exerting a forceful fore-downward impact against the vault table at hand contact. This type of repulsion action causes the freely swinging lower half of the body to rotate quickly about the momentarily anchored upper half. The net effect is transfer of momentum from the lower body into the total body, further increasing the rotary potential in the upcoming post-flight phase.

1. Shoulder Girdle Action

Although powerful arms play an important role during impact and repulsion for any skill having a hand-support phase, their ultimate effectiveness inevitably depends on the performer's ability to take maximum advantage of concomitant shoulder girdle action, i.e., the "lifting effect" on the total body unit from forcefully elevating the shoulder girdle.³ *Precisely when this elevation action of the shoulder girdle should occur is contingent on the nature of the skill's input trajectory:*

- If the skill is of a nature such that hand impact can be realized during the ascent phase of the input trajectory (as in the repulsion phase of a vault), the shoulder girdle should powerfully move, or "explode," into a position of full elevation just as the hands make contact with the vault table. This timely action of exploding into full shoulder girdle elevation at hand contact provides further lifting impetus to an already-rising body; whereas
- If the skill is of a nature such that hand impact cannot be realized until the initial descent phase of the input trajectory (as in typical tumbling sequences), the shoulder girdle should already be fully elevated prior to contact. This ensures hand contact with the ground at the earliest possible moment, thus minimizing unwarranted downward motion. In these instances, the fully elevated shoulder girdle, upon sustaining the oncoming impact, momentarily undergoes slight depression and then instantly returns (*ballistic kick-back action*) to full elevation, projecting the body vertically into the air.

³ For additional information specific to shoulder girdle motions, refer to chapter 3.

It should be emphasized that *effective execution is determined not so much by shoulder girdle "position" as it is by virtue of shoulder girdle "action."* In virtually all power-oriented skills, it is not static positions that count, but rather dynamic movement patterns. With correct patterns, proper positions will be achieved (cause-effect). Keep in mind:

*Successful execution reveals itself not simply in the "position"
but rather in the "motion."*

The lifting effect of vigorous shoulder girdle elevation should always be accompanied by another, more subtle shoulder girdle action, i.e., protraction or retraction. The direction of this action depends on whether the intent of the skill is to rotate forward or backward as a result of the repulsion phase. In this light, the following arm-repulsion guidelines can be applied to all tumbling and vault skills:

- In backward-rotating skills, as the lifting effect of elevation occurs, the shoulder girdle should be simultaneously rounding or hollowing forward about the trunk. This concomitant shoulder girdle *protraction* during the repulsion phase facilitates backward rotary motion of the total body unit; whereas
- In forward-rotating skills, as the lifting effect of elevation occurs, the shoulder girdle should be simultaneously flattening or retracting backward about the trunk. This concomitant shoulder girdle *retraction* during the repulsion phase facilitates forward rotary motion of the total body unit.

LEG IMPACT AND LANDING

The basic objective of the landing is to reduce the performer's linear and rotary motions effectively to zero once ground contact is made. Although this may appear to be relatively simple to master, in practice it is often very difficult. Most successful coaches agree that *more often than not, the ability to stick the landing serves as "the great separator" between champions and would-be champions.* This is because the very nature of any landing is contingent on all that has gone before it. Seemingly minor inaccuracies in the skill's earlier phases often add up to produce major difficulties in the landing. In fact, *consistently poor control in the landing phase of a skill is usually a strong indication that the real problem lies with one or more of the preceding phases.*

To achieve a controlled landing, the gymnast must be able to accurately determine the precise position of her body relative to the ground throughout the airborne phase of the skill. This is why *effective use of the eyes, or "sighting," to establish a fixed frame of reference (the landing area) is so important.* By striving to see the oncoming ground

early in the airborne phase, the gymnast can better anticipate what to do in the landing phase. Rather than letting the ground suddenly appear as a last-minute surprise, *the wise gymnast sights it early in the airborne trajectory*. In so doing, she can *stretch for the ground* with her legs and feet before the full force of her landing momentum takes effect. *This ability to effectuate an early touch-down allows the gymnast to apply her stopping force through a greater distance, which, more often than not, translates into sticking the dismount.*

*Even the mightiest of eagles spreads its wings,
stretching downward with its feet
just prior to touch-down...*

This point is demonstrated by the techniques presented in figure 5.10 for landing a basic Yurchenko Vault. Because performer 1 fails to sight the ground until comparatively late in the descent phase, she does not have sufficient time to attain a fully extended body shape prior to touch-down. And *contacting the ground with a less-than-fully-extended shape reduces the potential distance through which the performer's stopping (landing) force can be applied*. Because her stopping distance is quite small, the realized force of impact is comparatively large—this often causes a rebound effect on the mat, i.e., hopping, stepping, or loss of control.

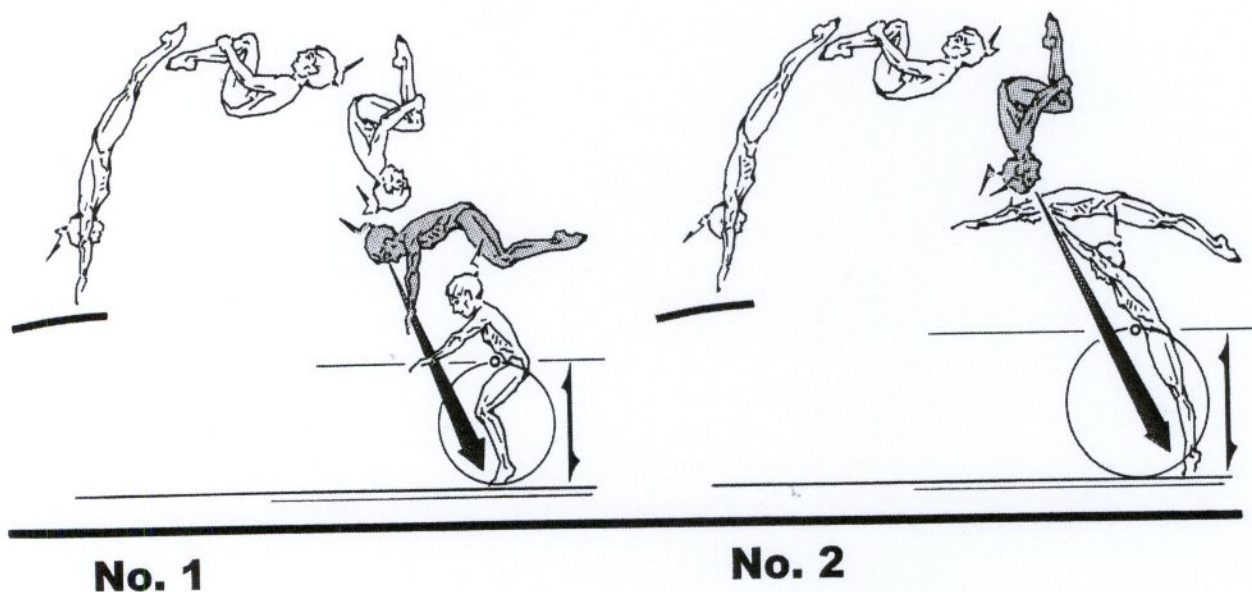


Figure 5.10. Comparative landing techniques in executing a Yurchenko Vault: (1) late sighting = incomplete extension = poor technique; and (2) early sighting = complete extension = good technique.

Notice performer 2 sights the ground comparatively early in the descent phase of the post-flight trajectory. As a result, she can assume a fully elongated body shape prior to touch-down. Also, maximizing the distance over which her stopping force can be applied reduces the actual force of impact at each interval in the landing phase (compare the vertical arrows at the moment of touch-down in each example). *Achieving full body extension prior to the actual landing is important for at least five good reasons:*

- The resulting angular velocity during this moment is reduced, thereby allowing for greater control in the upcoming landing phase.
- A more extended touch-down gives the performer a mechanical advantage in terms of her ability to apply a greater amount of stopping force.
- Less muscular effort is required to decelerate the body to zero.
- There is less "eccentric stress" on the legs, particularly at the knee joints.
- The rebound effect of the landing mat is substantially reduced, thereby increasing the performer's potential to stick the landing.

Simply put, the wise performer knows that to set the stage for maximum control of any landing, she must *establish a fixed frame of reference* for landing, *maintain early and continuous visual contact with the ground*, *reach for the ground* with her feet prior to landing, and *give in sufficiently with the legs* upon touch-down.

*For every controlled landing, the ground beckons,
"See me, touch me, feel me..."*

1. Landing Techniques

A common error often observed in landings centers upon the gymnast's failure to take proper advantage of ankle, knee, and hip flexion for efficient absorption of the impact force. The fundamental reason for this insufficient bending upon landing is *lack of muscular strength at these joints' deeper ranges of flexion.* Rather than employing an absorptive bending action of the legs through a sufficient range of motion, the poorly conditioned athlete attempts to compensate for this strength deficiency with a "punch action" against the mat at touch-down. As a direct result of this compensatory technique, the impact force upon landing is significantly increased, causing a rebound effect on the mat, which results in the inability to consistently stick the dismount.

Strive to land as a feather on rice paper...

As noted, proper landing technique requires the performer to reach for the ground with her legs and feet immediately prior to touch-down. And upon actual touch-down, every effort should be made to attenuate the impact force by bending sufficiently at the ankles, knees, and hips. All other things being equal, *the performer who makes contact with the mat sooner rather than later, and applies her stopping force over a greater rather than a lesser distance, is most likely to stick the landing consistently.*

2. The Angle of Touch-Down

*Just as the "angle of input" directly influences the characteristics of the take-off, so too does the "angle of touch-down" (landing angle) significantly affect the accuracy and control of the landing.*⁴ Selecting the most appropriate landing angle depends on the nature of the given skill and how well it has been executed. Assuming the movement sequence is properly executed, the following guidelines should prove helpful:

- If the body is traveling and rotating in the same direction, the performer should counteract this momentum by touching-down with the body leaning in the exact opposite direction. (See example 1 in figure 5.11.) Establishing the actual degree of this landing angle depends directly on the combined horizontal and rotary motion in the skill's airborne phase. *Greater quantities of these motions in the airborne phase require a correspondingly greater angle of touch-down in the landing phase.*
- If the body is traveling in one direction and rotating in the opposite direction, little or no body lean at touch-down is necessary. (See example 2 in figure 5.11.) This is because the effects of these directly opposing motions tend mostly to cancel out. Consequently, a more upright body position—less, if any, angle of touch-down—can be employed in the landing phase.

Regardless of scenario, the optimum angle of touch-down depends on the nature of the skill and the quality of its execution as well as on the kinesthetic and perceptual capabilities of the performer. This is why:

*Tedious repetition of successful execution of the skill
is so important to learning precisely
"how" to stick the landing.*

⁴ Angle of touch-down, often referred to as "landing angle," can be defined as the angle formed by the body's center of mass relative to the vertical at the exact moment the performer's feet contact the ground.

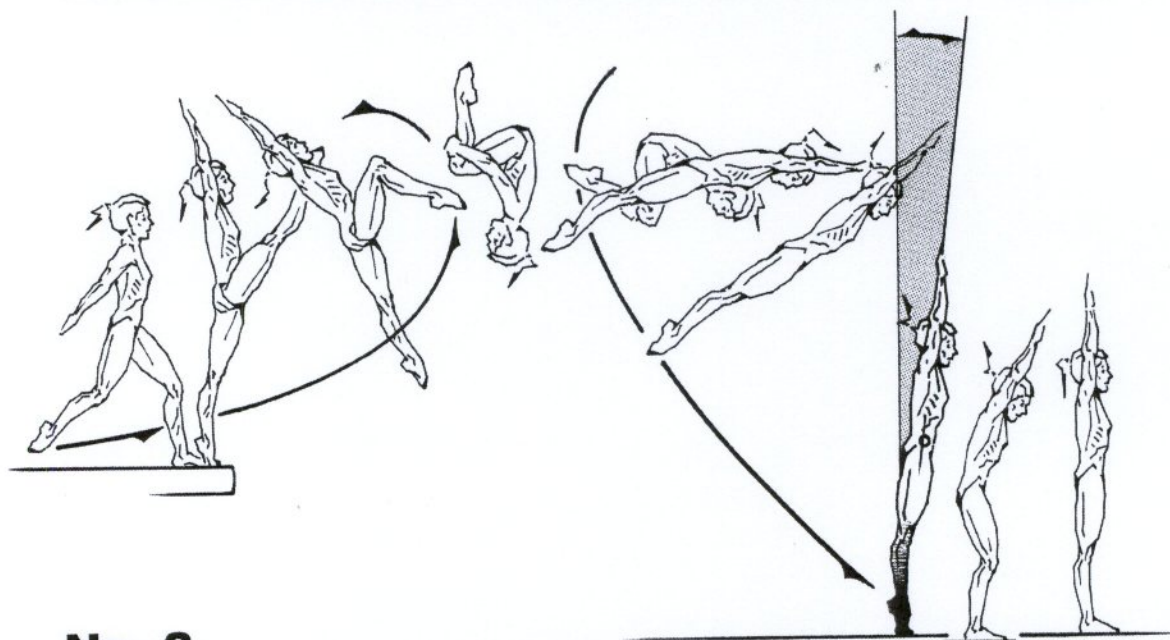
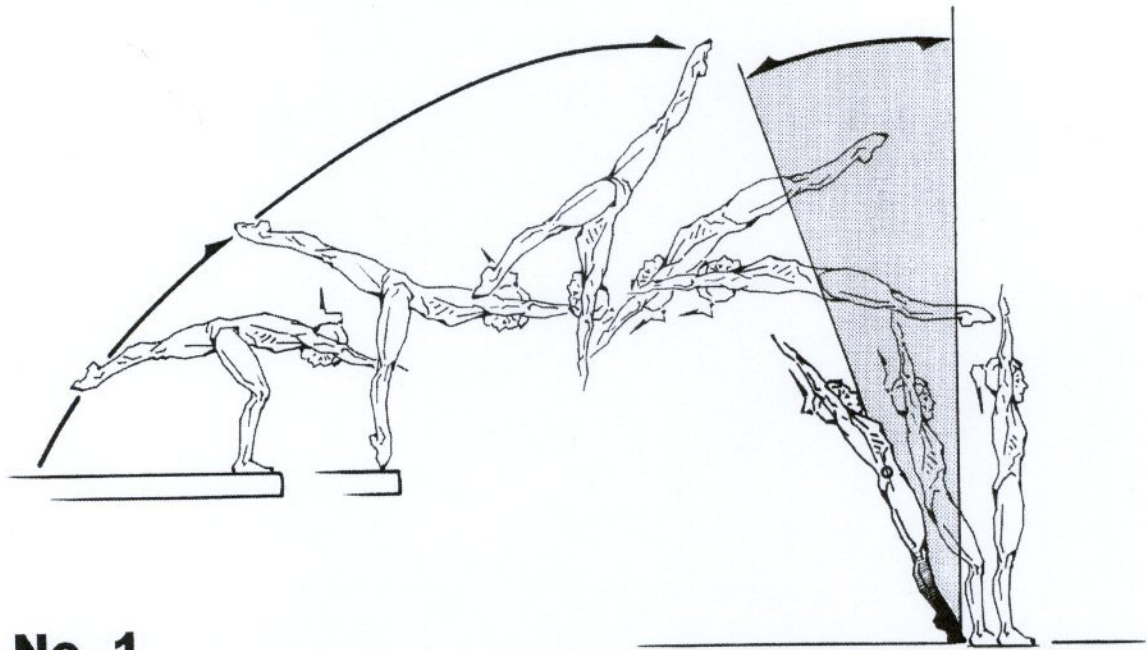


Figure 5.11. Comparative angles of touch-down for improving landing control: (1) Forward Aerial Dismount = traveling and rotating in the same direction = larger angle; and (2) Tucked Backward Gainer Dismount = traveling and rotating in opposite directions = smaller angle.

SIMILARITIES IN MOVEMENT PATTERNS

All properly executed gymnastics skills follow a specific sequence of movements, and skills involving "impact" are no exception. In fact, an overriding pattern of similarity exists in virtually all skills. In earlier sections of this book, for example, it was discussed that landings are essentially the reciprocal of take-offs. From a conceptual viewpoint, they are what the backward roll is to the forward roll—the very same techniques are employed, only the sequence is reversed. Just as a wave at sea progressively builds on itself to unfold its might at the crest, so too does the gymnast progressively unfold her body parts in a specifically designed sequence to optimize skill execution. *This flow pattern, often referred to as the "kinetic chain of the movement," travels either up the body from feet to hands or down the body from hands to feet, depending on the skill's objective.*

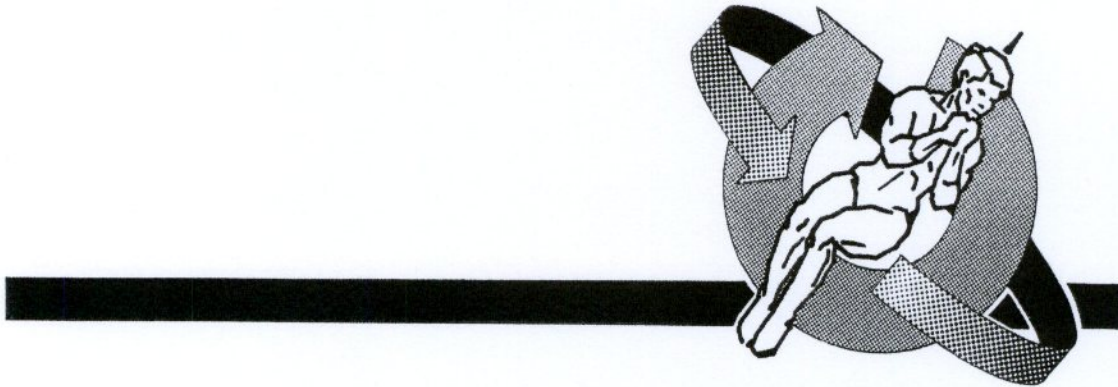
The implication here is to *view skills, as much as possible, according to their technical similarities*. In this way, new or seemingly complex movement patterns become little more than a reapplication of already-mastered skill sequences.

*Gymnastic skill analysis is rather simplistic,
once one realizes that
the similarities far outweigh the differences!*

FUNDAMENTAL CONCEPTS OF IMPACT

1. The effectiveness of the "take-off" sets the stage for all that is to follow. Once airborne, the performer's center of mass follows a predetermined parabolic trajectory, and the quantity of available rotary motion is irrevocably established.
2. Ensuring a sufficient measure of lift is always the first order of business in every airborne skill.
3. The lead-up trajectories employed to establish proper impact conditions for the final airborne phase of virtually every vaulting or tumbling sequence should be short, flat, and very fast.
4. Ensuring a maximum amount of horizontal motion while maintaining a relatively small angle of input at touch-down is a key ingredient for maximizing rotation in the airborne phase of the skill.
5. The impact phase for every vaulting or tumbling sequence should be "short" in terms of duration and "great" in terms of force.
6. Strive to make leg impact with the board and arm impact with the vault table on the ascent phase of the trajectory (Staircase Effect), i.e., adding an impulse to an already-rising body.
7. Stand as tall as mechanically possible, particularly during the impact phase of any airborne skill.
8. For multiple-somersault skills, it is wise to trade off a small portion of "lift" in order to reap the tremendous dividends in "rotation" by adjusting the angle of input accordingly.
9. To facilitate "sticking the landing," strive to establish a *fixed frame of reference* for landing, maintain early and continuous *visual contact* with the ground, *reach/extend* for the ground with one's feet prior to landing, and *give in* sufficiently (eccentric contraction) with the legs upon impact.
10. Achieving a fully extended body shape upon take-off, as well as immediately prior to landing, is a fundamental litmus test for championship execution.

CHAPTER SIX

THE MECHANICS OF ROTATION AND TWISTING

Big wheels keep on a-turnin'...

In most airborne gymnastic skills, one or a combination of rotary motions can be observed. As depicted in figure 6.1, the body's rotary movements occur about one or more of the three traditional axes: 1) rotation about the body's lateral axis as in forward- and backward-somersault skills; 2) rotation about the body's anterior-posterior axis as in sideward-somersault skills; and 3) rotation about the body's longitudinal axis as in twisting skills. Notice these three axial lines are always at right angles to one another and intersect at a conceptual point—the body's center of mass. *It is this point (center of mass) about which all rotation of the airborne body occurs.*

Certain airborne skills are characterized solely by a somersault component, whereas others are characterized solely by a twist component, as shown in figure 6.2. Because these examples involve rotation about a single axis (*uniaxial rotation*), they may appear relatively easy to understand and control. However, when somersaulting and twisting are combined within the context of a single skill, the situation becomes a bit more complex. In this light, let us *first examine the rotational mechanics specific to somersaulting and then those specific to twisting before combining them under the single heading of biaxial rotation.*

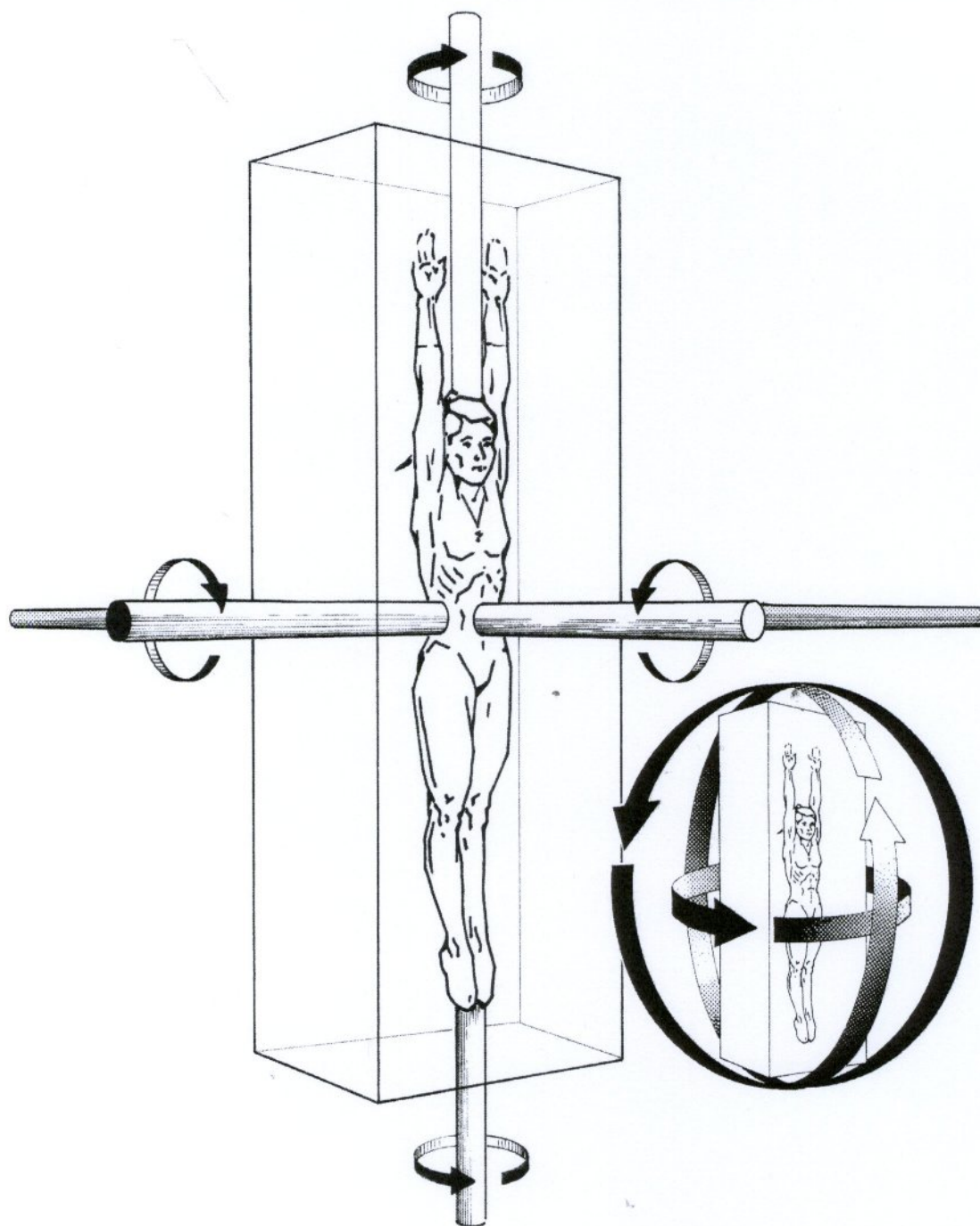


Figure 6.1. The three traditional axes about which the airborne body can rotate: (1) lateral axis; (2) anterior-posterior axis; and (3) longitudinal axis.

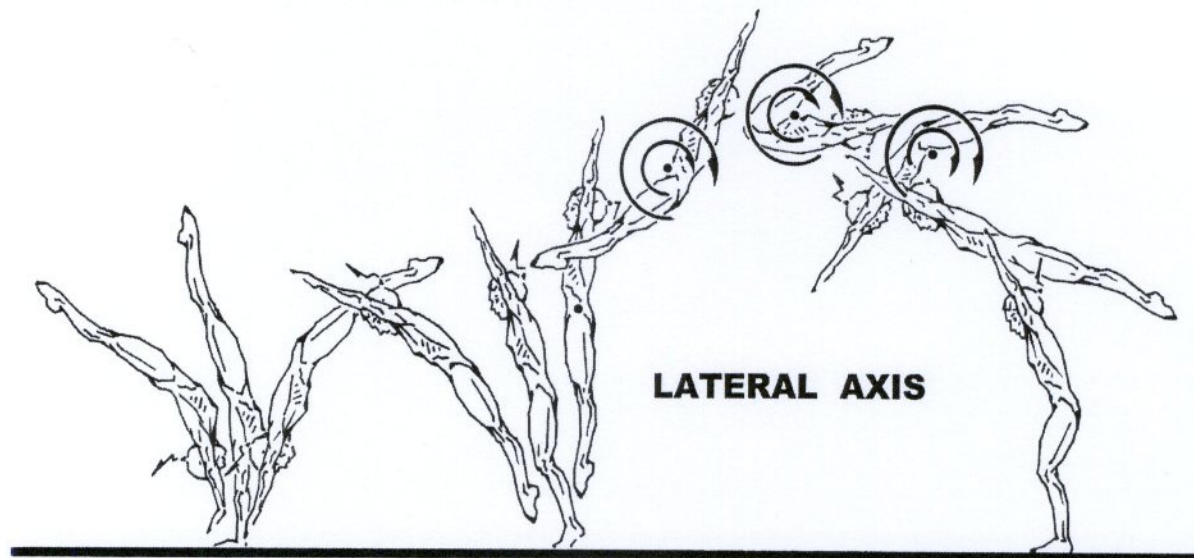
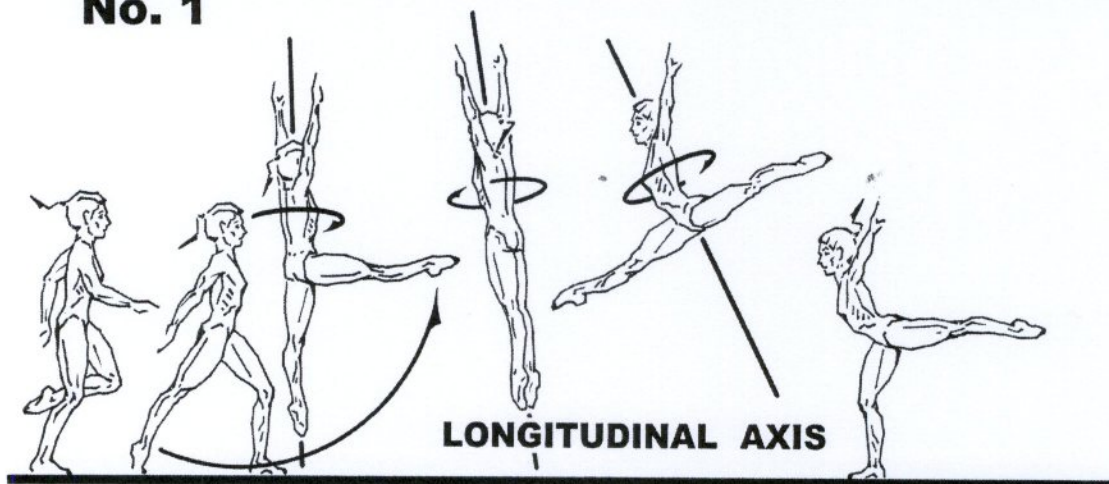
**No. 1****No. 2**

Figure 6.2. Examples of airborne uniaxial rotation: (1) Piked Backward Somersault in tumbling = rotation about the lateral axis; and (2) Tour Jeté on the beam = rotation about the longitudinal axis.

SOMERSAULT ROTATION

In chapter 5, "The Mechanics of Impact," it was discussed that the nature of the impact and take-off in any skill (whether in Floor Exercise, Vaulting, or Balance Beam) determines the shape of the trajectory as well as the angular momentum that the body possesses during the airborne phase. *And because even the best performers can only remain airborne for a very brief period, it becomes essential that an adequate amount of rotation be generated at take-off.*¹ From a practical viewpoint, it is important to understand the following principles:

¹ Refer to chapter 5 for a discussion of how to regulate trajectory and angular momentum.

- All effective somersault rotation must be initiated from the ground (or the apparatus, which is firmly attached to the ground); and
- Once initiated, somersault rotation continues to occur throughout the airborne phase of the trajectory.

Because the skill's trajectory and angular momentum are irrevocably established at take-off, *the only aspect the performer can control during the airborne phase is its "rate" of rotation.* And the extent to which rate of rotation can be controlled is determined by the degree to which the performer can change body shape.

*The ease with which a somersaulting body can rotate
is directly related to its shape!*

As revealed in figure 6.3, because of its comparatively smaller radius of rotation, the pucked body shape (illustration 2) has a proportionately greater tendency to rotate than does the fully extended body shape (1). If the body were further compressed into a piked (3)—or better yet, a fully tucked (4)—shape, its tendency to rotate would be further increased. This measure of control available to the performer during the airborne phase of any somersault skill can be expressed in terms of the following converse relationships:

- Progressively shortening the rotation radius of an airborne body (going from a fully extended to a fully tucked body shape) proportionately increases its rate of rotation; whereas
- Progressively lengthening the rotation radius of an airborne body proportionately decreases its rate of rotation.

The timing and quickness with which a performer alters body shape also bear directly on the resulting degree of somersault rotation. For example, in executing a Double Backward Somersault from a tumbling sequence, the sooner and faster the performer changes from a fully extended into a fully tucked shape once airborne, the earlier and quicker the rotations are completed. The somersault's rate of acceleration will noticeably increase as well. This early, quick shape change helps the performer complete a majority of the somersault rotation during the trajectory's ascent phase (peaking).

*The eyes of the technical evaluators
long to see
high acceleration rates!*

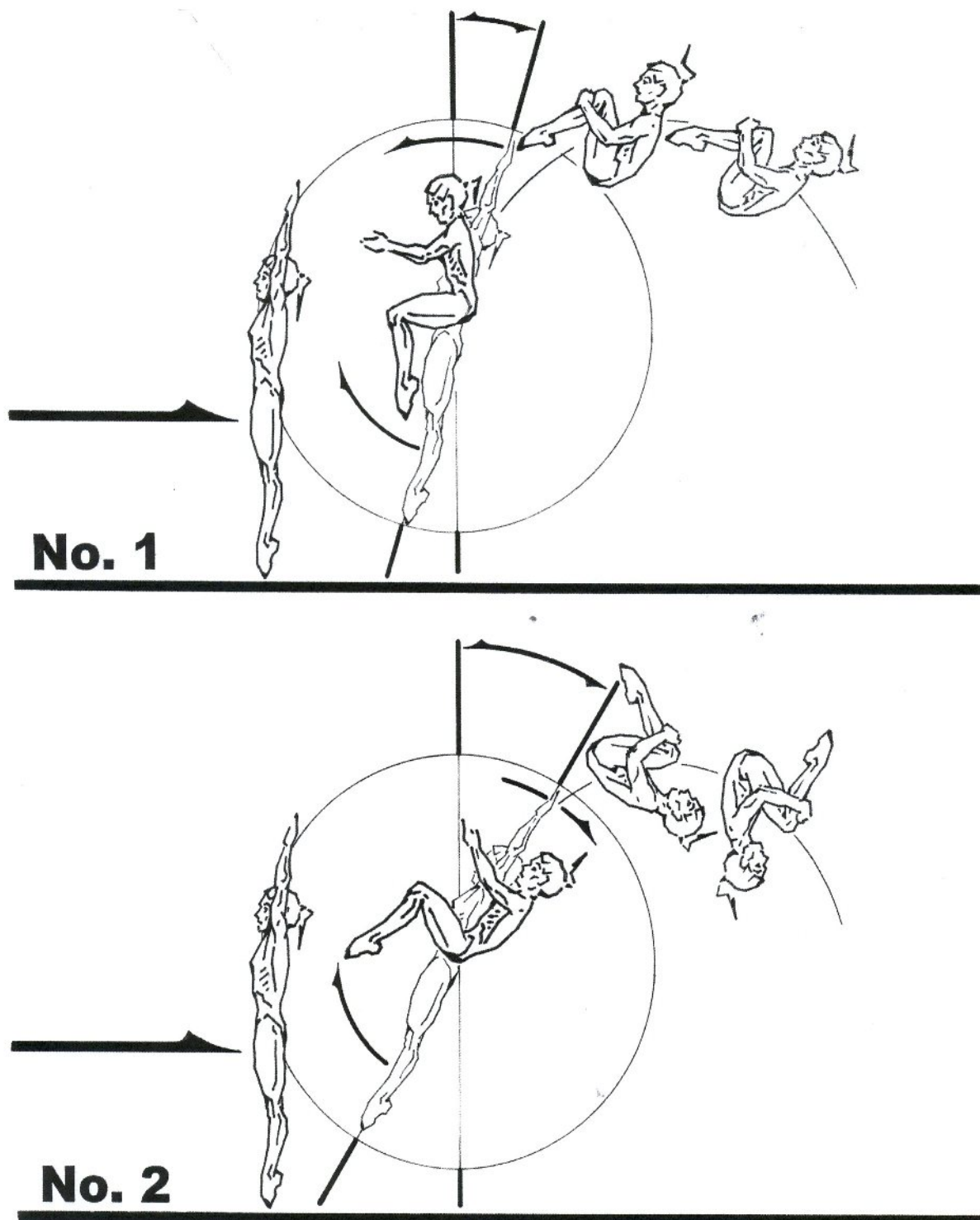


Figure 6.4. Comparative figure-ground effects of take-off on a Tucked Backward Somersault: (1) with insufficient rotary motion at take-off, chest and knees move toward each other; and (2) with sufficient rotary motion at take-off, knees rise to chest.

When the first performer executes the tucking action, notice her lower body is moving clockwise (in the same backward direction as the somersault), while her upper body is simultaneously moving counterclockwise. Although this opposite-and-equal action-reaction scenario must occur, *from a purely figure-ground perspective, the upper body is rotating forward, "against the grain" of the backward movement pattern!*

Many coaches mistakenly believe that instructing the gymnast to execute the tuck action by bringing or lifting knees to chest rather than by dropping chest to knees will automatically rectify this problem. After all, effective somersaulting requires the upper body to continue rotating in the same (backward) direction during the tuck-action sequence. *Although bringing the knees up to meet the chest (rather than vice versa) is the desired outcome of the tuck, the fact is, once airborne, the performer has absolutely no choice in the matter.*

When the quantity of somersault rotation at take-off is comparatively small as in the first example, any tuck action results in the chest coming down to the knees, which are simultaneously rising to the chest. On the other hand, *when sufficient rotary motion is established at take-off, the upper body continues to rotate backward as the knees rise.* Although any tucking action causes the upper and lower body to move in opposite directions (action-reaction), if the backward rotary motion is sufficiently large when the tucking action occurs, then the knees will come to the chest!

For example, notice the second performer's total body continues to move in the same backward (clockwise) direction despite the action-reaction motions created by the tuck. Consequently, *the true coaching solution centers on ensuring a sufficient quantity of angular momentum is first established at take-off.* Then the desired effect of the tuck action—knees rising to chest—will automatically occur.

In terms of this figure-ground perspective (the same perspective used by the judges), the following relationships are specific to *tucking or piking into airborne somersaults*:

- With sufficient backward rotary motion at take-off, the tuck action causes the legs to move rapidly toward the rotating trunk; whereas
- With insufficient backward rotary motion at take-off, the tuck action causes both the trunk and legs to move toward one another.
- With sufficient forward rotary motion at take-off, the tuck action causes the trunk to move rapidly toward the rotating legs; whereas
- With insufficient forward rotary motion at take-off, the tuck action causes both the trunk and legs to move toward one another.

Note also the converse relationships, which apply when a performer is *opening out* of tucked or piked somersaults:

- With sufficient backward rotary motion at take-off, the opening action causes the trunk to move rapidly away from the momentarily stabilized legs; whereas
- With insufficient backward rotary motion at take-off, the opening action causes both the trunk and legs to move in opposite directions.
- With sufficient forward rotary motion at take-off, the opening action causes the legs to move rapidly away from the momentarily stabilized trunk; whereas
- With insufficient forward rotary motion at take-off, the opening action causes both the trunk and legs to move in opposite directions away from one another.

TWIST ROTATION

Twisting can be described as rotation about the longitudinal axis of an airborne body. As shown previously in figure 6.1, twist rotation involves motion about a comparatively smaller radius than that of its counterpart, somersault rotation. *Consequently, twist rotation is easier to achieve than somersault rotation.*

Because twisting is rotational, many of the same principles already presented for somersaulting can be readily applied. The Jump Full Twist in figure 6.5 demonstrates this concept. In initiating the jump-twist (illustrations A, B), notice *as the legs and feet push against the ground in a downward-clockwise direction, the ground simultaneously pushes back with a force equal in magnitude and opposite in direction (upward-counterclockwise).* Obviously, the force the performer exerts is not nearly sufficient to move the tremendous mass of the earth! However, the earth's reaction force possesses sufficient magnitude to produce motion in the performer's body. *The observed action-reaction effects are lift and rotation (about the performer's long axis) in a direction opposite the force exerted by the performer (C).*

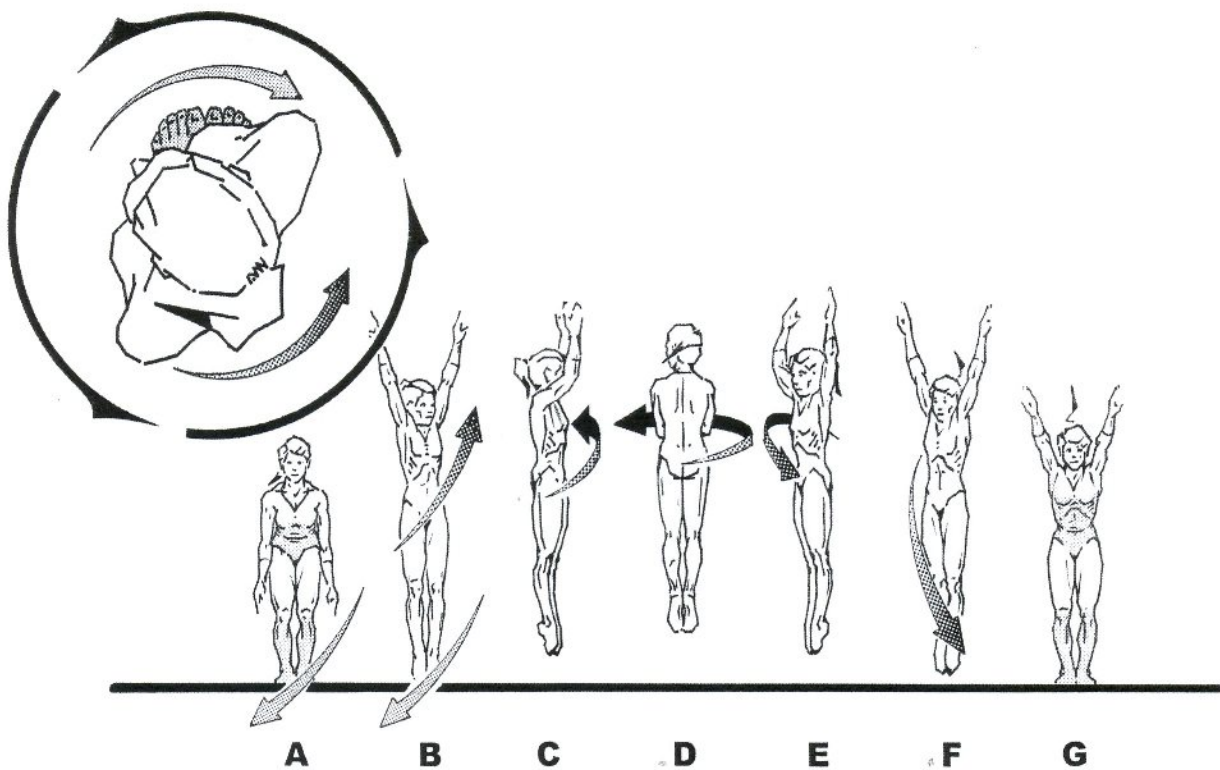


Figure 6.5. An ideal model for a Jump Full Twist.

This example also provides insight into a number of fundamental twist techniques that can—and should—be applied to most somersault-oriented twist skills initiated from the ground or apparatus. Let's take a closer look at these techniques.

FUNDAMENTAL TECHNIQUES OF TWISTING

- Except for the feet, which are firmly anchored to the ground during the push phase, *the twist should be initiated using as much of the total body as possible* (illustrations A, B).
- When as much of the total body as possible is employed to initiate the twist, the actual degree of body-shape change is quite small, while the quantity of twist rotation is comparatively large.
- To render the illusion of initiating the twist after becoming airborne, the arms, upon being thrown overhead, are also spread somewhat laterally. *A wider arm-set action, coupled with using as much of the total body unit as possible, allows the performer initially to minimize the rate of twist rotation without compromising the quantity (A, B).*

- Although scarcely discernible, the twist is actually initiated as the total body unit is extending into a straight-line shape. *This technique of twisting directly through the longitudinal axis of rotation is most effective (A, B).*
- At take-off, the performer is completely extended, *with the twist rotation occurring throughout the long axis of the straight-line body shape (B, C).*
- Upon becoming airborne, *the arms quickly swing in the direction of the twist as they are being pulled inward against the body. This timely decrease in the body's twist radius increases its rate of twist rotation (C, D).*
- As the majority of the twist rotation is occurring, notice all parts of the body rotate about the performer's long axis in the same direction, through the same angle, and in the same amount of time. *In other words, the twist is uniform, encompassing the total body unit (C, D, E).*
- To render further the illusion of completing the entire twist while still airborne, the arms, upon being returned overhead, are again spread somewhat laterally. *This timely action of increasing the twist radius decreases the body's twist rate immediately prior to actual touch-down, thus facilitating a more "squared" and controlled landing (E, F, G).*

BIAXIAL ROTATION—TWISTING SOMERSAULTS

The term "biaxial rotation" refers to any combination of somersault and twist occurring simultaneously within an airborne skill. To be successful, an appropriate balance must be struck between these two rotary components. Remember, however, somersault rotation is generally considered the more difficult to achieve and, as such, should receive primary emphasis. At least three good reasons support this premise:

- Because of the semi-rectangular shape of the fully extended body (see figure 6.1), it takes significantly greater effort to generate rotation about the lateral or anterior-posterior axis (somersault axis) than about the longitudinal axis (twist axis).
- Many advanced aerial skills (particularly those twisting into or out of multiple somersaults) require the gymnast, after becoming airborne, to "borrow" a portion of the somersault rotation for twist initiation.
- Regardless of the twist requirement, it should be obvious that sufficient somersault rotation must be initiated from the ground (or apparatus) to ensure a reasonably safe landing!

Although these underlying mechanical principles remain the same, *one—or more often, a combination—of three basic techniques is used to initiate twist rotation while somersaulting: the On-Ground Twist Initiation Technique, the Body-Extension Twist Initiation Technique, and the Body-Tilt Twist Initiation Technique.* Depending on the objectives and demands of the given skill, specific advantages and disadvantages are inherent to these techniques. Let's take a look at the nature and function of each.

1. The On-Ground Twist Initiation Technique

Although all effective somersault rotation must be initiated from the ground (or apparatus), twist rotation does not necessarily have to be ground-initiated. However, *in this technique, the actual twist initiation does occur prior to becoming airborne.* In fact, the twist in most single-somersault skills is usually initiated from the ground (or apparatus) in much the same fashion as presented for the basic Jump Full Twist.

Compare the techniques used to initiate, execute, and complete a Backward Somersault with a Full, Double Full, and Triple Full Twist respectively, shown in figure 6.6. Notice the positions and body shapes are strikingly similar through the entire sequence for each of these twisting somersault skills. In addition, each involves a definite *set phase, wrap phase, and open-out phase.* Also notice all the *fundamental techniques of twisting* outlined previously are strictly adhered to in each case.

Because the airborne phases of multiple twisting backward somersaults require comparatively greater quantities of twist rotation, the observed amount of on-ground twist initiation must be proportionately greater than in a somersault with only a single twist. This more-pronounced twist initiation is accomplished during take-off by quickly raising the arms above the head using a slightly wider arm-set, while more forcefully rotating the total body unit about its longitudinal axis in the intended direction of the twist. In addition, *increasing the number of twist rotations requires executing the wrap phase a bit sooner (once airborne) and maintaining it for a comparatively longer duration of time.*

It is important, however, to recognize that *these supposed differences are essentially a matter of degree and not of kind.* Or to put it another way:

*The similarities observed in twist-oriented somersaults
far outweigh the differences!*

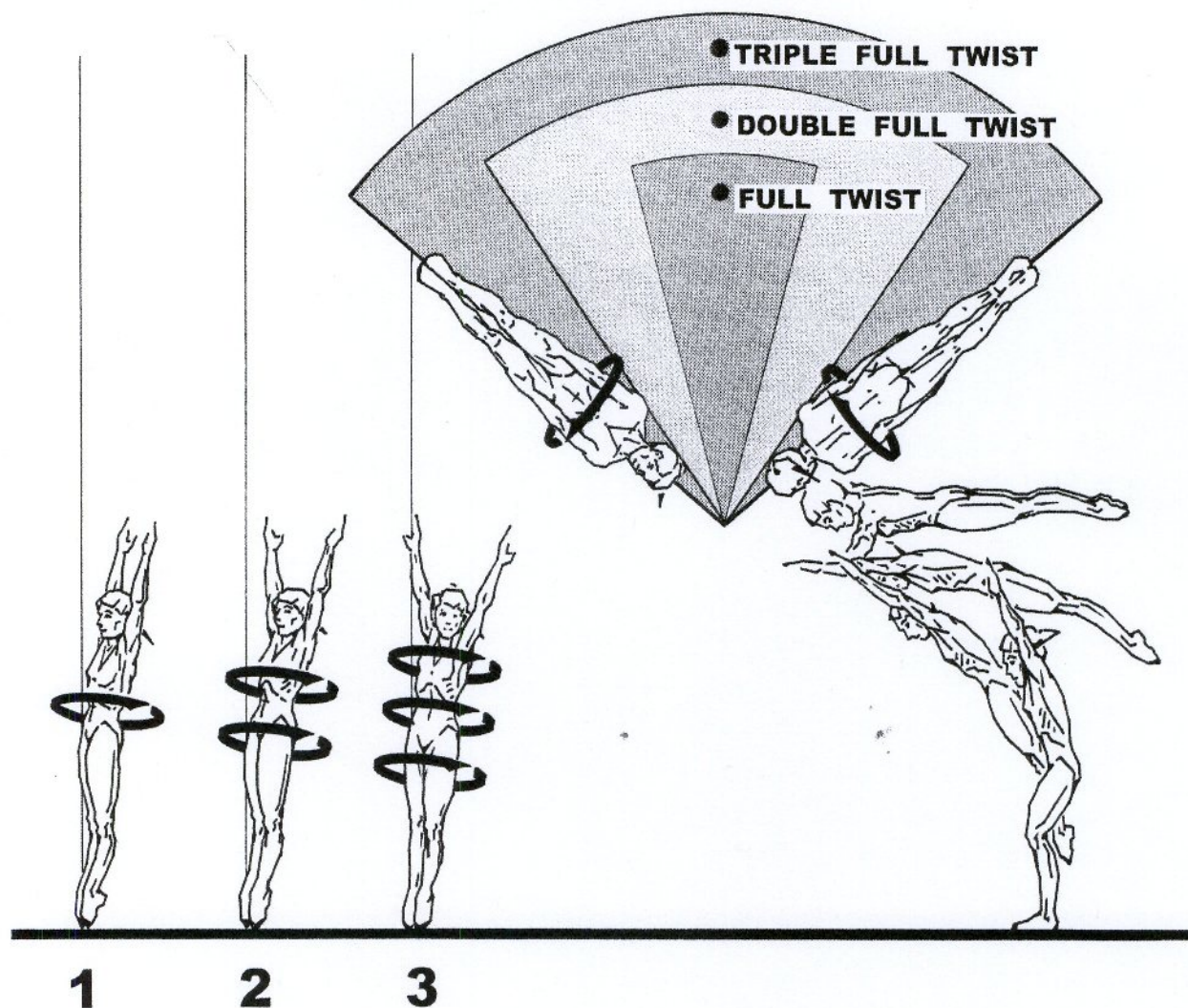


Figure 6.6. Comparative take-off and wrap phases in executing Twisting Backward Somersaults using the On-Ground Twist Initiation Technique: (1) Full Twist; (2) Double Full Twist; and (3) Triple Full Twist.

Whenever the On-Ground Twist Initiation Technique is employed with a single somersault, the resulting twist rotation also continues throughout its entire airborne trajectory. And just as the Peaking Principle was applied to somersault rotation in chapter 2, it can and should be applied to the twisting component.² To demonstrate, the pie-shaped areas in figure 6.6 illustrate "high-velocity zones" wherein most of the twist rotation should occur. By comparison, the least twist rotation should occur outside these zones, i.e., during the take-off and initial ascent phases as well as the final descent and landing.

² Refer to *Peaking Principle* in chapter 2.

Collectively, these motion changes—from scarcely discernible twist rotation at take-off, to instantaneous acceleration into high-velocity rotation at the apex, and then instantaneous return to low-velocity rotation prior to landing—"render the illusion" of executing the entire twist solely during the apex phase of the airborne trajectory. Or in more mundane terms:

*Effective use of the Peaking Principle involves
Squeezing the greatest percent of twist rotation
into the smallest percent of the pie!*

Regardless of the number of twists, the performer is inevitably confronted with having to minimize twist velocity in preparation for landing. To accomplish this, it should be obvious that, at some point during the descent phase of the somersault, *the performer must open out of the twist by returning her arms laterally overhead.* This timely action increases the radius of twist rotation and thus decreases twist velocity.

However, this is but a story half-told, as a second and perhaps more effective technique for decreasing twist velocity is to assume a slightly hollowed total body shape just prior to landing (see the landing phases in figure 6.6). *Hollowing the body unit further increases the performer's twist radius (about her longitudinal axis), thereby significantly slowing the twist rotation.* The net effect of these two actions promotes the best set of conditions for achieving a squared and controlled landing.

A. Advantages of On-Ground Twist Initiation

Among the several advantages specific to initiating twist rotation from the ground (or apparatus) are:

- 1) Because either the ground or apparatus (both inherently stable bases of support) is the point of initiation, *the on-ground technique holds the greatest potential to generate maximum twist rotation.* Consequently, it is generally considered the most effective technique for twist initiation in single somersault skills, particularly multiple-twist single somersaults.
- 2) Because the wrap phase simultaneously decreases the body's rotation radius about both its longitudinal and lateral axes, the potential exists to execute a majority of both the somersault and twist rotations within the smallest portion of the trajectory's apex. Appropriately timed, *this technique renders the illusion that the entire twist is initiated and completed during the somersault's airborne phase (peaking the skill).*

- 3) *The bilateral orientation of the arms during the wrap enhances total body symmetry and also renders the "illusion" of having attained greater height (lift) from the ground.*

B. Disadvantages of On-Ground Twist Initiation

On-ground twist initiation is also characterized by some functional limitations and disadvantages. Among these are:

- 1) *This technique cannot be employed for that category of multiple somersault skills requiring twist initiation to be delayed until after the performer completes the first somersault and is entering the second.*
- 2) *Rather than "setting" with the arms first and then initiating the twist with the total body unit, there is a tendency to omit the arm-set, thereby rushing the twist initiation. This tendency to "roll" into the twist reduces the performer's ability to accelerate the twist during the wrap, an essential component to optimum execution. Remember: *twist initiation is in that movement category calling for highly unobvious body-shape changes.*³*
- 3) *Because all freely rotating bodies seek the axis of least resistance, there is a natural tendency (particularly in single-somersaults with multiple-twist rotations) for the straight-line body shape to somersault slightly off top-dead-center. In other words, rather than the plane of motion being directly perpendicular to the ground, it has a slight but observable tilt, or slant—referred to as "pancaking" the somersault, e.g., nutation.*⁴

³ Refer to Closure Principle in chapter 2.

⁴ In physics, nutation is a slight irregular motion (etymologically, "nodding") in the axis of rotation of a largely axially symmetric object, as seen in a spinning top or a planet.

2. The Body-Extension Twist Initiation Technique

Contrary to the beliefs of some teachers and coaches, *twist rotation can be—and often is—initiated after the performer becomes airborne.* This is particularly true in skills with multiple somersault rotations. As depicted in figure 6.7, the actual twist phase of a Handspring Forward Somersault with ½-Twist is not initiated until well into the post-flight phase of the vault. *Effective twisting is made possible by vigorously extending the lower half of the body about the upper half during a time in which the total body possesses a large quantity of forward somersault rotation.* This rapid extension motion creates a "dynamic stability" in the somersaulting plane, similar to a rotating bicycle wheel (illustrations F, G).

During this brief moment, the performer can capitalize on her dynamically stable base to initiate the twist rotation. Although barely discernible, notice *the twist through the longitudinal axis of the upper body is initiated off the dynamically stable lower body and occurs slightly prior to attaining complete hip-joint extension*. As the total body unit extends into a straight-line shape, its twist radius progressively decreases and the resulting rate of twist rotation correspondingly increases (G, H).

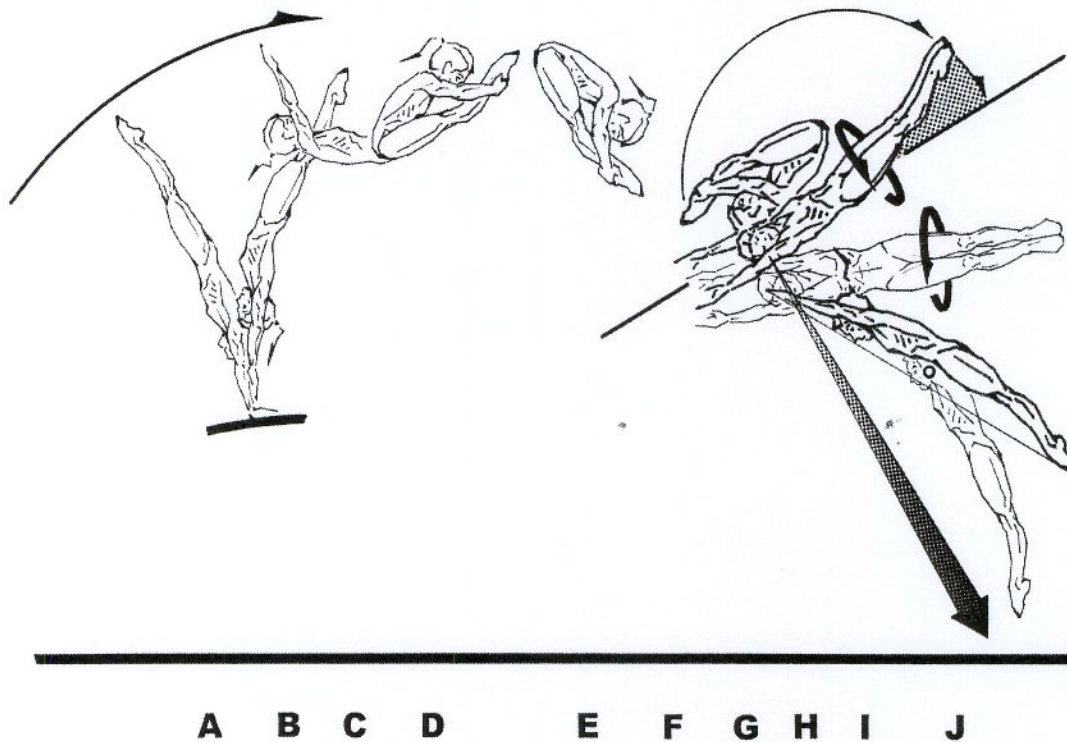


Figure 6.7. Using the Body-Extension Twist Initiation Technique in executing a Handspring Forward Somersault with $\frac{1}{2}$ -Twist Vault.

Figure 6.7 also demonstrates two important techniques for enhancing maximum execution and control in this and virtually every airborne skill involving biaxial rotation. First, notice *the performer sights the landing area very early in the descent phase and continues to maintain this visual fix throughout the descent* (G, H, I). The sooner and longer the performer can sight the ground prior to touch-down, the greater the opportunity to make the necessary adjustments for a controlled landing.

Second, notice *the performer assumes a slightly hollowed total body shape just prior to touch-down* (I). This timely hollowing increases her radius of twist rotation (about the longitudinal axis), thereby decreasing twist velocity. And when it comes to maximizing landing control, touch-down from a somersault blessed with slow twist rotation is significantly easier to control than one burdened by fast twist rotation!

It should be pointed out that *the body-extension technique can be employed to accomplish airborne twisting without benefit of any already-existing somersault rotation*. For example, when executing a basic Swivel Hips on the trampoline,⁵ there is no rotation of the total body unit upon which the performer can capitalize. In this case, the twist is accomplished exclusively by vigorously opening the body from its piked position and then initiating the twist off the final aspect of this extension.

However, *in the absence of somersault rotation, no angular momentum of the total body is actually generated*. Rather, an action-reaction scenario takes place wherein the twist only occurs while the airborne performer is extending one body part about another. Or to put it another way, without benefit of somersault rotation, the potential amount of twist this technique can achieve is quite limited. Consequently *in order to generate a large amount of twist rotation using the body-extension technique, a correspondingly greater amount of somersault rotation must first be generated at take-off*.

A. Advantages of Body-Extension Twist Initiation

The advantages specific to this technique include:

- 1) Because the impetus for twist initiation is derived from two interacting sources—the already-existing somersault rotation and the body's internal-swing rotation (extending)—*it is particularly appropriate for multiple-somersault skills wherein the twist does not occur until after the first somersault*. Typical examples include the Tucked Backward Somersault In–Double Full Twisting Backward Somersault Out (Back In–Double Full Out) and a Forward Somersault In–1½-Twisting Forward Somersault Out (Front In–Rudi Out Fliffis).
- 2) *It can be readily combined with the On-Ground Twist Initiation Technique for double-somersault skills with twist requirements in both somersaults*. More specifically, the on-ground technique is used to initiate the twist in the first somersault, and the body-extension technique is then used at the beginning of the second somersault to provide additional impetus for successful completion of the twist requirements. Typical examples are a Full Twisting Backward Somersault In–Full Twisting Backward Somersault Out (Full In–Full Out) and a ½-Twisting Backward Somersault In–1½-Twisting Somersault Out (Half In–Rudi Out).
- 3) *The twist can be initiated by extending out of any compressed body shape, i.e., opening out from a tucked, piked, or pucked into an extended shape*.

⁵ Swivel Hips on trampoline: from an upright bounce, seat drop, rise to full body extension into a ½-twist, and return to a seat drop.

B. Disadvantages of Body-Extension Twist Initiation

The disadvantages specific to this technique include:

- 1) *Without sufficient somersault rotation to capitalize on, it is virtually ineffective as a twist initiation technique for skills requiring twist rotations greater than 360°.* This realization further substantiates the critical importance of achieving adequate somersault rotation at take-off.
- 2) *Twisting with an open-tucked (pucked) body shape results in a roll (or slower) type of twist action.* However, this disadvantage is somewhat offset in that the performer can regain visual contact with the ground earlier and for a longer time.

The Backward Somersault In-Full Twisting Backward Somersault Out depicted in figure 6.8 attempts to employ *"the best of both worlds," i.e., early and continuous visual contact with the ground while peaking the full twist.* As soon as the performer obtains visual contact with the ground during the first somersault, she extends to a pucked body shape (illustrations C, D). This timely opening up allows her to maintain visual contact with the ground throughout the twist phase. Remember:

*Early and continuous visual contact with the ground
is a fundamental prerequisite to sticking a dismount
like a dart!*

As the full twist is initiated and executed, notice how *the performer's head, although in alignment with the trunk, is positioned to maintain continual visual contact with the ground.* Because the initial portion of the twist (first 90°) is executed in a pucked body shape, it appears—and is—comparatively slow (D, E).

Then, as the performer's feet approach top-dead-center (1½ somersaults), the legs extend vigorously while the arms are rapidly brought to the sides of the body (F). These actions decrease the body's twist radius, markedly increasing the rate of twist rotation. As a result, the remaining twist (270°) is completed within the smallest percentage of the second somersault's trajectory (F, G, H). *Therefore, in addition to early and continuous visual contact with the ground, the twist is effectively peaked.*

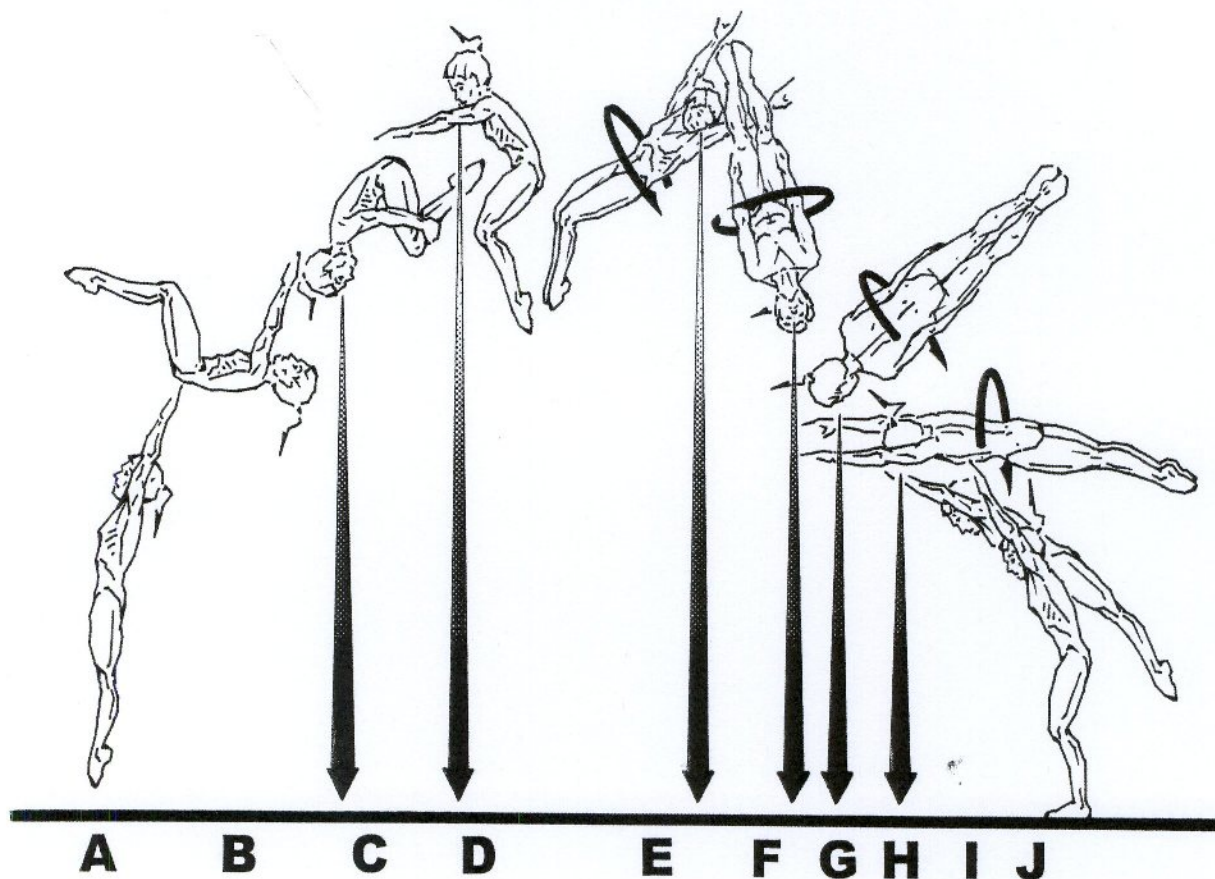


Figure 6.8. A Backward Somersault In-Full Twisting Backward Somersault Out. Early and then continuous visual contact with the ground is a fundamental prerequisite to a controlled landing.

3. The Body-Tilt Twist Initiation Technique

Another method employed for twist rotation after becoming airborne is the Body-Tilt Twist Initiation Technique. *By tilting the rotating body slightly outside the somersault plane, the gymnast can borrow a small portion of the already-existing somersault rotation and convert it into twist rotation.* As shown in figure 6.9, twist initiation in a Layout Backward Somersault with $\frac{1}{2}$ -Twist is accomplished by altering one side of the body so that an "off-center" radius of rotation is established. The action of dropping one arm to the side while maintaining the other arm overhead causes a simultaneous reaction of the total body, i.e., "tilting" slightly off top-dead-center in the somersault plane.

Because the somersaulting body in this instance is rotating slightly off top-dead-center, a portion of its rotary motion in the A-P (somersault) plane is transferred into the transverse (twist) plane, resulting in biaxial rotation. And because twist rotation is easier to accomplish than somersault rotation, this technique is particularly useful in multiple somersault skills wherein no twisting occurs until after the first somersault.

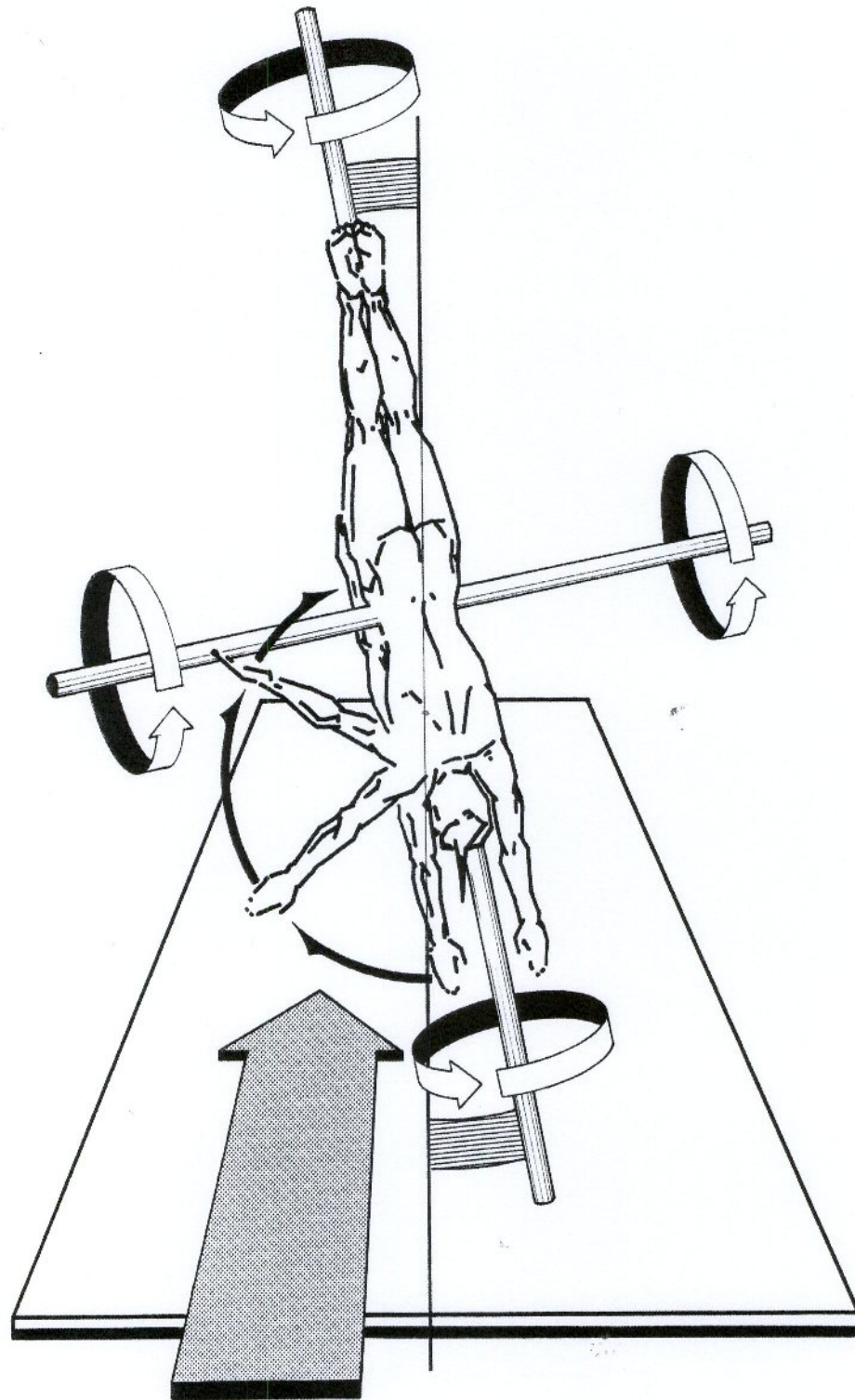


Figure 6.9. Using the Body-Tilt Twist Initiation Technique, a portion of the somersault rotation is converted into (right) twist rotation in executing a Layout Backward Somersault with $\frac{1}{2}$ -Twist.

A. Resulting Direction with Body-Tilt Twist Initiation

When employing the body-tilt technique, the resulting twist direction is determined by the somersault direction (forward or backward) and the side of the body's radius being shortened (left or right). The relationship between these two sets of variables can be expressed as follows:

- 1) If the *right side* of the body is shortened while executing a *forward somersault skill*, the resulting direction of the *twist* will be to the performer's *left*; whereas
- 2) If the *left side* of the body is shortened while executing a *forward somersault skill*, the resulting direction of the *twist* will be to the performer's *right*.
- 3) If the *right side* of the body is shortened while executing a *backward somersault skill*, the resulting direction of the *twist* will be to the performer's *right*; whereas
- 4) If the *left side* of the body is shortened while executing a *backward somersault skill*, the resulting direction of the *twist* will be to the performer's *left*.

Perhaps a simpler way to clarify the direction of twist resulting from the Body-Tilt Twist Initiation Technique can be found in the following axiom:

*The shortened side of the body always leads (twists)
into the direction of somersault rotation!*

For example, upon completing a squared take-off (no on-ground twist initiation), the performer in figure 6.9 somersaults backward and, once airborne, shortens the rotation radius on the right side of her body. Notice the resulting twist direction is, in fact, to her right.

B. Advantages of Body-Tilt Twist Initiation

- 1) When used *in conjunction with either the on-ground or body-extension technique*, it serves as an effective supplement to maximize the twist.
- 2) Because one arm remains overhead during the initiation of the twist phase, *greater control can be maintained within the somersault component*. This characteristic helps establish more favorable conditions for landing.

C. Disadvantages of Body-Tilt Twist Initiation

- 1) *Without sufficient somersault rotation to capitalize on, it is virtually ineffective as a twist initiation technique for any skill.*
- 2) *In single-somersault skills, it has limited practical value beyond a full twist.* Compared to the on-ground technique, the potential quantity of twist rotation it can generate in single-somersault skills is quite small.
- 3) Certain twist movements, such as those in the preflight phases of many advanced vault skills, require both hands to make contact with the apparatus as soon as possible after take-off. (Examples include a $\frac{1}{2}$ -Twisting Yurchenko as well as a $\frac{1}{2}$ -Twisting Handspring onto the vault table.) Because the $\frac{1}{2}$ -twist must be initiated, executed, and completed in such a brief period, it is wiser to employ the on-ground technique.

Arm-Wrap Techniques for Twisting

Earlier in this chapter, a performer was shown using on-ground twist initiation with a somewhat lateral overhead arm-set. The slightly wider arm-set creates a larger radius of rotation about the body's longitudinal axis. Although this scenario results in a slower (and therefore less obvious) rate of twist during actual take-off, it does not compromise the quantity of twist rotation available for the upcoming airborne phase. Such a scenario renders the "illusion" that the twist is not initiated until some point after take-off.

Once airborne however, the performer has the option of calling upon one of two classical techniques to execute the "arm-wrap" phase. Figure 6.10 compares these *two arm-wrap techniques, either of which can be employed successfully in most twist-oriented somersault skills*. Performer 1 sets the take-off and then drives her arms, with *bent elbows*, downward across the upper trunk in the direction of the twist, ultimately placing her hands symmetrically across her chest. This is the usual and customary technique for shortening one's radius of rotation. However an alternate and perhaps more effective technique for executing the "arm-wrap" phase is presented in the second example. Notice that performer 2 maintains straight arms (*locked elbows*) while swinging her arms downward across the trunk and placing them at her sides.

Regardless of which technique is employed, the wrap action of the arms about the longitudinal axis of the body should occur in a rapid 1-2 sequence rather than simultaneously. In addition, the intended twist direction determines the actual 1-2 sequencing order of the arms. For example, if the twist direction is to the performer's left, her 1-2 arm-wrap sequence should be a forceful left-arm-then-right-arm drive.

In other words, *the arms are sequentially driven across the body in the direction of the twist*—this technique further enhances twist efficiency.

Although it is true that either technique effectively decreases the radius of rotation about both the twisting as well as the somersaulting axes, *the straight-arm wrap is clearly more advanced, for at least three good reasons:*

- Although slightly more difficult to control, the number of body segments used to execute the arm-wrap phase is reduced to the necessary and critical few, i.e., better use of the Segmentation Principle.
- Both the twist radius and the somersault radius can be more effectively shortened, i.e., better use of the Peaking Principle.
- The total body unit shape is characterized by a “cleaner” symmetry and, as such, is more aesthetically pleasing.

Regardless of the arm-wrap technique employed, *all twist-oriented somersaults should display this distinct sequence of arm actions:*

- At take-off—*SET*
- Upon becoming airborne—*WRAP*
- Prior to landing—*OPEN*

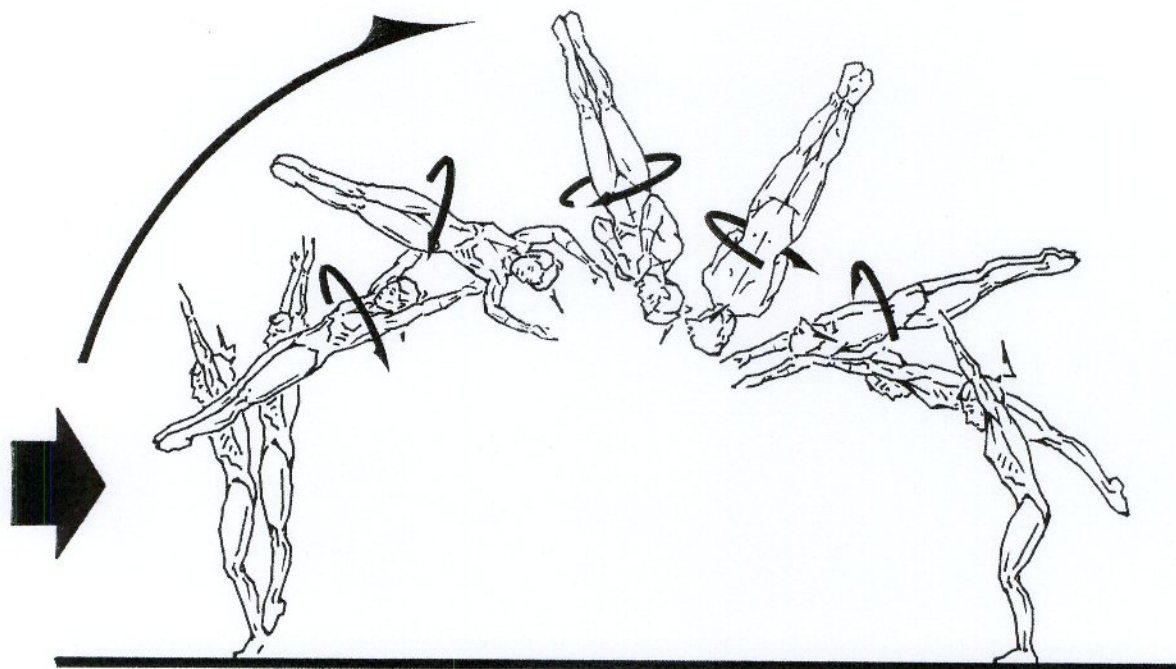
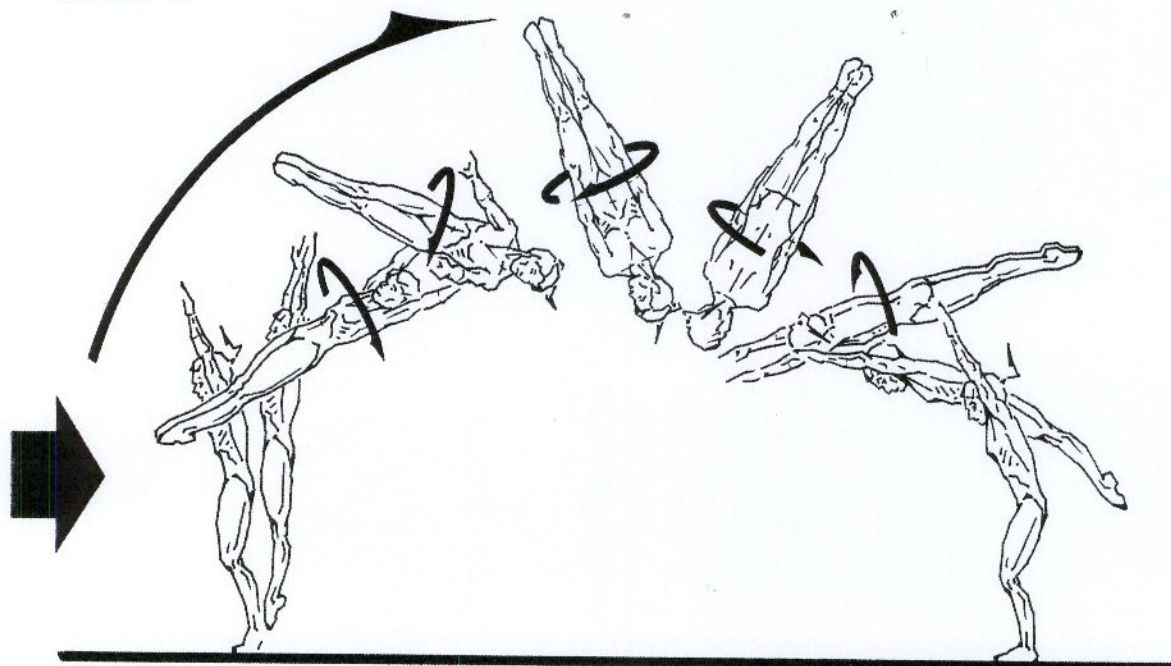
**No. 1****No. 2**

Figure 6.10. Comparative 1-2 wrap techniques that can be effectively employed in executing most twist-oriented somersaults: (1) bent-arm wrap technique; and (2) straight-arm wrap technique.

Twist Direction for Somersault Skills

Questions often arise with regard to *which twist direction (left or right) should be employed for executing which types of somersaults*. Is it better to twist in one direction for backward somersaults and in the opposite direction for forward somersaults? Or would it be better to twist in the same direction for both forward and backward rotating skills? Does it really make any difference?

Preferences in twist direction appear to be a perplexing problem, particularly when individual differences of gymnasts are taken into account. Some performers prefer to twist left when somersaulting forward and right when somersaulting backward, or vice versa. Others prefer to twist only in one direction regardless of whether the somersault component is forward or backward. And finally, a few performers claim to twist equally well in both directions!

Although there may be some rather unique exceptions, it is generally a good idea to *learn how to twist in the same direction for both forward and backward somersaulting*. The fundamental reasoning for this guideline centers on what the gymnast will inevitably face as she approaches elite-level tumbling and vaulting skills as well as dismounts from the uneven bars, i.e., multiple-twist/multiple-somersault skills. For example, if a tumbler were to attempt a Backward Somersault with a $\frac{1}{2}$ -Twist In-Forward Somersault $1\frac{1}{2}$ -Twist Out (Half In-Rudi Out), it would behoove her to employ a twist component that is in the same direction for both somersaults. Otherwise, she would be confronted with the near-impossible task of having to reverse her twist direction in mid air!

One time-tested and generally accepted procedure for determining a novice's natural or dominant twist direction is to have her attempt to perform the basic Jump Full Twist (see figure 6.5) in each direction for a number of times. Most gymnasts will inevitably find that twisting in one direction (be it left or right) feels more natural than in the other direction. Once discovered, *all twist-oriented somersault skills, regardless of whether the somersault is forward or backward, should be learned according to the gymnast's dominant twist direction*.

Turn Direction for the Round-Off

Although technically a "turn" rather than a "twist" skill, *the Round-Off in tumbling is an exception to the above twist-direction rule*. This is because a number of traditional routines include more than one Round-Off in the same tumbling sequence. In these instances, landing out of a Backward $\frac{1}{2}$, $1\frac{1}{2}$, or $2\frac{1}{2}$ Twisting Somersault *from* an initial Round-Off necessarily involves a step-out phase *into* the second Round-Off. And *when the performer's Round-Off is in the opposite direction to her dominant somersault-twist direction, the actual "step-out" into the second Round-Off will be sequentially correct and therefore immediate*.

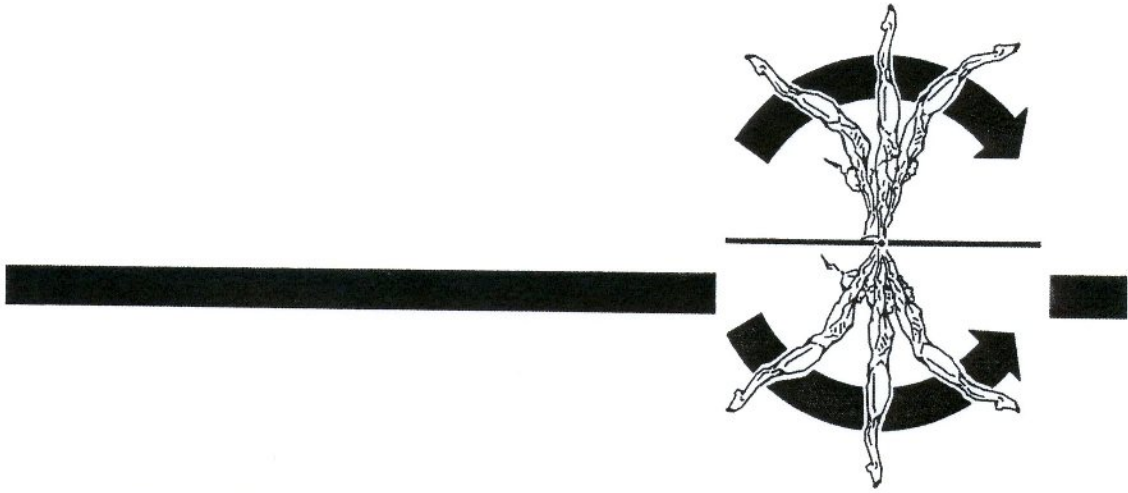
Simply put, it is mechanically easier and more natural to "step out" from a $\frac{1}{2}$, a $1\frac{1}{2}$, or a $2\frac{1}{2}$ Twisting Backward Somersault into a Round-Off that turns in the direction opposite the direction of the intended somersault-twist. To put it another way, if the "twist" for the somersault and the "turn" for the upcoming Round-Off were to occur in the same direction, the performer would be confronted with having to switch her legs in midair to execute an immediate step-out! Therefore, if the direction of turn in a Round-Off is opposite the performer's established airborne twist direction, a greater variety of twisting somersaults can be executed "into" and "out of" the Round-Off.

FUNDAMENTAL CONCEPTS OF ROTATION AND TWISTING

1. Establishing a sufficient quantity of somersault rotation at take-off is a fundamental prerequisite to successful performance.
2. All effective somersault rotation must be initiated from the ground or the apparatus (which is firmly attached to the ground). Once initiated, somersault rotation continues to occur throughout the airborne phase.
3. Increasing or decreasing rotational rate is the only measure of control the performer enjoys after becoming airborne, and then only within the confines of the quantity of rotation that was already established at take-off.
4. Somersault rotation should always be initiated prior to twist rotation.
5. In terms of twisting, master the On-Ground Twist Initiation Technique first. Always follow this distinct sequence: (1) set the twist using as much of the total body as possible; (2) wrap fully and completely during the ascent phase, using the 1-2 arm-wrap sequencing technique; (3) open fully prior to landing.
6. Hollowing the total body unit just prior to touch-down effectively minimizes twist velocity and better prepares the performer for the oncoming impact with the ground.
7. Learn how to twist in the same direction (be it to the left or right) for both forward and backward somersault skills. To ensure the best of both worlds, the direction of turn in the Round-Off should be opposite the performer's somersault twist direction.
8. Never forget that early and continuous visualization of the ground is a key component to orientation, and therefore to sticking the landing.
9. The basic objective of all rotations is to squeeze the greatest percent of both the somersault and twist rotations into the smallest percent of the pie (airborne trajectory).
10. To the observer's eye, the axiomatic criterion for effective somersaulting and twisting centers upon the ability to accelerate the rotation.

CHAPTER SEVEN

PATTERNS OF MOTION



*Like mountain waters rushing to the sea,
all gymnastics movements flow through
evolving patterns of motion...*

The importance of form (body shape) should be patently obvious to all professionals associated with judged sports. Yet more often than not, specific interpretations of *correct body shape* are incomplete, inaccurate, or both. Rarely does this concept go beyond aspects such as locked elbows and knees, pointed toes, legs held together, deep pikes, wide straddles, and the like. Asymmetrical cervical, thoracic, and lumbar curvatures, improper pelvic girdle alignment, and poor arm-trunk or leg-trunk angles are some of the typical body-shape deviations that slip by seemingly undetected. Relying on such *compensatory techniques* makes true mastery of elite-level skills an improbable task.¹ As elite performers strive to achieve ever-higher levels of difficulty and technical excellence, careful examination of the hidden components that optimize execution becomes essential.

Under appropriate conditions of training and practice, the human body can be thought of as a quasi-rigid structure. As noted in chapter 4, this structure consists of an articulated system of levers which circle about one another in a properly coordinated sequence to achieve a desired outcome. However in the performance of a gymnastics routine, the gymnast is required to shape her body such that it literally unfolds into skilled movement patterns, flowing effortlessly one into the other. And because gymnastics elements are mostly ballistic in nature, it stands to reason that the "shapes"

¹ Refer to *Compensatory Techniques—The Achilles Heel* in chapter 1.

assumed in order to achieve a skill's objective should not consist of a series of jagged angles formed by rigid, straight lines, but rather shapes expressed by "dynamically curved lines." *These shapes should not only be symmetrical in form but should also be developed using specific sequential flow patterns.*

*It is the symmetry in basic patterns,
the posture of the movement so to speak,
that opens the door to achieving technical excellence.*

MASTERY OF BODY SHAPE

The term "body shape" refers to the relative relationship that the various body parts have to one another during the performance of skilled movement. From a strictly artistic perspective, proper body alignment accounts at least partly for why one performer looks better than another even though it "appears" that both have executed the same skills in precisely the same way.

Conceptually speaking, the segments of the body can collectively take on one of two basic shapes. In the performance of any gymnastics skill, these segments are aligned either to form a straight-line shape or they are not, in which case they should be arranged in a symmetrical fashion to form some curved-line shape. Remember *it is the straight-line shape serves as the "baseline,"* the point of reference to and from which all curved-line shapes evolve. And regardless of kind, *all curved-line shapes should be (to the extent possible) spread uniformly throughout the body.* This consideration not only enhances the art of the movement but also equips the performer with the opportunity to take maximum advantage of key mechanical factors to success. Keep in mind:

*Curved shapes are in effect rounded shapes,
and
rounded shapes are stronger than straight or flattened shapes.*

Mastery of correct body shape is particularly critical in the beginning stages of learning. In addition, the ability to move into and out of these basic shapes efficiently and effectively using proper mechanical technique serves to establish the correct "patterns of motion" that directly transfer into the more complex skills seen in elite-level performance.

Contrary to conventional wisdom, *learning to simulate proper body shape and function at the beginning levels of performance is the single most difficult aspect of gymnastics to master.* Mastering beginning-level movement patterns takes considerable time, patience, and tedious attention to detail. Perhaps this accounts for why many performers and well-intentioned coaches who blindly attempt to fast-forward mastery of

the basics ultimately discover that all they have managed to accomplish is to compound movement problems at the elite level.

This chapter will set forth a number of classical examples comparing a variety of typical body shapes employed in the execution of gymnastics skills. The fundamental purpose is to demonstrate how *seemingly minor differences in basic body shape actually have a dramatic effect on both the artistic and mechanical factors characteristic to elite-level movement*. Even the most complex skills are fundamentally simplistic in nature—provided that the prerequisite basic skills have been mastered. Consequently, *the hidden component can be found in taking the time and effort to master the basics*.

*Absolute mastery of the basics
is only necessary
for those who seek absolute excellence.*

FUNDAMENTAL CONCEPTS OF BODY SHAPING

Any form of bending—whether in the forward, backward, or sideward mode—should be done in a fashion such that the flow of motion in the body is actually “expanding.” And yet considering the fact that any act of bending is “contractive” in nature, such a concept appears (at first blush) to be contradictory! However, careful examination of how to create expansive bends in the body will perhaps clarify this seemingly perplexing concept.

Figure 7.1 compares two gymnasts executing the initial bending phase of a Backward Walkover. To initiate the bend, performer 1 simply rotates her upper body backward about her lumbar region. This movement, in and of itself, is contractive in nature, causing the internal flow of motion to travel downward. Rather than “point loading” the bend at the lumbar region, *performer 2 makes every effort to stretch (extend) her total body unit in an upward direction prior to as well as during the actual backward bending motion*. This action serves to spread the bend through the entire back, causing the internal flow of motion to be upwardly expansive.

This motion concept of “stretching before bending” can be applied to virtually every gymnastics skill. It is based on the premise of taking in or consuming as much space as possible to execute changes in shape. Expansive body-shape changes are smoother in flow, aesthetically more pleasing, and—in the final analysis—mechanically more accurate. Let’s take a closer look at what constitutes proper body shape, why mastery of these shapes is important, and how this relates to success in elite-level performance.

*Like the branches of the giant oak,
scoop-up as much space as possible
prior to bending!*

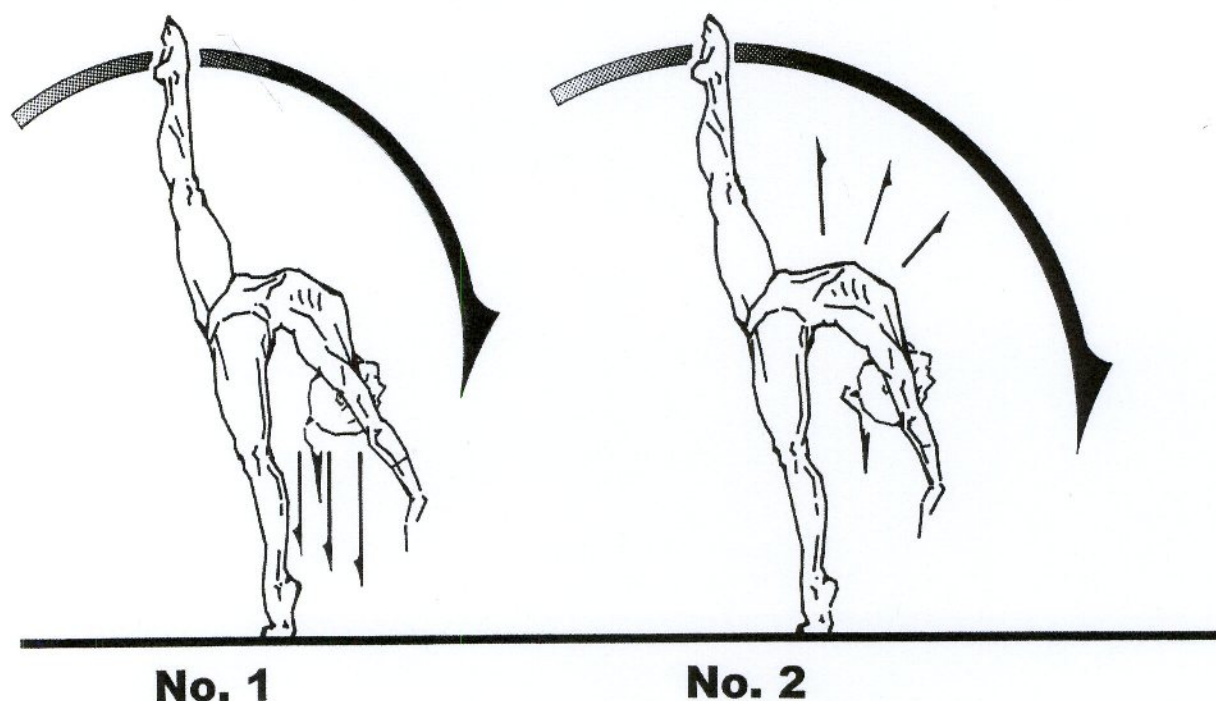


Figure 7.1. Comparative motion-flow techniques for initiating the bending phase of a Backward Walkover: (1) downward flow = poor technique; and (2) upward flow = good technique.

Because the straight-line body shape is the point of reference, any changes in this baseline shape require some form of bending. Although bending sideways does occur in a limited category of movements, the large majority of gymnastics skills involve bending in either the forward and/or backward modes. Let's examine some of the more common examples.

1. Flexion—Forward Bending

Notice performers 1 and 2 in figure 7.2 assume decreased shoulder and hip-joint angles to accomplish their bending tasks. *Rather than confining the bend only to the shoulders and hips (point loading), proper technique requires the performer to spread the bend evenly throughout all the relevant joints of the body.* In so doing, each joint site contributes to a portion of the total bend that forms the curved shape. Spreading the bend allows performers 3 and 4 to *achieve a uniformly hollowed total body unit, a shape essential to success in a large variety of ballistic-oriented skills.*

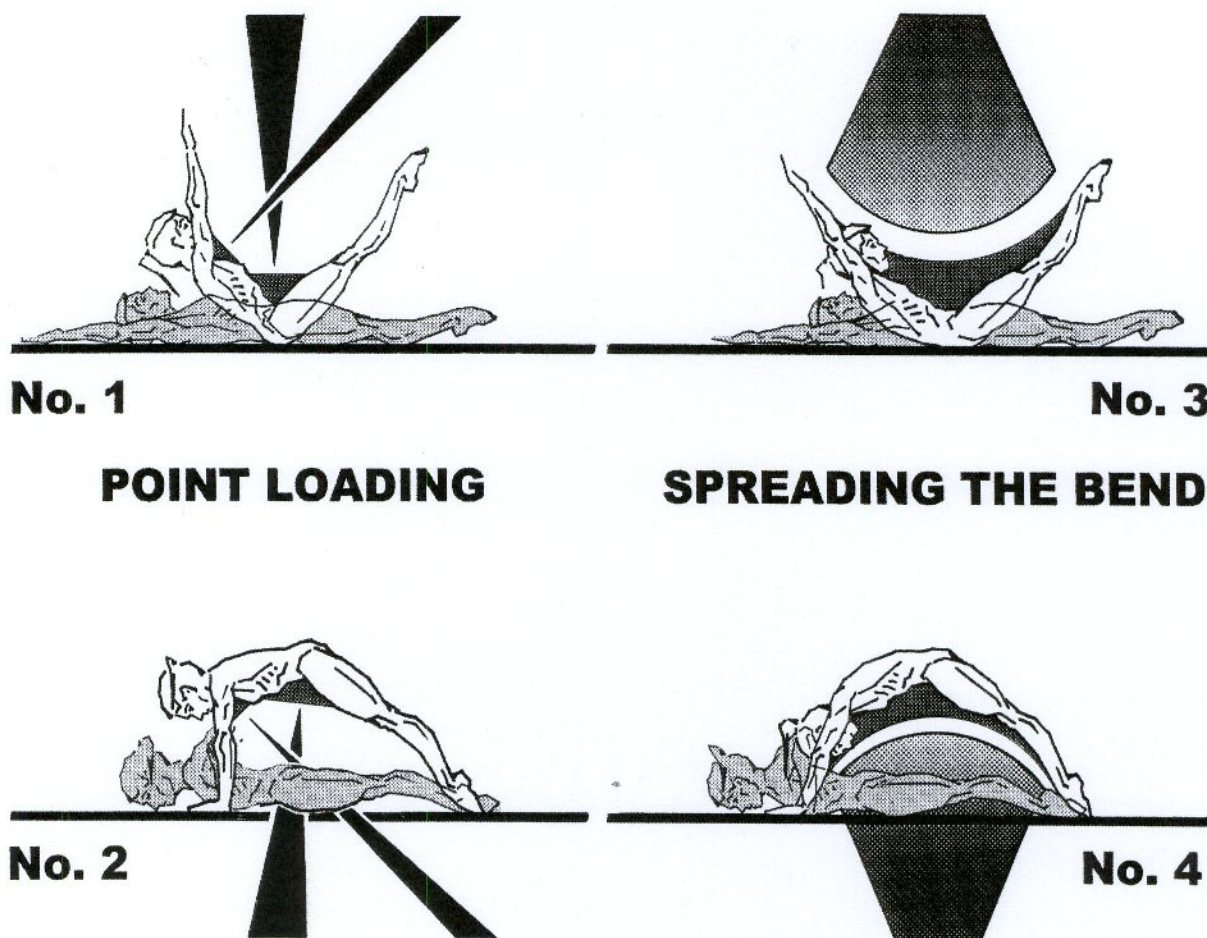


Figure 7.2. Comparative body-bending techniques in forward flexion: (1, 2) point loading = poor technique; and (3, 4) spreading the bend = good technique.

As shown by the circled illustrations in figure 7.3, these uniformly hollowed body shapes are strategically employed in varying degrees in virtually all snap-down-related skills. Typical examples include the snap-down phase of Backward Handsprings as well as the snap-down and repulsion phases of all Yurchenko-oriented vaults—to mention a few. Although the actual degree of body-shape change does vary according to the objective of the skill, *the basic concept is to employ as much of the total body unit as possible to create the desired curved shape.*

*In the final analysis,
all elements in our universe prescribe
perfectly regular curved shapes.*



Figure 7.3. Typical examples of uniformly hollowed body shapes: (1) snap-down phase of a Backward Handspring; and (2) snap-down and repulsion phases of a Yurchenko Vault.

2. Extension—Backward Bending

As can be seen in figure 7.4, performer 1 relies almost entirely on the range of motion in her low back (point loading) to accomplish the arched or hyperextended shape. By comparison, performer 2 spreads the arched shape through as much of her total body unit as possible. Notice the curved body line is distributed evenly by using the shoulders, entire back, and hip joints to “spread” the bend. *Using as much of the total body unit as possible* to accomplish the arched shape not only renders a more aesthetically pleasing line, but more importantly, *sets the stage for maximizing the momentum transfers so essential to success in executing elite-level skills.*

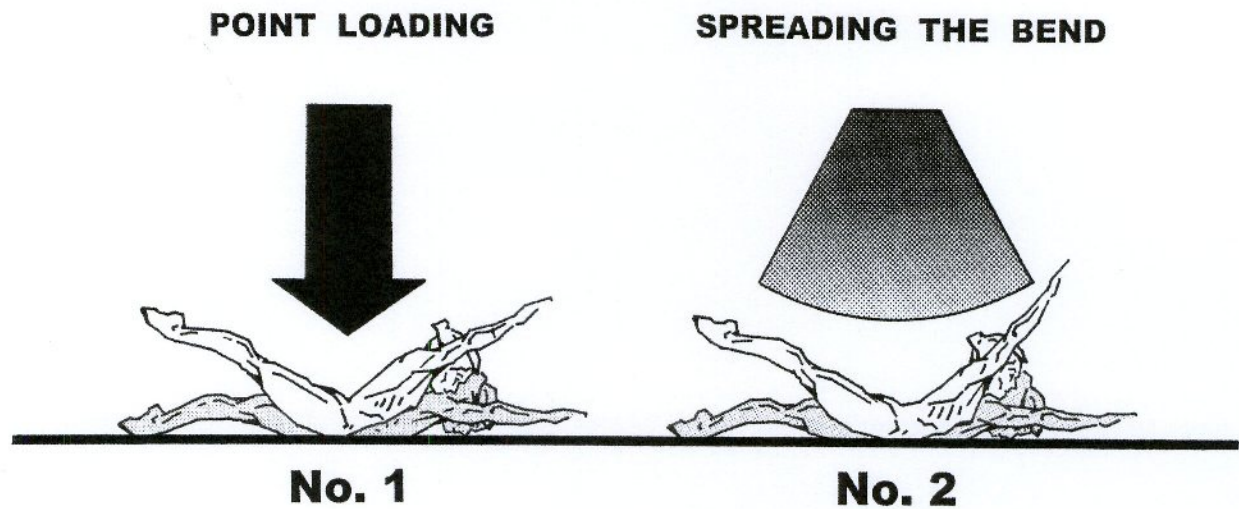


Figure 7.4. Comparative techniques in backward (hyperextension) bending: (1) point loading = improper technique; and (2) spreading the bend = proper technique.

Because the basic concept of “spreading the bend” can—and should—be applied to virtually any curved shape, the same skills used to demonstrate flexion or *hollowed shapes* in figure 7.3 are used in figure 7.5 to demonstrate its application to uniformly extended or *arched shapes*. Although these arched shapes occur at different times in the movement sequences, the principle of spreading the bend still applies:

*Always strive to use as much of the total body unit as possible
to create the desired curved shape.*

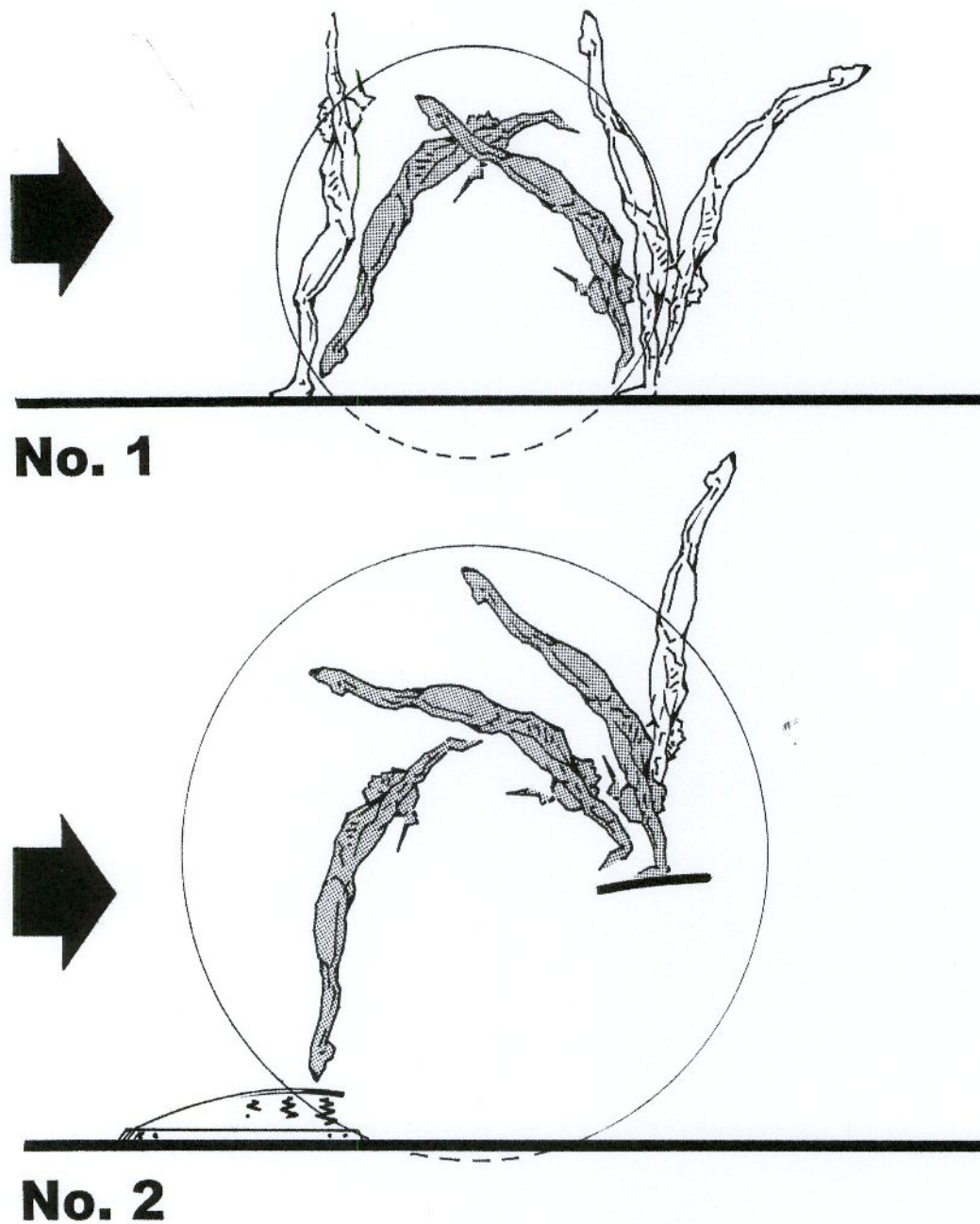


Figure 7.5. Typical examples of uniformly arched body shapes: (1) airborne phase of a Backward Handspring; and (2) take-off and preflight phases of a Yurchenko Vault.

3. Flexion—Forward Bending in Long-Hang Swing Position

While hanging from the upper rail of the uneven bars, performer 1 in figure 7.6 executes the “toe-on” body shape primarily by decreasing the shoulder and hip joint angles, while also increasing the arch (hyperextension) in the low back. Such a posture is, among other things, unsightly and mechanically counterproductive.

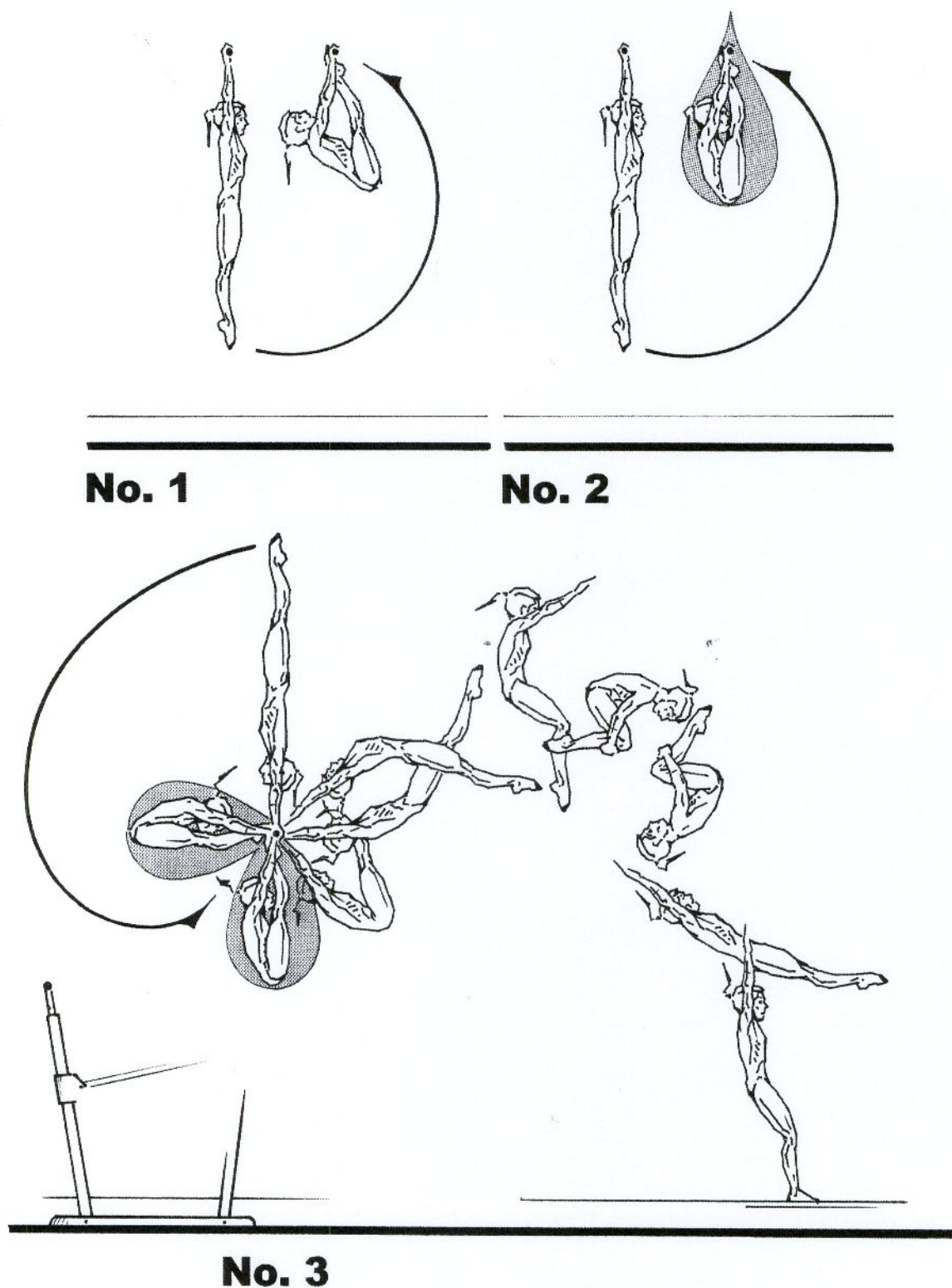


Figure 7.6. Forward bending in the toe-on swing position: (1) angled shape = poor technique; (2) teardrop shape = good technique; and (3) using the teardrop shape in optimizing a Toe-On/Toe-Off Forward Somersault Dismount from the uneven bars.

By comparison, performer 2 successfully accomplishes the same task by uniformly spreading the bend throughout the hip, back, and shoulder regions. *Not only is this "teardrop" body shape more pleasing to the eye, but it also positions the performer's mass center farther from the bar.* Such a consideration ensures greater amplitude for all sequentially related skills requiring maximum descent swing. For example, notice how performer 3 employs this "teardrop shape" during the final aspect of the descent phase in order to optimize execution of the Toe-On/Toe-Off Forward Somersault Dismount.

4. Extension—Backward Bending in Long-Hang Swing Position

Figure 7.7 presents two performers attempting to maintain a straight-line body shape in the long-hang swing position while being lifted toward the horizontal. Due to weakness in her anterior midsection (frontal core), performer 1 is unable to maintain proper shape and sustains the bulk of the bend in her low back. Performer 2, however, not only maintains tension in the abdomen but also spreads whatever bend there is evenly throughout the shoulder, back, and hips. Consequently, the backward bending observed as a result of the induced stress is very slight at any one joint. Remember: *the ability to maintain proper body shape under conditions of extreme stress is one of the key ingredients for success at every level, particularly the elite level.*

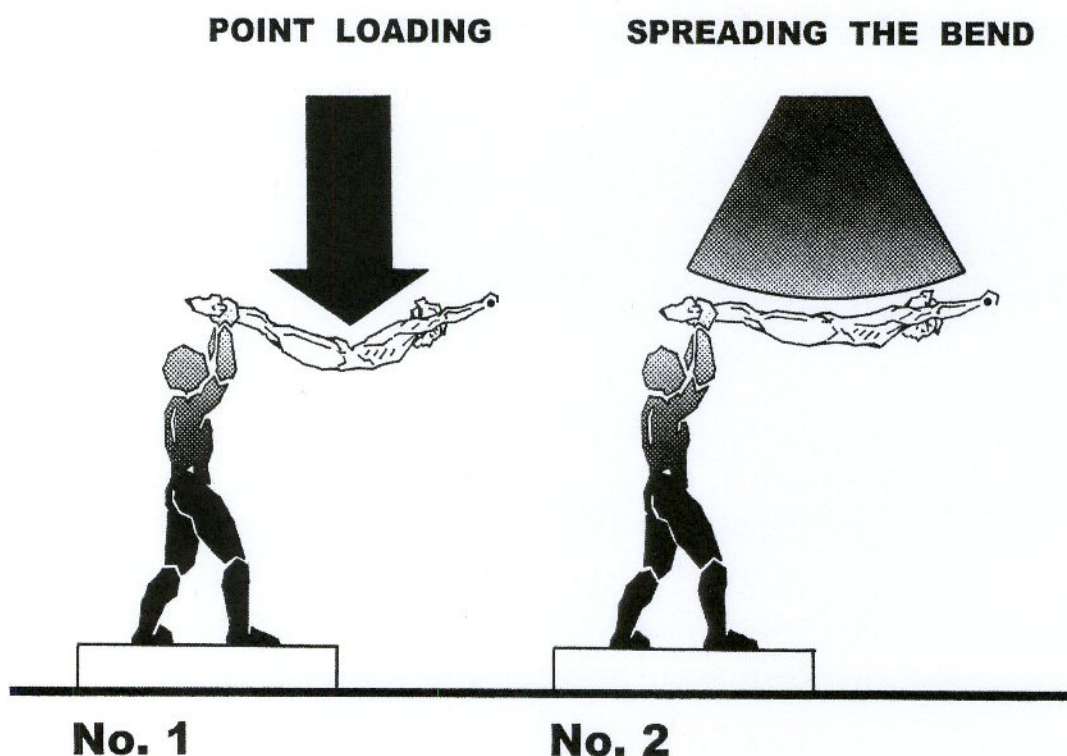


Figure 7.7. Comparative examples for maintaining proper body shape under stress in the long-hang swing position: (1) point loading = poor technique; and (2) spreading the bend = good technique.

Maintaining proper body shape under stress is particularly critical when executing elite-level release-grip skills. For example, figure 7.8 depicts how *the performer employs the total body unit to initiate the "reverse-Hecht action" for a Tkatchev on the uneven bars*. This reverse-Hecht is accomplished by quickly and forcefully opening from a hollowed shape into an arched shape, both of which are uniformly distributed through the total body. Not only is this more aesthetically pleasing, but it also sets the stage to maximize the two most critical factors in successful execution of a Tkatchev, i.e., maximum "lift" with sufficient "forward rotation" in the airborne phase.

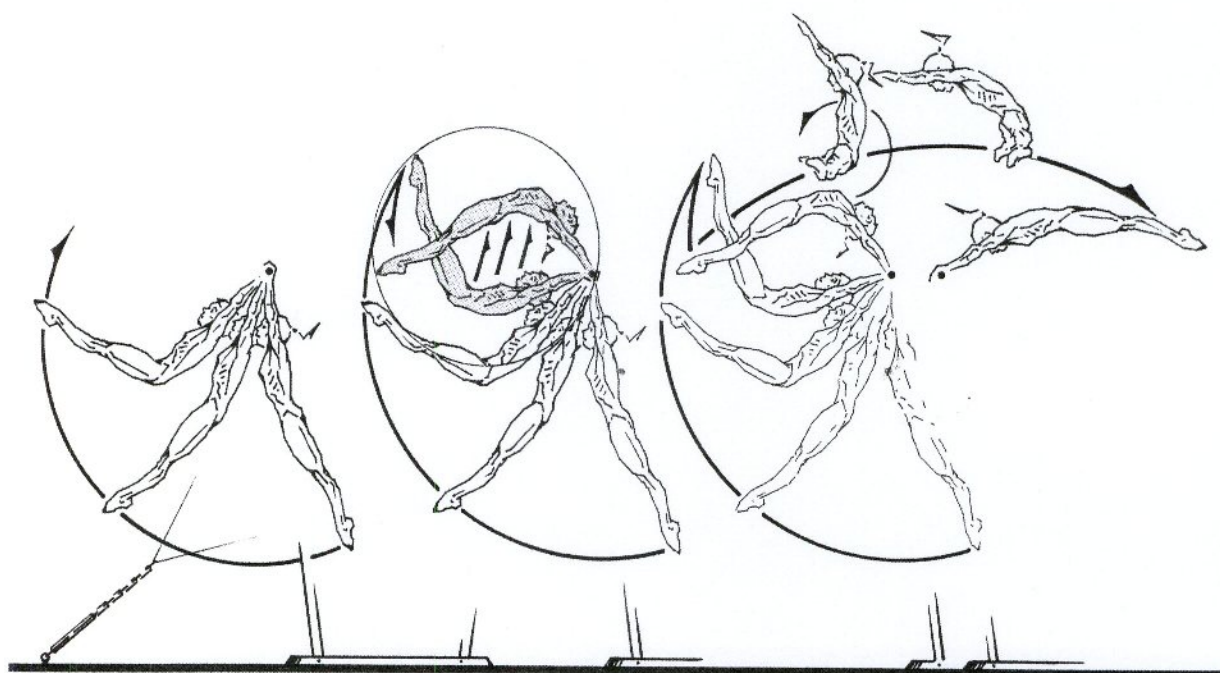


Figure 7.8. Using the total body unit to initiate a "reverse-Hecht action" in executing a Tkatchev on the uneven bars.

5. Repetitive Forward/Backward Bending

It is important to note *a large number of gymnastics sequences consist of repetitive movement patterns that alternate into and out of these slightly arched and slightly hollowed total body shapes*. This is particularly true not only for many long-hang swing skills but also for traditional backward-tumbling sequences. For example, in a Backward Handspring Series into a Layout Backward Somersault, seen in figure 7.9, notice the total body unit vacillates from an arched to a hollowed shape for each skill in the tumbling sequence. *Clearly, the similarities in movement patterns far outweigh the differences. And the observed differences are more so a matter of degree than of kind!*

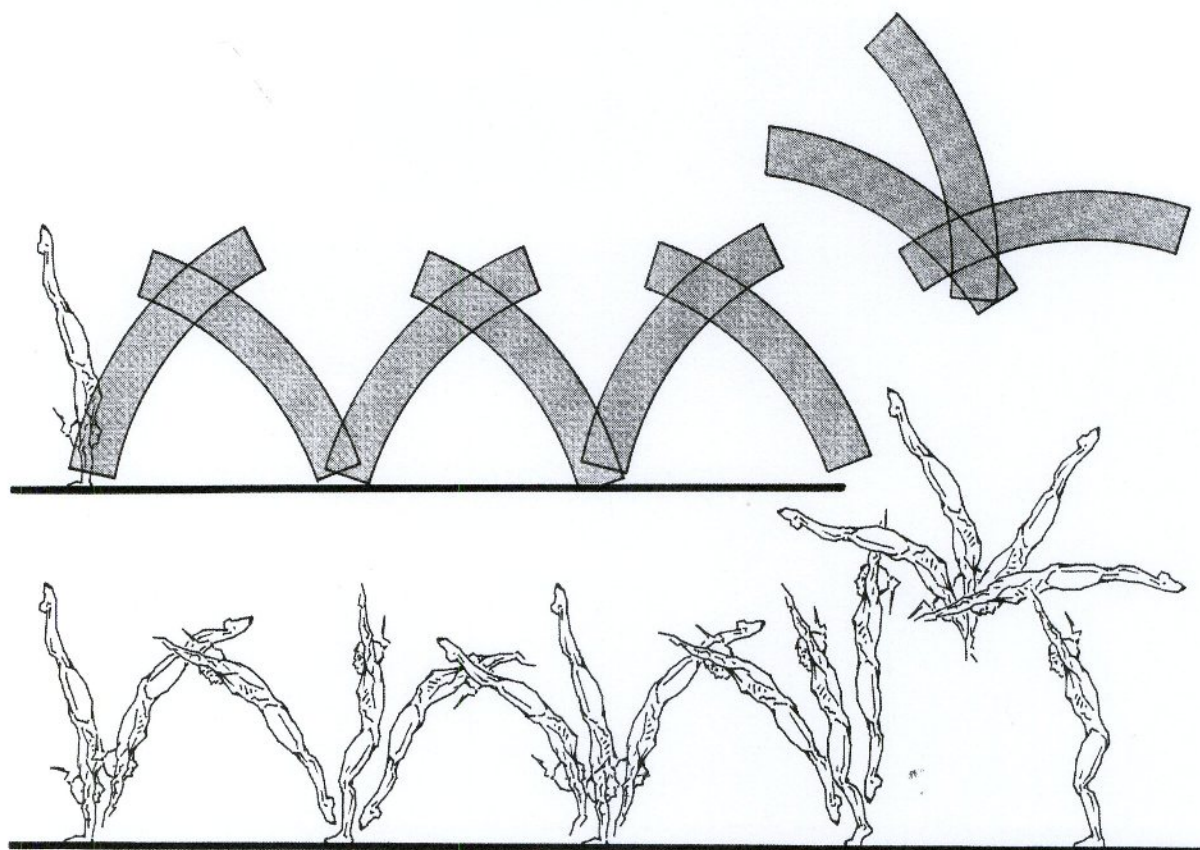


Figure 7.9. Repetitive shape-change similarities in executing a Backward Handspring Series into a Layout Backward Somersault.

Applying the Closure Principle presented in chapter 2, Backward Handsprings and Layout Backward Somersaults clearly fall into that category of skills requiring highly unobvious changes in body shape. Consequently, *for ballistic skill sequences wherein the observed shape changes are repetitive, it is fair to say:*

*As power and efficiency increase,
the degree of body-shape change
will correspondingly decrease.*

PATTERNS OF MOTION—THE KINETIC CHAIN

To ensure maximum efficiency of available force, it becomes critical that a systematic movement sequence of the various body segments be strategically employed, flowing through the total body unit either upward or downward, depending on the dictates of the skill. This progressive opening or closing of the body should reveal itself as a uniform pattern of motion, much like the development of a giant wave at sea. From a biomechanical perspective, timely transfer of momentum from one body part to the next part, and so forth, results in a greater net effect than the sum of its individual parts!

To ensure an unbroken kinetic chain of force in the movement sequence, it becomes imperative that *all changes in body shape follow a specific sequential 1-2-3 or 3-2-1 pattern of motion*. In so doing, the shape changes not only evolve into a natural flow pattern, but equally important, they serve to maximize momentum transfer—an axiomatic ingredient for successful execution of every gymnastics skill. Let's examine how this principle applies to some of the more typical movements in gymnastics.

1. Kinetic Chain Sequence for Take-Offs and Landings

The underlying mechanics for all take-offs and for all landings are fundamentally the same. For this reason, the basic Standing Jump and Land presented in figure 7.10 serves as a classical example of the proper timing sequence to employ at the hip, knee, and ankle joints. Prior to the jump, notice *a vigorous upward-throwing action of the arms sets the stage for the kinetic chain sequencing of the legs*. Because it is more difficult to start a body moving than to keep a body in motion, *a powerful extension at the hips provides the fundamental motive force*. This initiation of hip-joint extension (1) is the cue to begin immediate, forceful knee-joint extension (2), which in turn is the cue to plantar-flex the ankle joints (3). *The specific 1-2-3 (hip-knee-ankle) sequencing order must occur to ensure a most effective momentum transfer*. As mentioned, each movement builds on the previous in a rapid, explosive fashion, so their effect on total body motion becomes far greater than the sum of their parts.

*The specific sequencing of hips-knees-ankles for take-offs
and ankles-knees-hips for landings
apply to all airborne skills, regardless of type.*

Once airborne, the legs remain fully extended until just before touch-down. *Because the landing sequence is merely the reciprocal of the take-off, it follows the mirror-image 3-2-1 (ankle-knee-hip) sequence*. Notice how, as the outstretched feet make initial contact with the ground, the plantar-flexed ankles begin to dorsiflex (3) to absorb the initial landing force. This action is the catalyst to bend in at the knees (2), which in turn is the catalyst to bend in at the hips (1).

*Good landing technique is perhaps best conceptualized as
"striving to get one's feet back onto the ground
before the rest of the body actually arrives"!*

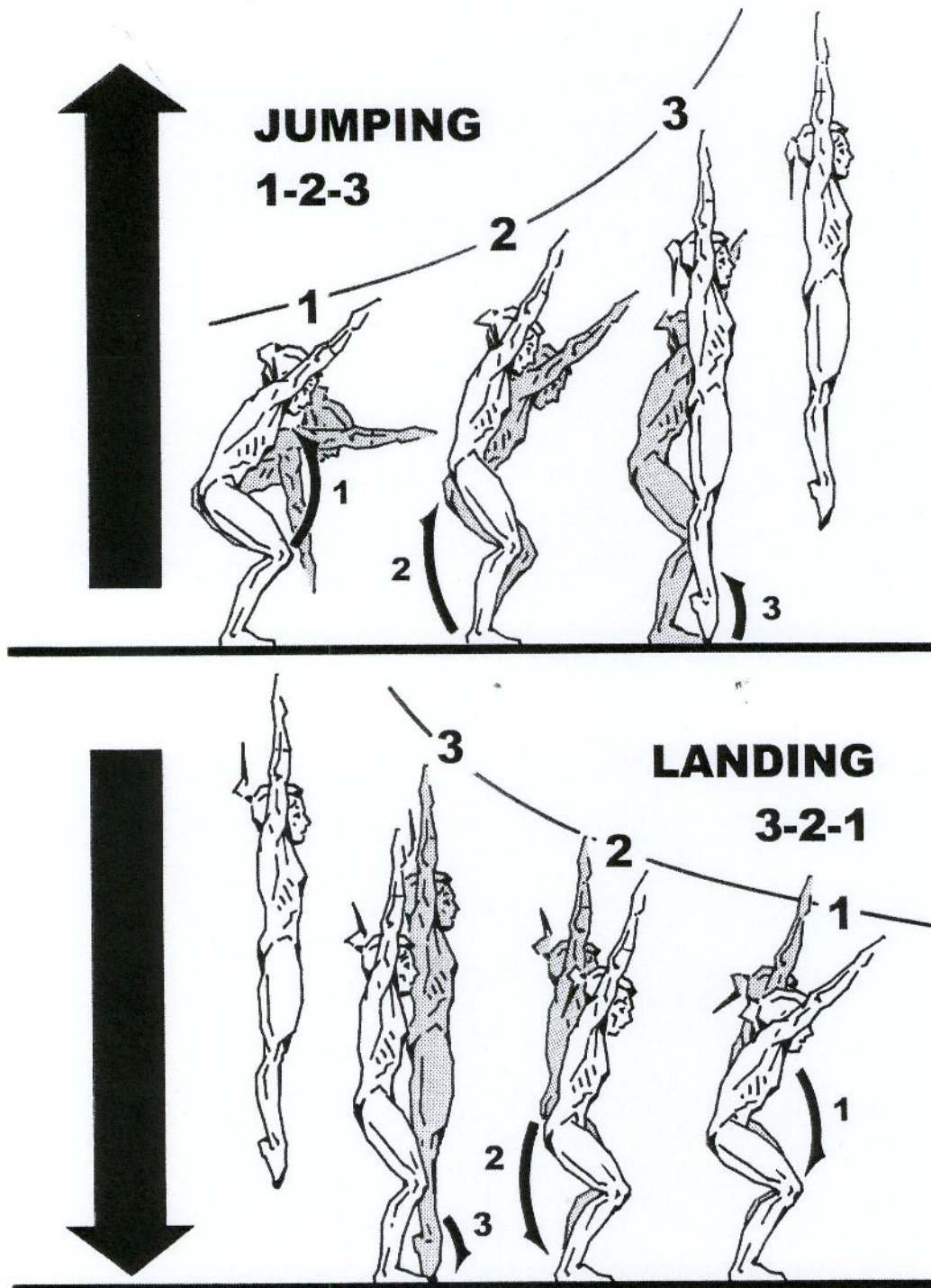


Figure 7.10. Proper kinetic chain sequence in executing a Standing Jump and Land: (1) jump phase = hips-knees-ankles, 1-2-3; and (2) landing phase = ankles-knees-hips, 3-2-1.

2. Kinetic Chain Sequence for Tucking/Opening Forward Somersaults

As with all ballistic movements in gymnastics, the mechanics for initiating, executing, and completing somersaults follow a specific movement pattern. Figure 7.11 provides an "on-ground example" of proper sequencing for both tucking into and opening out of forward somersault skills. Notice the tuck action is initiated at the region of highest location and moves progressively down the body until a fully tucked shape is achieved. Simply put, a wise performer initiates the tuck by bending first in the upper trunk, followed by the lumbar region, then the hips, and finally the knees. This 1-2-3-4 sequence ensures a most effective tucking action for virtually all forward somersaults.

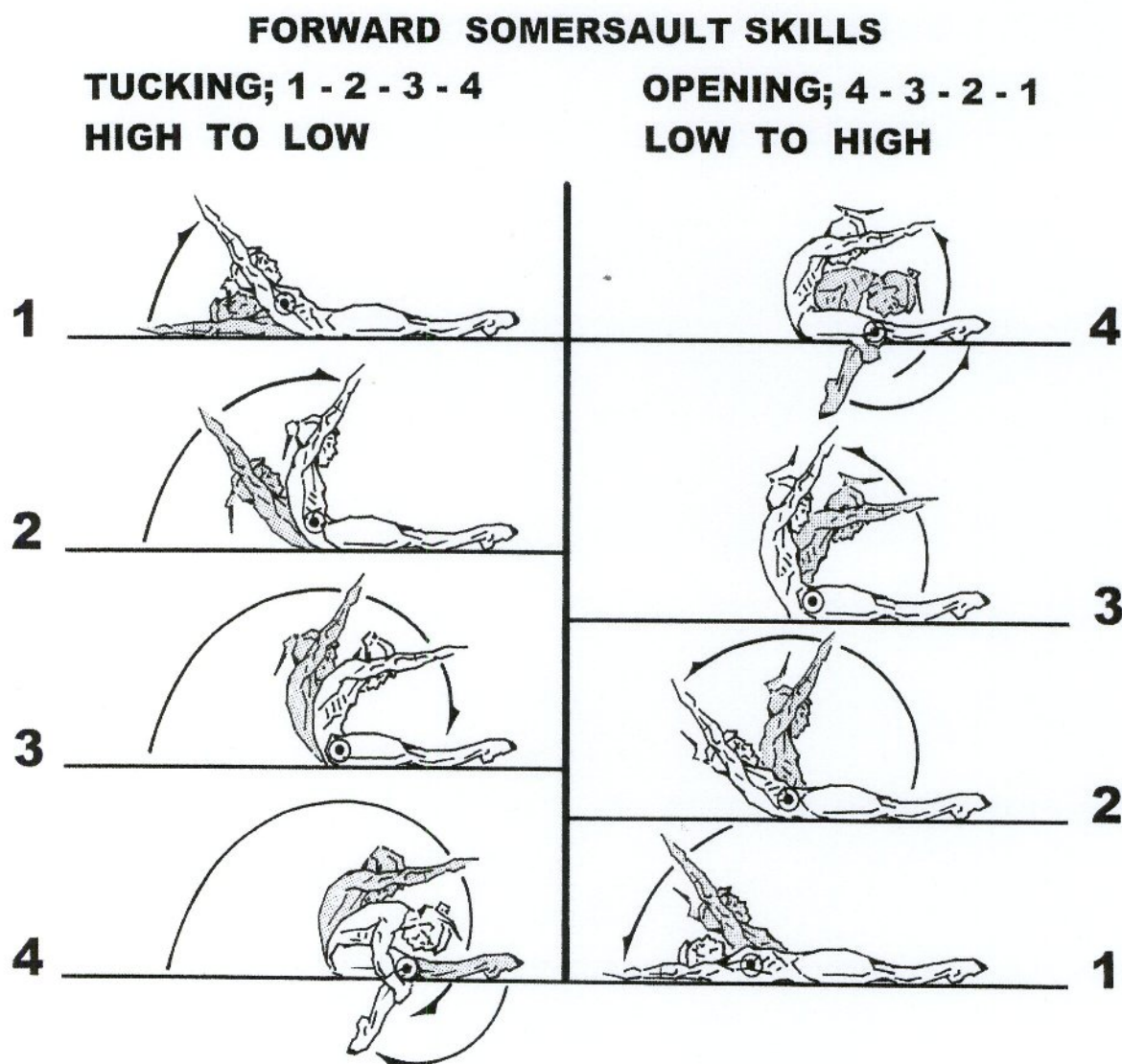


Figure 7.11. On-Ground example depicting the proper kinetic chain sequence for tucking into and opening out of a Forward Somersault.

By comparison, the opposite 4-3-2-1 sequence is employed to open out of the tuck effectively. Knee-joint extension initiates the kick-out phase, followed by extension of the hips, then the lumbar region, and finally the trunk. *This progressive unfolding of the body out of the tucked shape is similar to unrolling a throw-rug onto the floor.*

To demonstrate the importance of employing proper sequential movement patterns, figure 7.12 compares two techniques for initiating the tucked body shape in forward-somersault skills. Notice performer 1 primarily employs hip-joint flexion to generate most of the initial throwing action. Using hip-joint flexion as the initial mode for the throw causes the entire upper half of the body to be driven in a fore-downward direction. While this action admittedly does supplement forward rotary potential, it clearly cuts off the natural flow pattern of circular movement.

TUCKING - FORWARD SOMERSAULT SKILLS

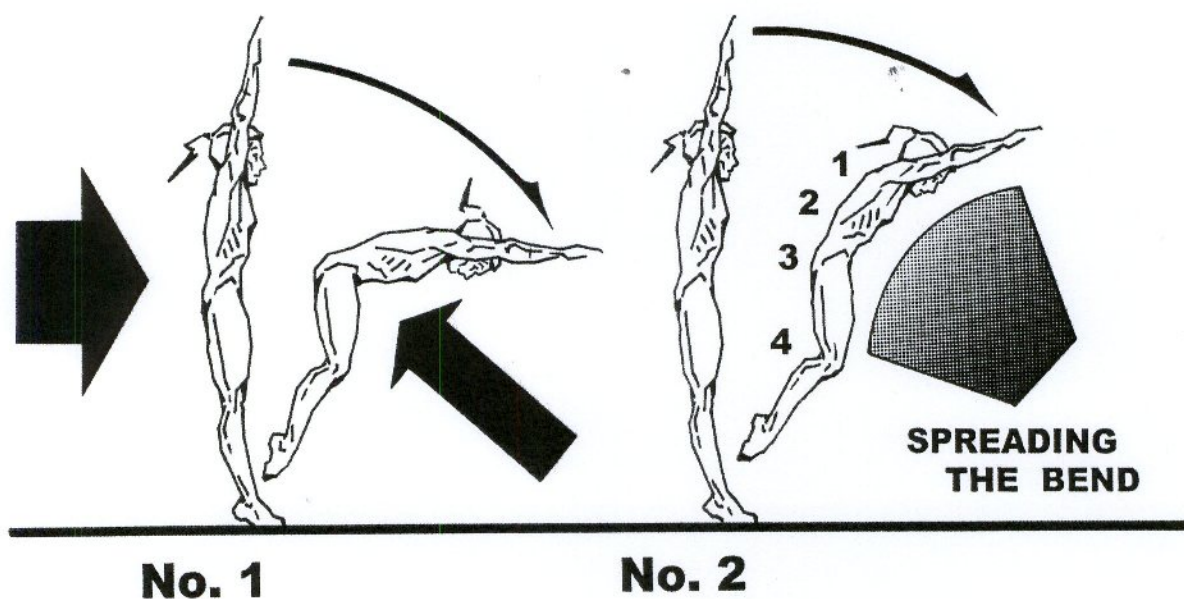


Figure 7.12. Comparative kinetic chain sequencing for tucking into a forward somersault: (1) initial hip flexion = poor technique; and (2) initial head-neck-thoracic flexion = good technique.

Performer 2 initiates the tuck action by first bending in the head, neck, and upper trunk regions (1), followed by bending in through the lumbar region (2), then bending in at the hips (3), and finally bending in at the knees (4). As in figure 7.11, the initial bend for all forward somersaults should occur at the region of highest location, followed by progressive bends down through the body. *Notice how the curling action is executed so the total body unit actually rises upward into the*

tucked shape, almost as if the performer were attempting to execute the somersault over a high-jump bar. The ability to complete most of the somersault rotation during the ascent phase of the trajectory is an infallible mark of excellence (Peaking Principle).

*Like the giant curl of an ever-expanding wave,
tuck over the top of the rising body.*

Figure 7.13 demonstrates the proper sequential pattern for opening out of a Tucked Forward Somersault. As in figure 7.11, notice how the performer kicks out of the tucked shape: first rapidly extending the knees (4), followed immediately by hip extension (3), then lumbar extension (2), and finally trunk extension (1). *Opening out of the tuck using the reverse (4-3-2-1) sequential order better stabilizes the head during the airborne descent, thereby significantly enhancing control of the oncoming landing.*

OPENING - FORWARD SOMMERSAULT SKILLS

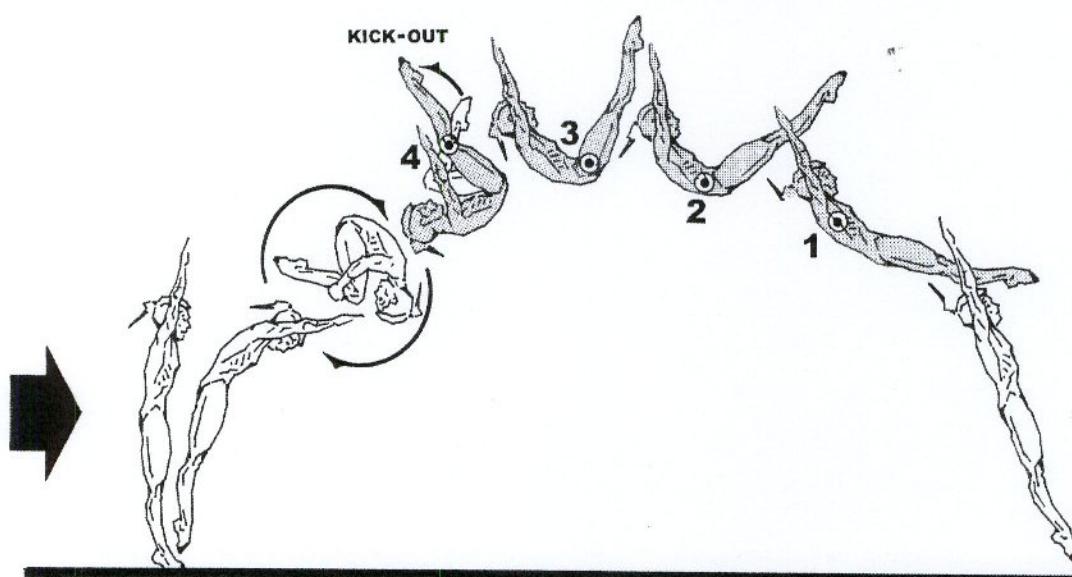


Figure 7.13. Proper kinetic chain sequence for opening out of a Tucked Forward Somersault.

3. Kinetic Chain Sequence for Tucking/Opening Backward Somersaults

In the performance of tucking (or piking) for backward somersault skills, note the actual body bend is forward, even though the total body unit is rotating backward at the same time. Consequently, *the movement pattern for tucking into as well as opening out of all backward somersaults should follow the same (1-2-3-4) order of sequence.*

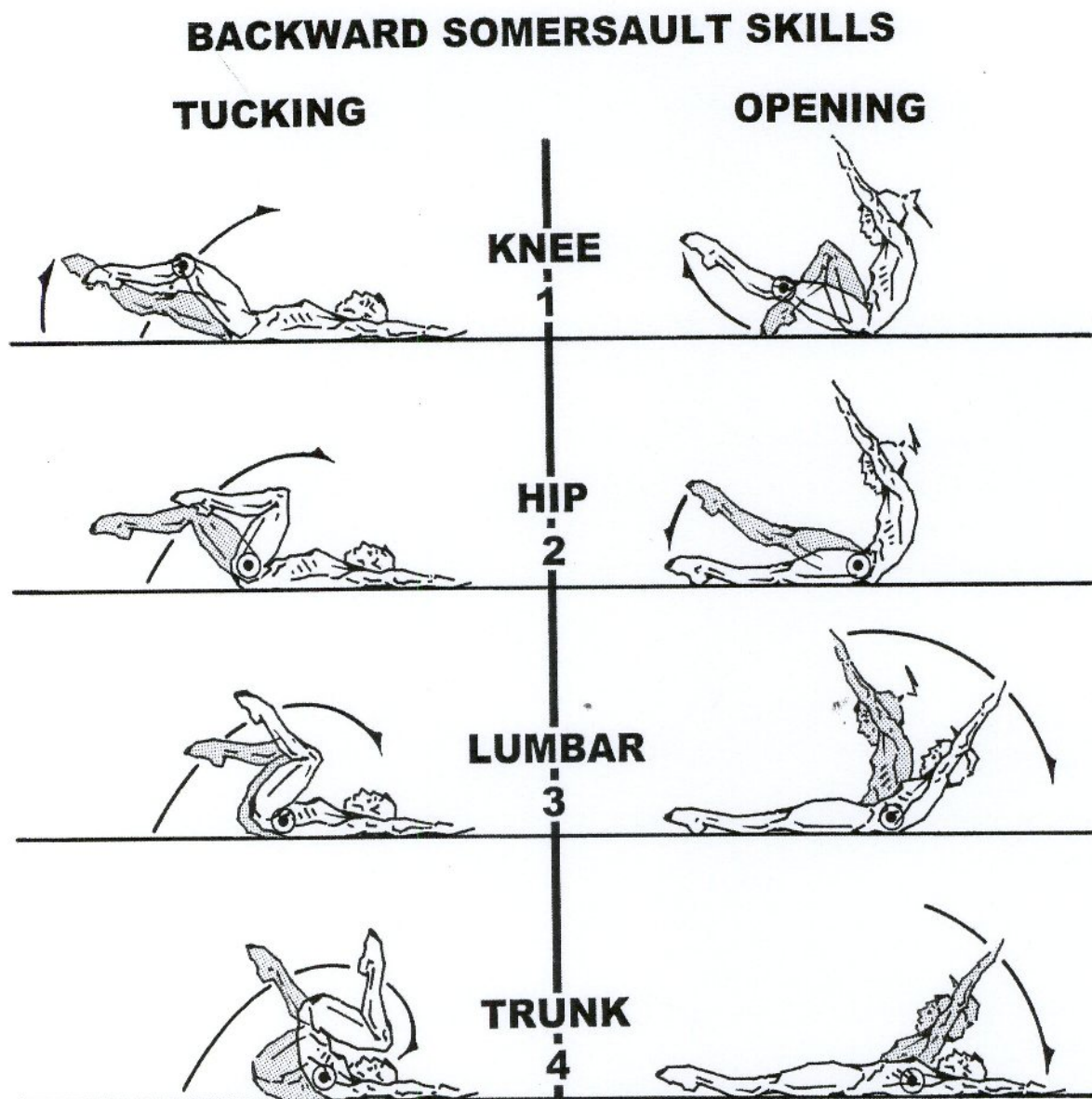


Figure 7.14. On-ground example depicting the proper kinetic chain sequence for tucking into and opening out of a Backward Somersault.

Figure 7.14 provides an "on-ground" example of the kinetic chain sequence that should be employed when tucking into as well as opening out of a backward somersault. Notice *this particular sequence occurs in precisely the same order for both movements*. In other words, both movement patterns flow from a body region of lower location to one of higher location, i.e., knee (1), hip (2), lumbar (3), and then trunk (4). Notice that, in both instances, a "foot-lead action" and/or kick-out (relative to the total body unit) is initiated prior to executing the actual 1-2-3-4 kinetic chain sequence.

When actually performing backward somersault skills, the gymnast is first confronted with having to open up into a fully extended shape prior to initiating the tuck action. Figure 7.15 depicts this "low-to-high" sequential movement pattern for bending or tucking into a backward somersault from a typical tumbling series. Notice how, upon take-off, the gymnast achieves a position of full extension in the total body unit. As soon as the fully extended body becomes airborne, a vigorous foot-lead action is initiated, similar to that of a Piked Backward Somersault. *This immediate foot-lead action in an already-rotating body sets the stage for the tuck's kinetic chain sequence.* Once this foot-lead is achieved, the tuck action occurs first in the region of lowest location, followed by progressive bends up through the body. *Done properly, the tuck phase of a backward somersault looks similar to executing a backward roll up a hill!*

TUCKING – BACKWARD SOMERSAULT SKILLS

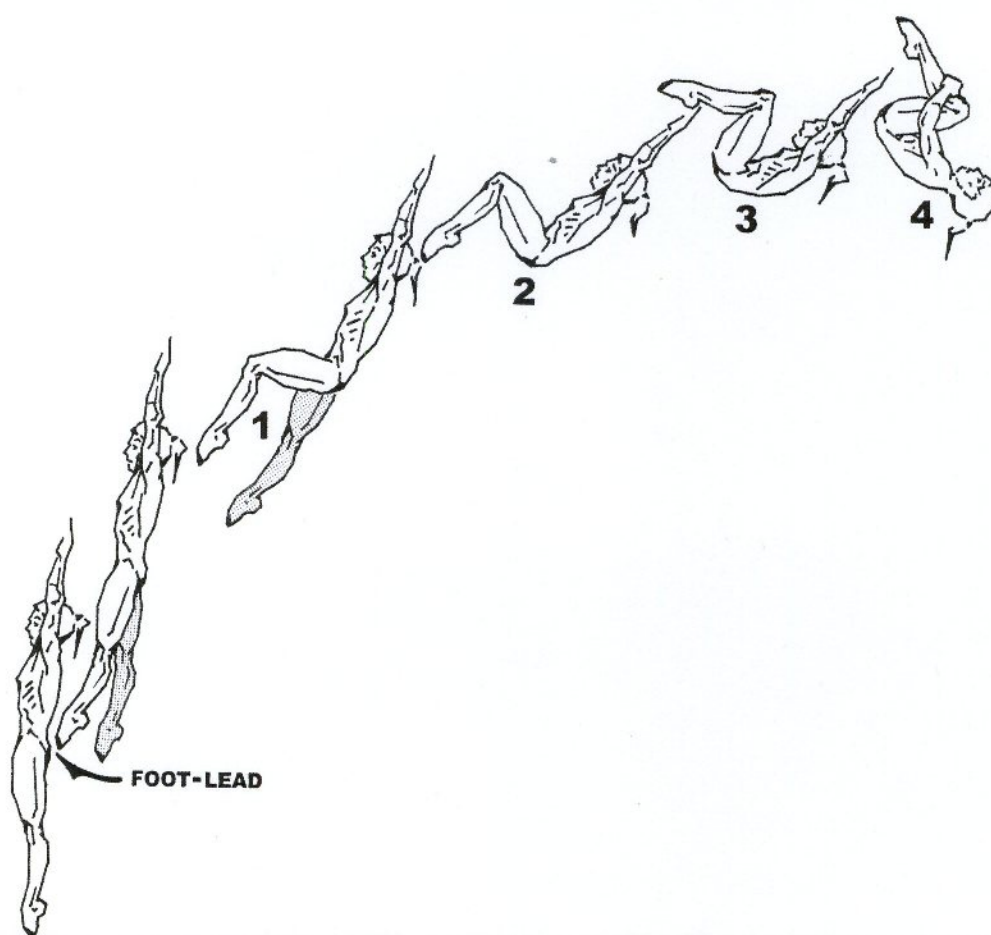


Figure 7.15. Proper kinetic chain sequence for tucking into a Backward Somersault from a typical tumbling series.

As shown in figure 7.16, opening out of a Tucked Backward Somersault employs the very same 1-2-3-4 pattern. To peak the somersault effectively, the kick-out of the legs followed by the progressive unfolding of the total body should occur during the initial apex of the airborne trajectory. *Proper timing of the open-out sequence renders a visual effect similar to that of a well-executed backward-roll extension in Floor Exercise.*

OPENING - BACKWARD SOMERSAULT SKILLS

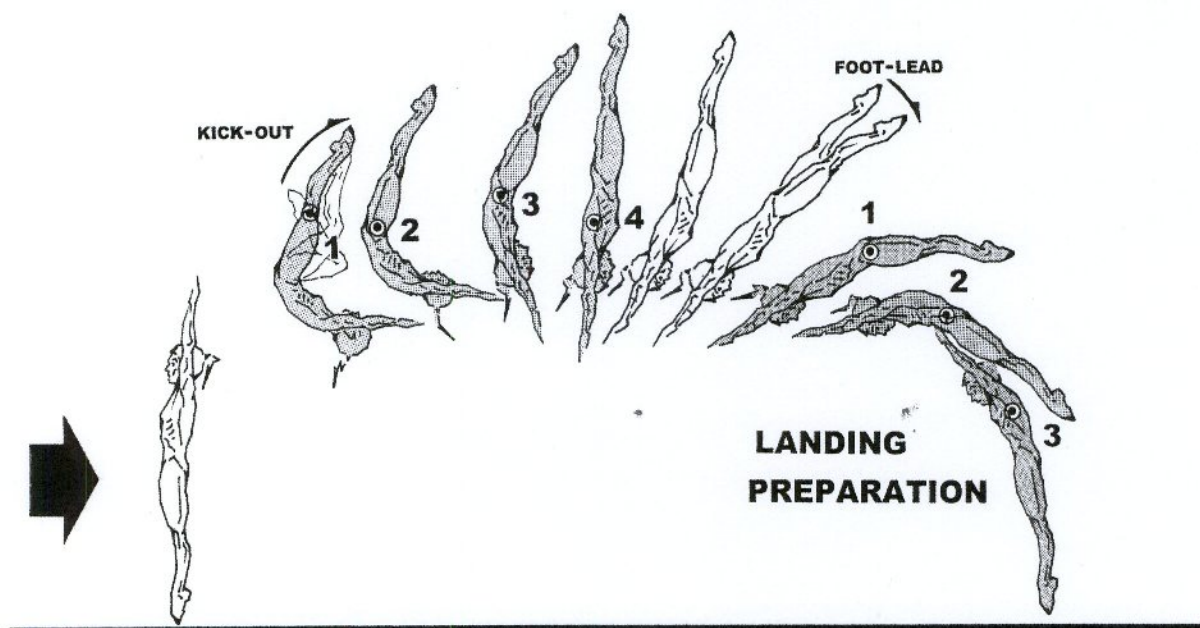


Figure 7.16. Proper kinetic chain sequence for opening out of a Tucked Backward Somersault.

*The ability to open up early in the somersault trajectory
is a clear and compelling mark of excellence!*

*All somersaulting should be viewed from the perspective of the body's airborne rotation in a fully extended shape. Any shape change—tucking, piking, and so forth—is but a momentary deviation from this straight-line shape. Therefore, as much of the rotation time as possible should be spent in a fully extended shape. In other words, the idea is to **get into and out of the tuck (or pike) early and quickly!** For example, a Tucked Backward Somersault should actually be conceived of as a Layout Backward Somersault briefly interrupted by a momentary tuck-open shape change.*

*When tucking or piking a somersault,
get in and out as early and as quickly as possible!*

As indicated by the shaded illustrations in figure 7.16, the progressive body-shape changes in the descent phase of the backward somersault follow a traditional hip-lumbar-trunk pattern. The net effect of these changes allows the gymnast to assume a slightly hollowed shape in preparation for landing. This progressive hollowing of the total body unit immediately prior to touch-down holds at least three distinct advantages: it minimizes head rotation, thereby increasing the potential for greater kinesthetic awareness; it places the body in a most advantageous shape for absorbing the force of impact; and in twist-oriented-somersault skills, it further minimizes twist velocity at impact, thereby increasing the odds for a more controlled landing.

4. Kinetic Chain Sequence for Closing/Opening Swing-Oriented Skills

All gymnastics elements follow specific sequential movement patterns, and swing-oriented skills are no exception. Because of its universal application to long-hang swing skills and dismounts on the uneven bars, the Overgrip Giant Swing provides perhaps the most compelling skill example for depicting proper kinetic chain sequencing. Previously mentioned in chapter 4, the proper sequencing for an Overgrip Giant Swing is illustrated in figure 7.17.

In the initial descent, notice how the performer creates a bend in her body using the low-to-high sequential format. This hollowing of the total body unit creates a foot-lead action that not only helps minimize body-shape distortion (arching) due to gravity but also positions the body to take maximum advantage of the oncoming "bottoming effect" of the bar. During the final aspect of the descent phase, notice how the hollowed shape progressively unfolds using the mirror-image high-to-low sequence. This timely unloading of the hollowed shape pushes the body's mass center farther from its axis of rotation (the bar) at the most opportune moment, i.e., just prior to the direct bottom of the swing. As a result, the "bottoming effect" of the bar occurs more deeply and for a longer duration of time, storing energy for use in the upcoming ascent phase.

To maximize ascent-swing amplitude, it is imperative that the performer initiate a forceful foot-lead action directly off the bottom of the swing. This foot-lead action continues throughout the initial aspect of the ascent phase in a progressive 1-2-3 sequence: first decreasing the hip-joint angle (1), then the lumbar angle (2), and finally the trunk or thoracic angle (3). During the final aspect of the ascent, the performer simply unfolds her hollowed body shape using the mirror-image 3-2-1 trunk-lumbar-hip order. Notice *all body parts line up with one another and with the upper vertical line at precisely the same time (Peaking Principle).*

but for some seemingly inexplicable reason, they are unable to achieve technical excellence in this regard. Usually, the missing link is inadequate strength in the abdominal region coupled with a lack of forward flexibility in the lumbar area.

In the absence of rock-solid abdominals and flexible lumbar vertebrae, many performers unfortunately rely on compensatory techniques to accomplish a skill. Although such techniques can (and often do) get the job done at some level, they inevitably fall miserably short of the ultimate objective, i.e., absolute mastery of skilled movement. Furthermore, the use of compensatory techniques sets a dangerous precedent, particularly when relied on to accomplish skills of higher difficulty. What seems at the time to be an "easy fix" for lower-level skills more often than not becomes the root cause of problems at the next level of performance.

To demonstrate the critical importance of having sufficient abdominal (core) strength and forward lumbar flexibility to maintain the proper kinetic chain, figure 7.18 compares two performers executing the necessary foot-lead action off the bottom of an Overgrip Giant Swing. *As performer 1 begins flexing vigorously at the hip joints to initiate the foot-lead, notice her pelvic girdle simultaneously tilts in the opposite direction (anterior pelvic girdle rotation), effectively canceling out a large portion of the initial momentum transfer.* This anterior pelvic-girdle tilt occurs primarily because of weak abdominals, which render the performer incapable of maintaining proper pelvic-girdle alignment with the trunk when flexing vigorously at the hips. Consequently, much of the momentum transfer in the kinetic chain is lost. *Such a scenario is akin to swinging on the uneven bars with the cables slackened!*

Many coaches are unaware of this subtle but significant break (defect) in the kinetic chain, and therefore cannot account for why some performers are unable to develop the necessary momentum transfer for effective execution of elite-level skills. Often they strive to resolve this dilemma by having performers attempt ever more-forceful foot-leads, only to discover such efforts merely compound the problem!

Because performer 2 has sufficient muscular strength in her abdominal (core) region as well as adequate lumbar range of motion in the forward-flexion mode, she is able to maintain and follow-through the necessary kinetic chain of events. Notice *as the foot-lead action is initiated, the straight-line relationship of the pelvic girdle and the trunk is steadfastly maintained.* Because of this, the proper sequence of first flexing vigorously at the hip joints (1) and then flexing in the lumbar area (2) can be executed. Instead of rotating against the flow of the foot-lead, *the pelvic girdle progressively rotates in the same direction as the foot-lead, thereby preserving the precious momentum transfer.*

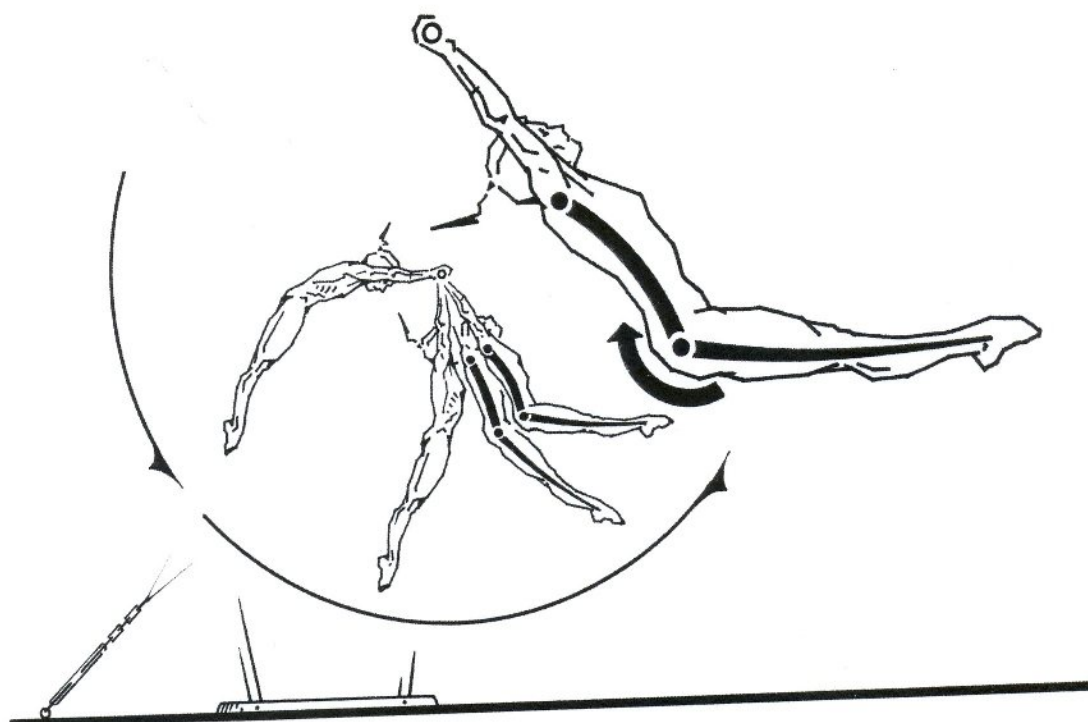
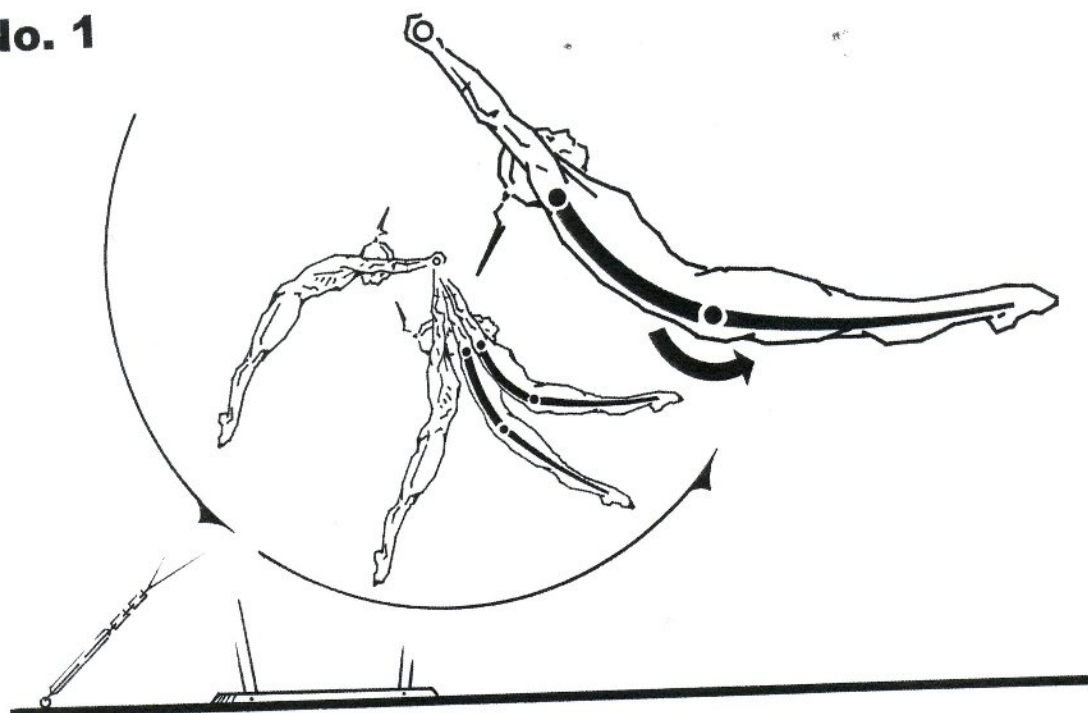
**No. 1****No. 2**

Figure 7.18. Comparative foot-lead actions off the bottom of an Overgrip Giant Swing: (1) breaking the kinetic chain = poor technique; and (2) maintaining the kinetic chain = good technique.

*Look about and you will see that
all of nature follows
natural sequential patterns of motion.*

Innumerable examples can be put forth to demonstrate the importance of maintaining proper sequential flow patterns of motion. Figure 7.19 depicts the kinetic chain for the snap-down phase of a Round-Off. Again, performer 1 falls prey to the same insidious problem of being unable to maintain proper alignment of the pelvic girdle and trunk when initiating a vigorous foot-lead action. As the legs and feet snap-down in one direction (clockwise), the pelvic girdle is simultaneously rotating in the opposite direction (counterclockwise). This predicament is grossly counterproductive and sorely compromises backward rotary motion of the total body. And *attaining sufficient rotary motion of the total body unit is the essential ingredient for maximum technical execution of all tumbling-oriented sequences.*

By comparison, performer 2 is able to initiate the snap-down phase using the proper 1-2-3 kinetic chain sequence. The vigorous foot-lead action occurs by virtue of hip-joint flexion (1), which flows into lumbar flexion (2), and finally into trunk flexion (3). Again, notice all body parts move in the precise same direction (clockwise). The net effect of these momentum transfers renders a hollowed total body shape characterized by maximum backward rotary motion.

This tendency to break the kinetic chain is most pervasive whenever the momentum transfer cuts across the very center of the total body unit—which is almost always! Consequently, it would be wise to emphasize training for maximum muscular strength and flexibility in the body's core. In so doing, the gymnast enters the arena armed with the prerequisites for success.

*When it comes to maintaining the kinetic chain,
the window of vulnerability is always open,
and the need to take charge is forever present!*

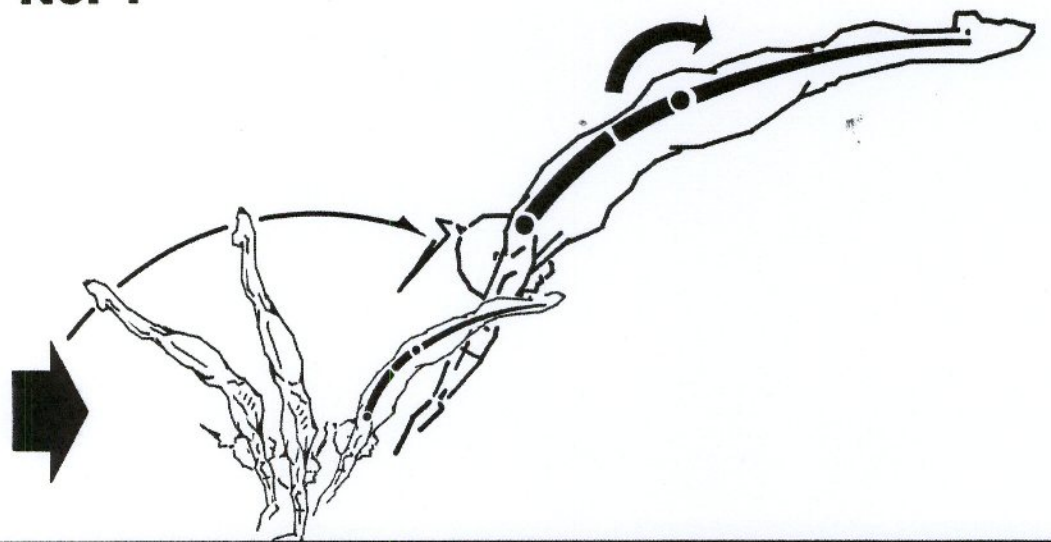
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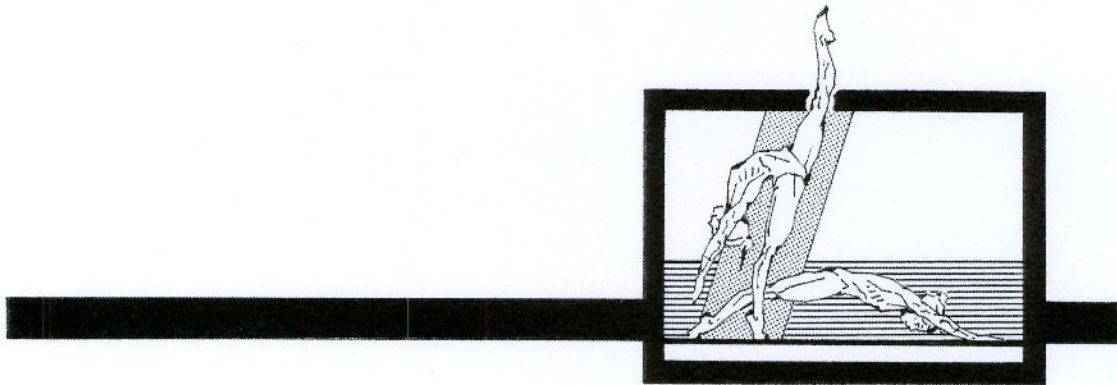
Figure 7.19. Comparative foot-lead actions in the snap-down phase of a Round-Off: (1) breaking the kinetic chain = poor technique; and (2) maintaining the kinetic chain = good technique.

FUNDAMENTAL CONCEPTS OF PATTERNED MOVEMENT

1. Absolute mastery of correct body shape and patterns of motion is particularly critical in the beginning stages of learning and is the single most difficult aspect in all of gymnastics.
2. Changes in shape should be symmetrical and should be developed using specific 1-2-3 or 3-2-1 kinetic chain sequences.
3. All curved-line shapes should be, to the extent possible, spread uniformly throughout the total body unit, i.e., "spreading the curve."
4. Any form of bending should be done in such a fashion that the flow of motion in the body is "expanding."
5. Always "stretch before bending," scoop-up as much space as possible throughout the bending action.
6. The ability to maintain proper body shape under conditions of stress is a fundamental prerequisite to success at every level.
7. The sequential movement patterns for take-offs and landings are essentially mirror images of one another.
8. To maximize momentum transfer in skill execution, strive to employ as much of the total body unit as possible.
9. The similarities in sequential movement patterns for gymnastics far outweigh the differences.
10. Beware of employing "compensatory techniques" in place of correct technical execution.

CHAPTER EIGHT

CONCEPTS OF TRAINING



*All the biomechanical techniques in the world
render themselves useless
in the absence of physical readiness.*

Physical readiness to perform a given task is a fundamental prerequisite to success. Yet many coaches fail to recognize precisely what constitutes readiness! One often observes coaches and gymnasts alike resorting to mimicry, conjecture, and relentless trial-and-error in an effort to accomplish what appears to be—but in reality isn't—a difficult learning task. The typical training session is fraught with more failed attempts than successful executions. Failure becomes routine, success becomes the exception. But even failure can be our teacher. For if we stop for a moment and truly analyze this scenario, it becomes obvious that *matching the physical readiness of the performer to the proper skill progression is the hidden component to ease of learning.*

In fact, correctly matching the readiness of the performer to the difficulty of the task is perhaps the single most important factor in successful learning. And this is best accomplished through *proper progressions, sufficient repetitions* at every stage in the progression cycle, and insisting that *mastery of technique* be demonstrated at each level *over an extended period of time.*

*Repeated failures indicate the skill being attempted
is too difficult for the performer's ability level
and implies the necessity of progressions!*

Ensuring the gymnast's physical readiness for the intended task also holds critical safety implications. A review of the safety literature specific to injuries in gymnastics

reveals *lack of performer readiness, more than any other variable, is the single most common cause of gymnastics injury.*

A seemingly endless number of physical variables contribute to successful learning and performance in gymnastics. For example, *physical size* and *weight* play a significant role in the gymnast's ability to perform effectively. Generally speaking, smaller, lighter performers enjoy a movement advantage over larger, heavier performers simply because they possess less *inertia*.¹

Additional factors such as *muscular endurance*, *cardiovascular endurance*, *speed*, *agility*, *reaction time*, and *kinesthetic awareness* are also very important and can be developed through a carefully planned yearly training program. *However, none are more fundamental to ultimate gymnastics success than flexibility (joint range of motion) and internal power (power-to-weight ratio).* Without the ranges of motion required to assume the desired shapes as well as the muscular power to move these shapes quickly and forcefully, the aspiring gymnast will do just that—aspire—but never achieve true excellence!

Although the demands of gymnastics are common to all participants, the needs specific to each performer are unique. Consequently, the wise coach carefully evaluates the individual performer's readiness profile and then employs this information to develop a training program that directly reflects the unique needs of that person.

Rather than recommending a rigid set of protocols, the underlying purpose of this chapter is to offer an organized system of principles and concepts that can be universally applied to all gymnastics training programs. The primary objective is to provide coaches and performers alike an improved set of tools with which to work, so that aspiring gymnasts might be blessed with positive rather than negative learning experiences. Remember:

*Good coaching implies that success becomes a learned trait
initially, rather than finally.*

FLEXIBILITY

"Flexibility" refers to the range through which body segments can move in relation to one another, i.e., joint range of motion. Because joint range is rotary in nature, it is usually measured in degrees of motion. Although criteria exist for "normal" flexibility, the demands of gymnastics generally require higher-than-ordinary ranges of motion in all the major joints of the body.

¹ "Inertia" refers to the "ease" with which a body can move or rotate. Smaller and lighter bodies have less inertia (less mass), and therefore can move or rotate more easily.

Flexibility is joint-specific. Practically speaking, there is no such thing as a totally flexible individual. More often than not, one discovers imbalances in any performer's joint ranges of motion—for example, one may be very flexible in the left hip yet somewhat less flexible in the right hip joint. Consequently, it is important to evaluate a performer's planes and ranges of motion in all critical joint areas with the intention of identifying and correcting any inequities from a bilateral perspective.

The basic idea here centers upon striving to strike the most effective balance in ranges of motion for the more critical joint areas, i.e., ankle, knee, hip, entire back, shoulder, elbow, and wrist. Once a reasonable balance is achieved, the next step in the training process should be to employ an ongoing flexibility program geared specifically to the gymnast's unique needs. In terms of assessing joint ranges of motion, it is fair to state:

*You need them all,
and all of them need to be balanced!*

1. Constraints on Joint Flexibility

While "genetic predisposition" largely determines the maximum ranges of motion an individual gymnast can possibly achieve, the "training environment" determines the extent to which her potential flexibility can be realized. That is why *having an effective flexibility training program throughout one's career is essential to success.* Given these constraints, the potential ranges of motion a gymnast can hope to attain are governed primarily by the following two factors:

Structural limitations on joint range of motion are due to the shapes of the body's non-elastic components, particularly the bone-to-bone articulating surfaces. For example, if the cuplike acetabulum of the pelvis is shaped to receive the head of the femur more deeply, the gymnast enjoys greater structural integrity of the hip joint at the expense of a decreased range of motion. In such instances, flexibility training has little if any effect other than simply maintaining what is already present.

Functional limitations on joint range of motion are due to the restraining effect of the body's elastic connective structures, i.e., muscles, tendons, ligaments, and surrounding connective tissues. Because these structures have a measure of elasticity, they have the potential to be "stretched" to some degree through a judicious flexibility training program applied over an extended period of time.

2. Range of Motion in the More Critical Joint Areas

While attaining an appropriate level of flexibility in all the major joints is essential to gymnastics success, but nowhere is that flexibility more important than in the hip joints, shoulder joints, shoulder girdle, and vertebral column. And within these four areas, perhaps *the most crucial but least understood is the vertebral column.*

As can be seen in figure 8.1, the normal vertebral column prescribes an undulating curved path commonly divided into four major sections: 1) the cervical vertebrae, which connect the head to the trunk; 2) the thoracic vertebrae, which attach to the ribcage and make up part of the trunk; 3) the lumbar vertebrae, which connect the trunk to the pelvic girdle; and 4) the sacral vertebrae, which are essentially fused and make up part of the pelvic girdle. *For purposes of achieving a "balance" in ranges of motion, the thoracic and lumbar regions should be considered the primary target areas.*

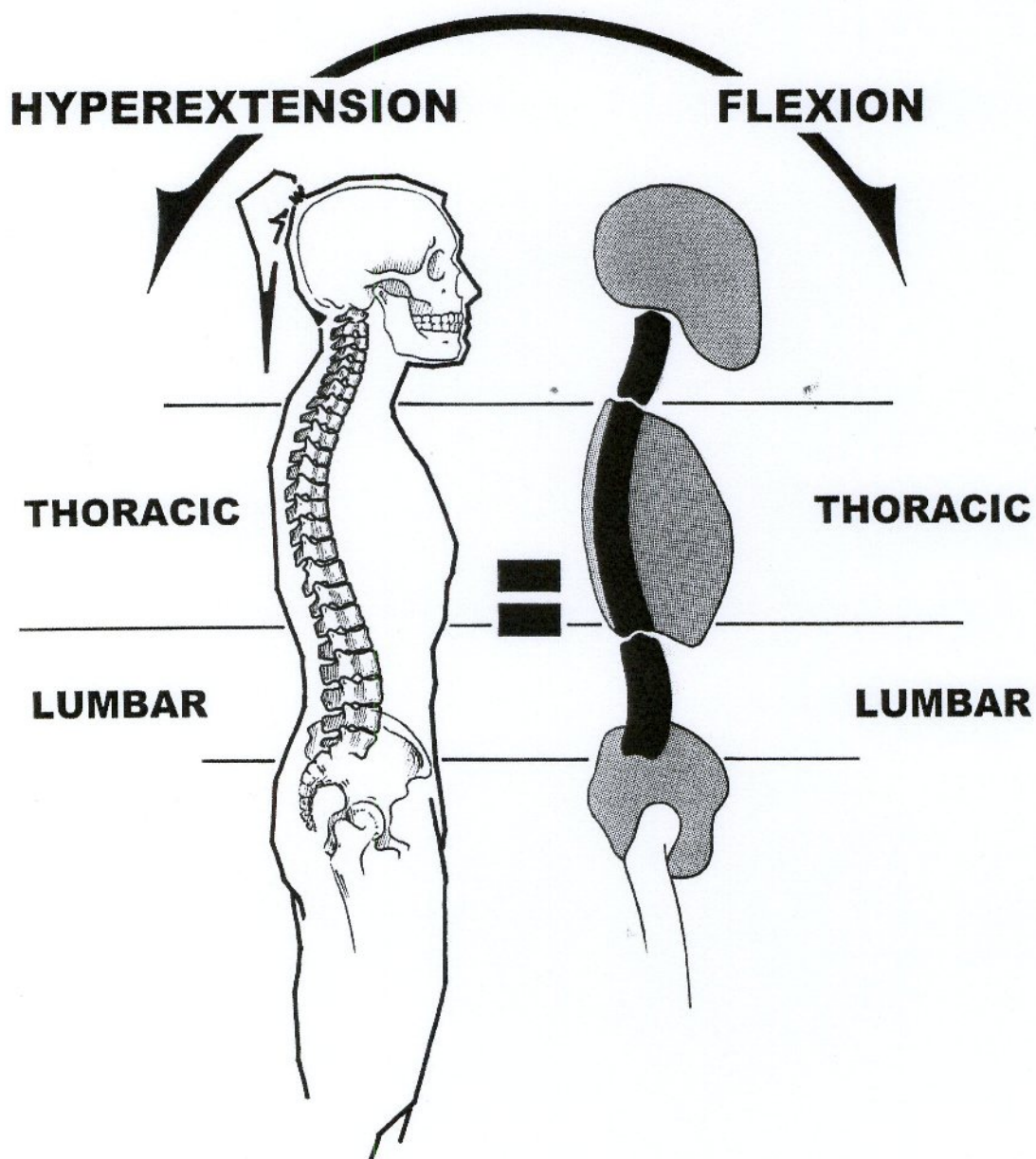


Figure 8.1. A sagittal view (A-P plane) of the human vertebral column.

By the nature of the human vertebral structure, our *lumbar vertebrae* tend to be relatively flexible in the *hyperextension* (backward-bending) mode but somewhat inflexible in the *flexion* (forward-bending) mode. By contrast, our *thoracic vertebrae* tend to be inflexible in hyperextension but relatively flexible in flexion. As a result, untrained or poorly trained gymnasts tend to rely almost entirely on their naturally more flexible regions when bending forward and backward.

Performer 1 in figure 8.2 demonstrates what typically occurs in the forward-bending (flexion) and backward-bending (hyperextension) modes. Notice that this performer employs her lumbar vertebrae almost exclusively when bending backward and her thoracic vertebrae when bending forward. Because she lacks an adequate range of motion in thoracic hyperextension as well as in lumbar flexion, she is incapable of "spreading the bend" throughout the vertebral column for either movement. Consequently, a sort of "point loading" occurs in her more flexible regions, thereby minimizing the potential for correct technical execution while maximizing the potential for overuse injury.

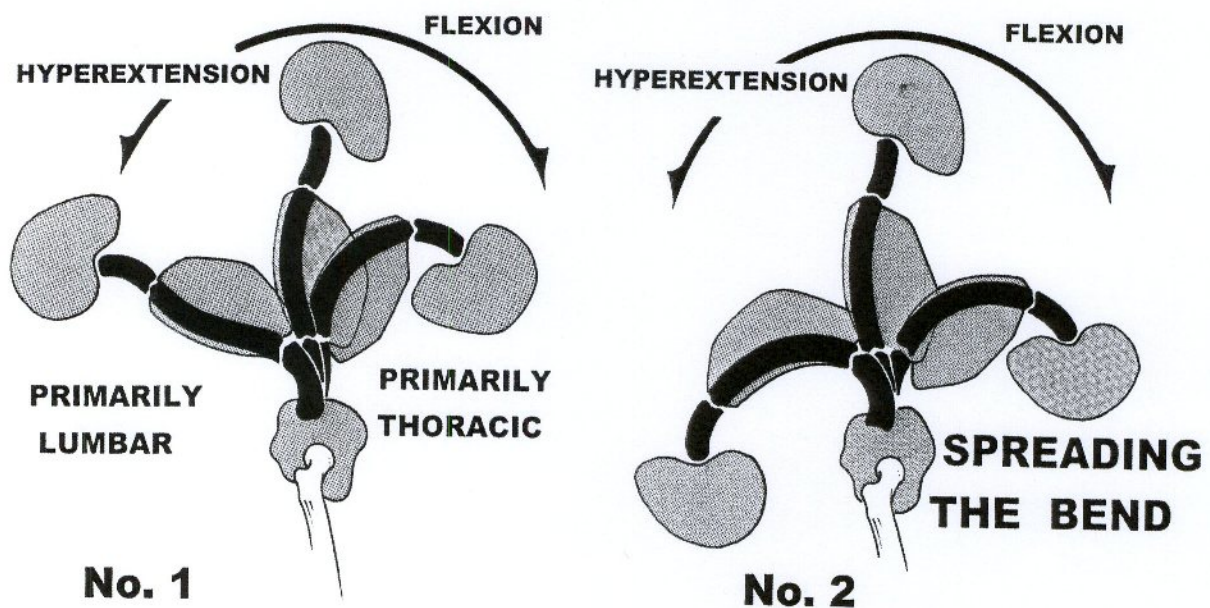


Figure 8.2. Comparative hyperextension and flexion of the vertebral column: (1) imbalance in thoracic and lumbar joint flexibility; and (2) proper balance in thoracic and lumbar joint flexibility.

Because performer 2 enjoys a "balance" of flexibility in her thoracic and lumbar regions, she is able to accomplish the range of movement in both the forward and backward directions by "spreading the bend" more evenly throughout her vertebral column. Having this balance of flexibility in these critical regions allows her the opportunity to: 1) flow through movements more evenly, using the proper body shape; 2) maximize momentum transfers up and down the spine; and 3) minimize

potential overuse injuries that often arise out of repeated "point loading." Therefore, *flexibility exercises that are specifically designed to improve a performer's range of motion in the "more inflexible areas" of her vertebral column should be an integral part of the training program.*

*Attaining adequate ranges of motion in
lumbar flexion and thoracic hyperextension
plants the seed for excellence in technique.*

Demonstrating the importance of balanced flexibility in one's vertebral column, figure 8.3 illustrates the rolling interplay between the lumbar and thoracic vertebrae as body weight is shifted back and forth in a Back Limber position. When the weight is borne primarily by the hands (illustration A), most of the bend is in the upper back (thoracic hyperextension). As the body begins to shift forward (B), observe how the bend rolls down the spine (thoracic and lumbar hyperextension), thereby allowing the weight to be evenly distributed between hands and feet. And finally, as the weight shifts farther forward onto the feet (C), the bend continues to roll downward so the majority of the bend is now localized in the low back (lumbar hyperextension). *This forward/backward "rocking" motion that occurs while shifting to-and-fro in the Back Limber should directly reflect the "rolling" action of the bending vertebral column.*

Rock-'n'-roll is here to stay!

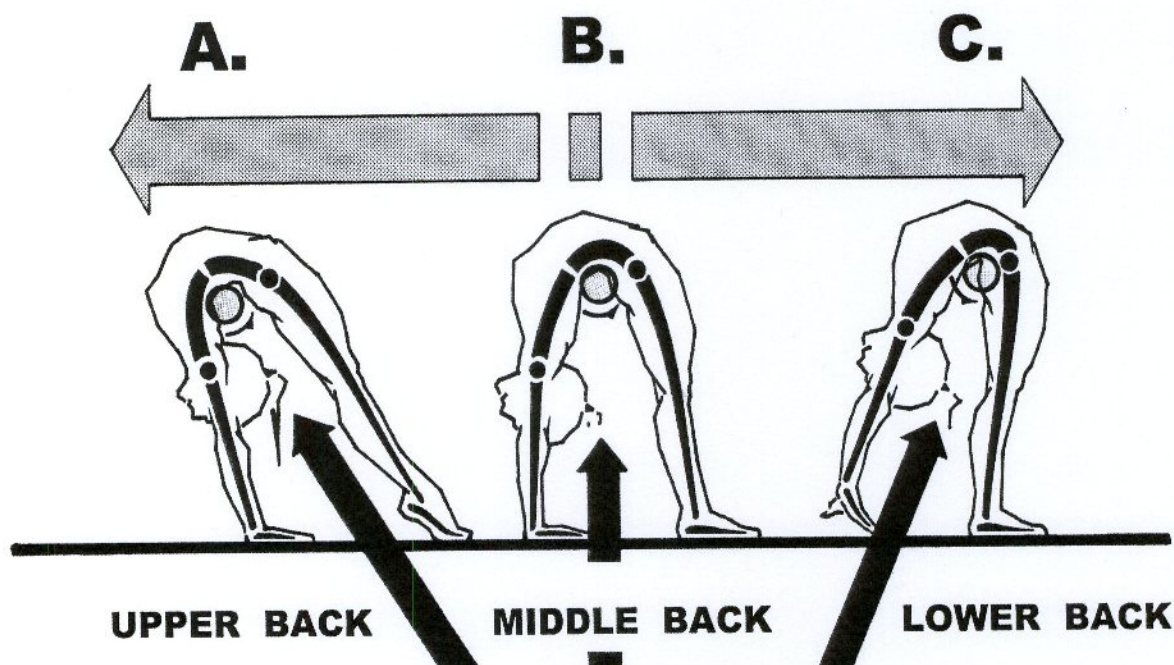


Figure 8.3. A conceptual model of the rolling interplay between lumbar and thoracic vertebrae while shifting body weight back-and-forth in a Back Limber position.

Chapter 2 discussed joint flexibility as a key factor in maximizing internal amplitude, and the importance of this relationship was depicted in the step-out phase of a Forward Walkover. The same skill is used in figure 8.4 to clarify precisely why having maximum, balanced ranges of motion are so important to achieving technical excellence. In illustration A, notice the total body remains on-balance while the lead foot gently reaches for the mat. Because the performer has a maximum, balanced range of motion in her shoulders, back, and hips, she is able to *place her lead foot close to her support hands prior to shifting her weight*. This allows her the opportunity to remain on-balance while taking a relatively small step. As a result, the actual "transfer of weight" from the hand-support position (illustration A) through hands-and-foot support (B) into the foot-support position (C) becomes not only easier to accomplish but also smoother in flow.

*Like the grasshopper walking lightly on rice paper,
take a small step first and then transfer your weight.*

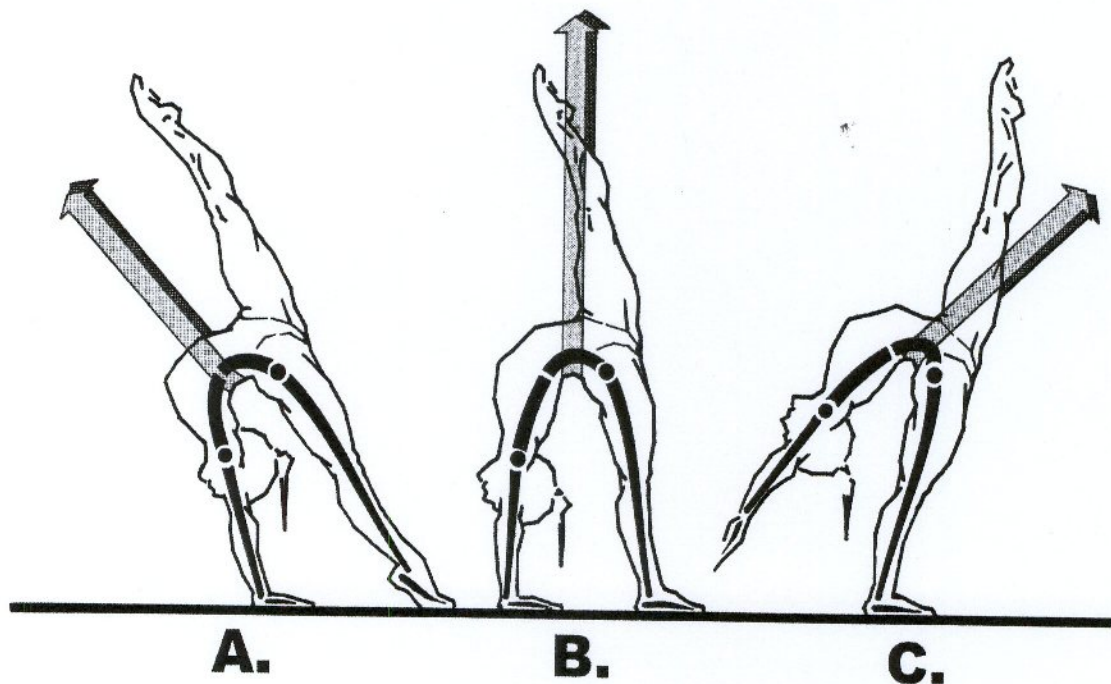


Figure 8.4. The effect of maximum, balanced joint flexibility on the step-out phase in a Forward Walkover.

3. Flexibility Training Protocols

There appear to be as many flexibility training protocols as there are opinions about which are most effective and why. The basic reason for these discrepancies centers on coaches and trainers not accounting for the unique needs and individual differences of each gymnastics participant. For the truth is, *virtually every prudent*

flexibility training program can be quite effective, depending, of course, on when, at what stage, and to whom it is applied. Consequently, it is not so much a matter of selecting a preconceived notion of what constitutes "the all-time-best program for everyone"—rather, it is a matter of accurately determining the unique flexibility needs of each performer and then selecting the most appropriate type and level of program for that person.

The trick is matching the correct flexibility training regimen to the unique needs of each individual performer.

With this in mind, let's look at the fundamental types of flexibility training and perhaps then we can better determine which program type best meets the unique needs of the given performer.

A. Static Flexibility Training

"Static flexibility training" refers to range-of-motion training wherein the performer holds (or is held in) positions that serve to gently stretch the muscles and connective tissues surrounding the target joints. Static stretching is generally considered to be the more appropriate technique in the initial stages of training, during warm-up sessions at every level, and as a fundamental protocol in rehabilitation.

Static training is often recommended over dynamic (motion) stretching techniques in the initial stages because it holds a number of advantages: 1) there is less danger of exceeding the extensibility limits of the tissues involved; 2) the energy requirements to perform the exercises are low; and 3) it has been shown to help relieve the muscular soreness that sometimes accompanies dynamic stretching.

As depicted in figure 8.5, *two methods can be employed in static stretching. The first and more basic is the Static-Passive Method. The term "passive" implies the stretch position is achieved by a means other than using one's own specific muscle groups normally responsible for moving the joints to that position. In this method, an external force—the performer's weight due to gravity and/or another person's assistance—is used to accomplish the actual stretch.*

The Static-Passive Method is employed in illustration A to stretch the hamstring and low-back muscles. *Because the motive force for the stretched position is derived externally rather than exerted by the specific muscles normally responsible for maintaining the shape, the range of motion achieved by the Static-Passive Method is considered non-functional in nature.*

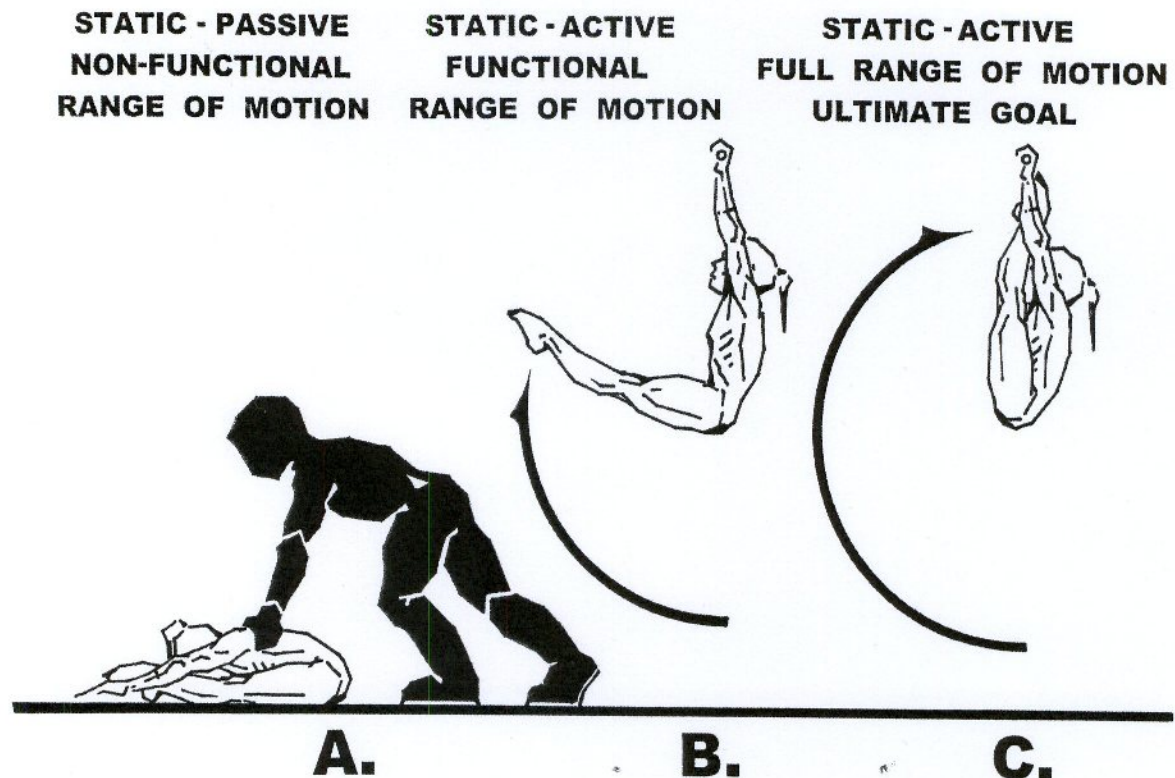


Figure 8.5. Static flexibility training: (A) Static-Passive Method = non-functional; (B) Static-Active Method = functional; and (C) ultimate goal of the Static-Active Method = the ability to employ the muscles most involved to achieve a full range of motion.

By comparison, the second and more advanced Static-Active Method is functional, because it requires the performer to use only the specific muscles responsible for holding the limb or body part in the stretched position. For example, when the same performer hangs from the upper rail of the uneven bars and attempts a basic leg-lift (B), notice she is unable to attain the same degree of stretch originally achieved in the seated position. Although this performer possesses an excellent range of motion in the piked position, she clearly lacks the necessary muscular strength to assume the same body shape under conditions of stress.

It is important to note, however, that whatever "degree" of body shape closure she does achieve under her own muscular effort is considered her "functional" range of motion. Here, *the ultimate objective of the Static-Active Method is the ability to achieve and hold a fully closed body shape while hanging from the bar (C).*

*The ability to control, guide and regulate one's ranges of motion
is more important to ultimate success than is
mere flexibility.*

B. Dynamic Flexibility Training

"Dynamic flexibility training" refers to the use of limb and/or body movements in a specific ballistic or swinging fashion to achieve an increased joint range of motion. Two methods can be employed in dynamic stretching. The first, the Dynamic-Passive Method, is similar to static-passive as it involves the application of an external force to stretch the target joint(s), but employing a rhythmic, bouncing mode. Because of the tendency to become over-zealous in this regard, caution should be exercised to avoid going beyond the natural extensibility limits of the limb or body part, possibly resulting in injury.

Illustration A of figure 8.6 depicts the same lumbar/hamstring stretch, this time by the Dynamic-Passive Method. With gravity as the external force, the performer allows her upper body to fold about her lower body using a ballistic, bouncing mode. While this dynamic action energetically stretches the target areas, it clearly does not employ the specific muscle groups—i.e., the hip and lumbar flexors—normally involved in moving the body against resistance through this range of motion. Consequently, the Dynamic-Passive Method, like static-passive, is classified as "non-functional." It nonetheless remains *an excellent, time-tested flexibility protocol and should be an integral part of every flexibility program.*

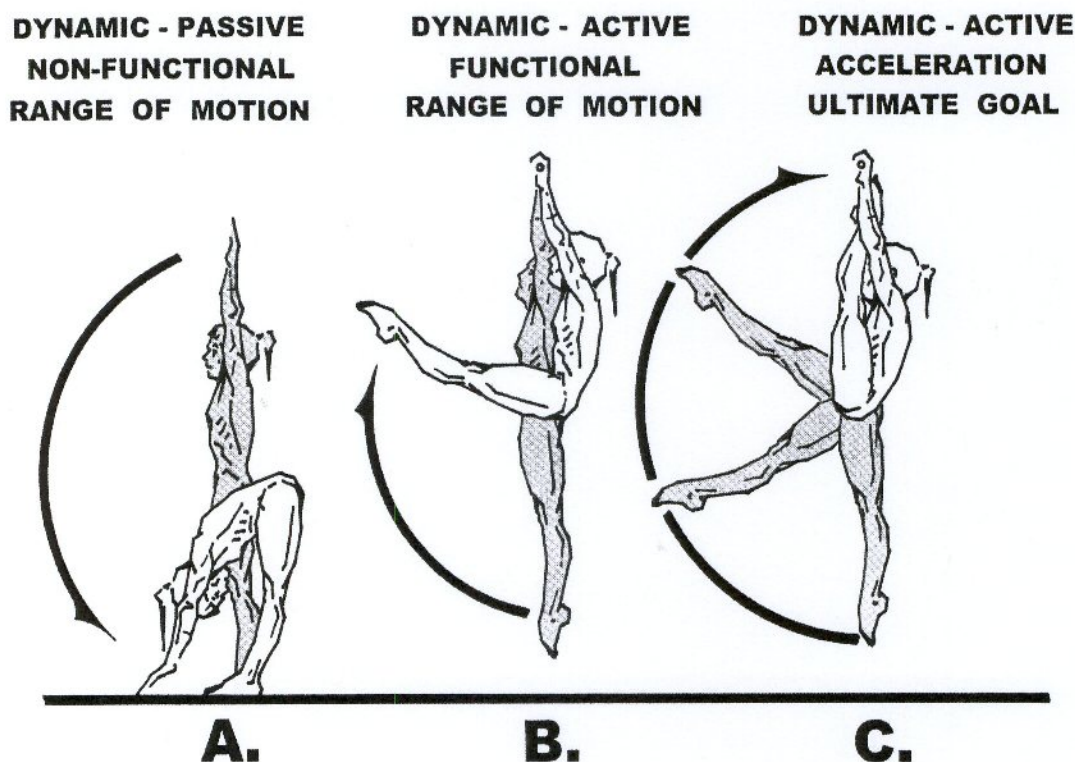


Figure 8.6. Dynamic flexibility training: (A) Dynamic-Passive Method = non-functional; (B) Dynamic-Active Method = functional; and (C) ultimate goal of the Dynamic-Active Method = the ability to employ the muscles most involved in *actively accelerating* the limb/body part through its full range of motion.

The second approach to dynamic flexibility, the *Dynamic-Active Method*, is generally considered the most advanced flexibility training protocol. This is because it requires the specific muscles normally responsible for the given movement to accelerate the limb or body part vigorously against resistance through its functional range of motion. In illustration B, notice the performer starts in a long-hang position on the uneven bars and then lifts the lower half of her body about the upper half. As with static-active, whatever "degree" of body-shape closure the performer achieves under her own dynamic effort is considered her "functional" range of motion. With judicious and consistent dynamic-active training, both the rate and degree of closure will continue to improve. *The ultimate objective of the Dynamic-Active Method is the ability to accelerate repetitively through a maximum range of motion as quickly as possible, using only the specific muscles most involved for the given movement range (C).*

*The ability to accelerate dynamically through full ranges of motion
using the proper muscle groups empowers you to
"touch the sky"!*

4. Specificity for Flexibility Training

The Specificity Principle supports the premise that the type of flexibility training that most closely approximates the skill or activity-in-question is generally considered to be the most effective. Consequently, the closer training comes to simulating a skill's objective, the better its ultimate effect on learning and performing the skill. An accurate conceptual model of the more common gymnastics movement patterns, as well as a precise working knowledge of the performer's readiness profile, are essential for selecting the most appropriate training protocols from which to embark.

*"Skill simulators"
are the key ingredients in effective specificity training.*

The Static-Passive Method should be emphasized in the beginning stages of flexibility training, in rehabilitative situations, and in cool-down sessions. Over time, as reasonable joint ranges of motion are achieved, it becomes advisable to supplement the flexibility program by employing the actual muscles most involved to attain these increased ranges. *The Static-Active Method should then be implemented to simulate the same movement ranges previously achieved in static-passive mode.* Such a procedure serves to train and strengthen the target muscle groups ultimately responsible for guiding and regulating the body through the given ranges of motion.

The Dynamic-Passive Method is an accepted protocol that can also be successfully employed in the beginning stages of training, if judiciously applied. But keep in mind that dynamic-passive, like static-passive, is "non-functional," meaning the stretch is not accomplished by the specific muscles normally involved in generating the given range of movement. Passive flexibility training can be quite effective in increasing joint ranges of motion, but accomplishes little in terms of strengthening and training the muscles ultimately responsible for dynamically accelerating the performer's body parts through those ranges.

In light of the Specificity Principle, it is important to recognize most elite-level gymnastics skills require the muscular capability of generating intense movement patterns that are ballistic in nature, dynamic in rate, and often quite extreme in joint range of motion. Consequently *for the seasoned gymnast, the Dynamic-Active Method should be considered the ultimate flexibility training protocol.*

5. Flexibility Training Intensity

Because of the wide differences in flexibility profiles among individuals, there exists no universal exercise prescription applicable to all gymnasts. Furthermore, there is no consensus in the research literature as to what constitutes the best type of program for every situation. However, there are some basic principles specific to training intensity that can help guide gymnasts along the path to safe and effective results.

To improve ranges of motion safely, the target joints should be mildly stretched beyond their comfortable limits on a regular and consistent basis over an extended period of time. This implies *the level of intensity should be such that it allows the performer to tolerate repeated applications of the given flexibility protocol on a daily basis.* Keep in mind that the performer's response to the given intensity level is the "litmus test" for its effectiveness.

As noted earlier, it is advisable to exercise extreme caution particularly when employing passive stretching techniques, i.e., the Static-Passive and especially the Dynamic-Passive Method. Because the force accomplishing the "stretched" position is derived from some external source, there is an increased—and risky—tendency to go beyond the natural extensibility limits of the limb or body part, possibly resulting in injury.

Regardless of the flexibility training method employed, the performer should never experience any feeling or physical sensation in the "stretched position" that exceeds what perhaps can best be described as "mild discomfort." In terms of achieving the best long-term results, it is always better to lessen the intensity of the stretch and to increase the frequency of its application. Simply put:

*"Ask your body" often and ask it gently,
remember often and gently, often and gently.
Its reply will bring a smile to your lips and a song to your heart!*

POWER

Power refers to the "rate" at which "work" is performed. It represents the amount of force that can be exerted through a given distance per unit of time. "Time" is the critical factor distinguishing power from mere "strength." For example, a gymnast may be strong enough to lift her legs through her arms to execute a stoop-in on the uneven bars, but not powerful enough to accomplish this action within the required time frame. For the gymnast, it's not simply a matter of being able to move one's body, but rather how quickly one can move the body!

*Muscular strength, an essential component of power, is roughly proportional to the cross-sectional area of the muscle belly. As area equals $height \times width$, it is a squared value. For example, with all other factors being equal, a gymnast whose calf muscle on one leg measures twice the cross-sectional area of the calf muscle on the opposite leg has a strength factor approximately 4 times greater in the larger leg! Simply put, *larger muscles are generally stronger muscles.**

Although there are other important variables that can and do come into play, a muscle's raw strength is generally considered to be highly related to power. Consequently, it would seem reasonable to employ a training program specifically designed to increase the gymnast's muscle size. In so doing, her strength factor would correspondingly increase. *However, another variable must be carefully factored into the performance equation, i.e., the weight of the muscle.*

*A muscle's weight is proportional to its mass and is a function of its volume. Volume is a cubed value, $height \times width \times length$. Thus, it can be conceptually demonstrated that as a muscle doubles in size, its strength increases by a factor of 4, yet its weight increases by a factor of 8! This means, in terms of the ability to move other objects, a larger calf muscle is clearly stronger and more effective than a smaller one. However, in terms of the ability to move its own leg or body, the larger calf muscle is weaker, relative to its increased weight. Therefore, *the more critical consideration for the gymnast is her strength relative to her weight—or her strength-to-weight ratio.**

*Having large muscles does not get you there.
Rather having well-trained muscles moving a lean body mass
is the ticket!*

Table 8.1 provides a conceptual model depicting this relationship between muscle size and strength as well as the effect of muscle weight on the ability to move one's own body. *The implication here is to employ a power training program emphasizing the development of lean body mass while reducing nonessential fats.*

<u>MUSCLE CHARACTERISTICS AFFECTING PERFORMANCE</u>		
<u>MUSCLE SIZE</u> (H x W)	<u>MUSCLE VOLUME</u> (H x W x L)	<u>STRENGTH / WEIGHT</u> RATIO
1 x 1 = 1 strength factor	1 x 1 x 1 = 1 weight factor	1 / 1 = 1.00 ratio
2 x 2 = 4 strength factor	2 x 2 x 2 = 8 weight factor	4 / 8 = 0.50 ratio
3 x 3 = 9 strength factor	3 x 3 x 3 = 27 weight factor	9 / 27 = 0.33 ratio
4 x 4 = 16 strength factor	4 x 4 x 4 = 64 weight factor	16 / 64 = 0.25 ratio

Table 8.1. Muscle characteristics affecting performance: a conceptual model of the relative relationships between size, weight, and strength-to-weight ratio.²

Consequently, whatever development and/or increase in muscle-size that does occur should be the direct consequence of a well-integrated power training program designed to simulate skilled gymnastics movement.

1. Specificity for Power Training

As noted earlier, the term "*specificity*" implies that the type of training which most closely mimics the actual activity is generally considered the most effective. In considering the nature of gymnastics, a significant number of skills are obviously power-oriented. Consequently, *the selected power training exercises should, to the extent possible, simulate movement patterns typically observed in elite-level gymnastics.* These exercises should be tailored to meet the gymnast's unique needs and employ her own body weight as the medium of resistance. Emphasis should be placed on "aggregate action" of the larger muscle groups to train them to move efficiently and effectively in a "teamwork" fashion. In order to achieve a "balance" in muscular strength, emphasis should also be placed on the muscles that serve to "flex" the body. And finally, particular attention should be given to training the "core muscles," i.e., abdominals and low back. Such considerations help to ensure more effective momentum transfers that regularly occur to and from the upper and lower halves of the body.

In the beginning stages of power training, it is wise to emphasize attaining the proper shape and pattern of movement under conditions of low resistance. This scenario better ensures that the "rate of movement" in each repetition can be emphasized initially, rather than finally. As performance efficiency improves over

² These are broad approximations, not precise values.

time, the amount of overload for the given exercise can then be judiciously increased without unduly compromising rate of movement. After all, *the ultimate objective of every power training regimen centers on the performer's ability to generate maximum acceleration under skill conditions specific to gymnastics.* Let's take a closer look.

*Power training
awakens the "sleeping giant"
in your movement patterns.*

2. Resistance Techniques

When the gymnast uses her own body as the medium of resistance in power training, *one or both of the following techniques can serve to alter the realized resistance: A) increasing the rate of movement; and B) changing body position relative to the ground.* These techniques are interdependent and can be employed to match the proper intensity level of the exercise to the physical capabilities of the gymnast.

A. Increasing the Rate of Movement

To illustrate the modification of an exercise's intensity to meet a gymnast's specific needs, figure 8.7 depicts four *stages of power training intensity* for a basic push-up. Performer 1 enacts the push-up on an inclined surface, which lessens the resistance of the exercise. With resistance minimized, she is better able to push through to the desired fully hollowed body shape. *Particular attention should be given to ensuring the correct shape and pattern of motion in every exercise*—in this case, pushing through to full protraction and elevation of the shoulder girdle.

Once the movement pattern can be correctly and efficiently executed, the next step centers on the "quickness" with which the gymnast can move her body (accelerate) through the prescribed range of motion. *The degree to which maximum acceleration can be achieved in this regard is often referred to as "explosive power."*

In power training, the basic idea is to *strive to increase the "rate" of the lift phase,³ with maximum acceleration being the ultimate objective.* Once maximum acceleration for a single repetition can be readily achieved, the next step centers upon producing maximum acceleration for multiple repetitions.

³Here, the term "lift phase" refers to the part of the movement which occurs against the force of gravity, e.g., the push phase in push-ups, the lift phase in leg-lifts, the pull phase in pull-ups, and the like.

*As rate of movement is increased,
so is the realized resistance!*

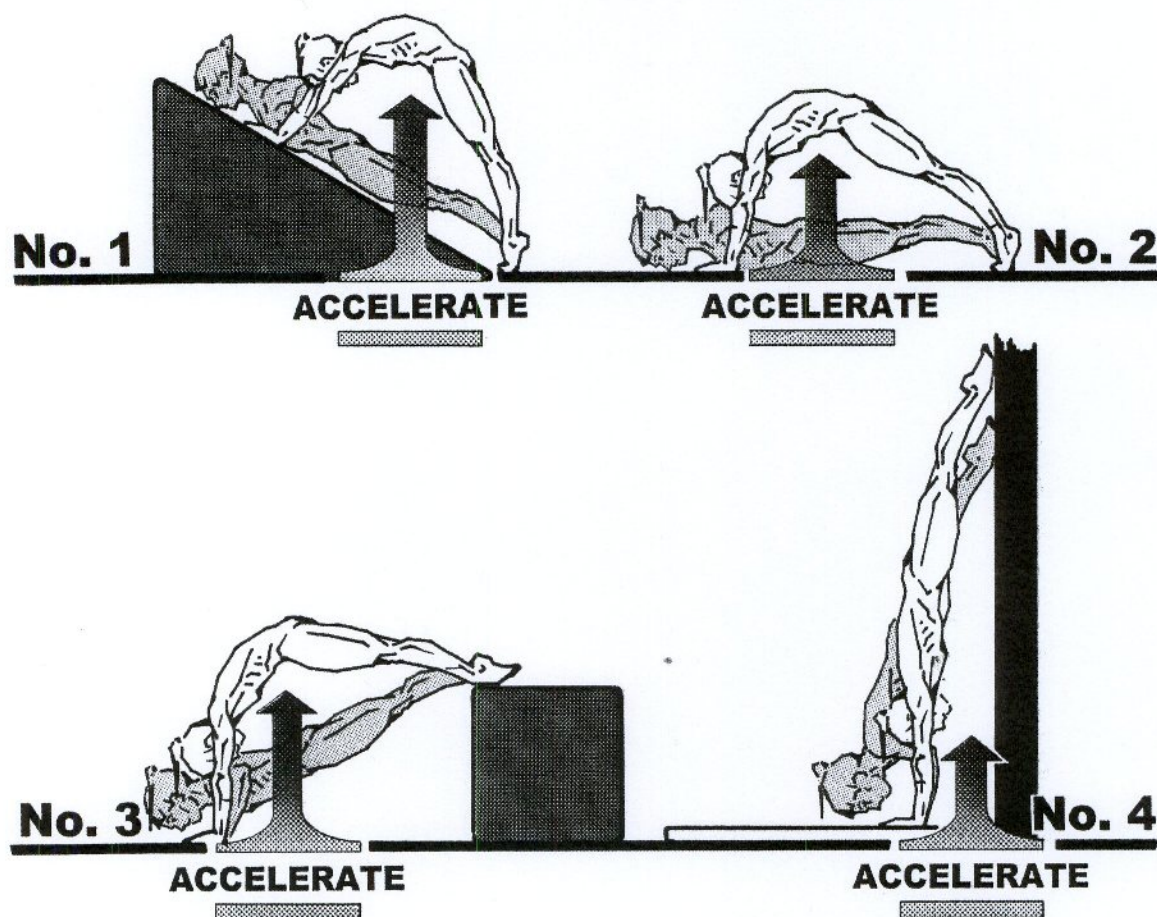


Figure 8.7. Stages of power training intensity for a push-up exercise: (1) inclined push-up; (2) horizontal push-up; (3) declined push-up; and (4) front-leaning handstand push-up.

B. Changing Body Position Relative to the Ground

The next level in the power training cycle for this exercise involves repositioning the total body relative to the ground and the pull of gravity to increase resistance. Because performer 2 is positioned horizontally, the realized resistance in her arms, shoulders, and chest during the push phase becomes somewhat greater. In placing the feet on a raised surface (3), even greater resistance must be overcome to achieve the push-up. And finally (4), the performer is positioned such that almost all the body's resistance is borne by the hands. *Notice that the front of the body is facing the wall for the push-up exercise and that the total body is tilted slightly off top-dead-center relative to the vertical.* This position requires the head and shoulders to move forward of

the hands during the “down phase” and then backward during the “up phase”—a movement pattern directly related to a large variety of gymnastics skills.

The principles employed to progress through each of these intensity stages are universal in nature and, as such, can be applied to virtually every power-simulation exercise. Remember to start by carefully evaluating the individual performer's physical capabilities relative to the given skill's objective, and then select a progressive series of simulation exercises specifically designed to achieve part of, and then—when feasible—the entire performance objective.

3. Additional Core Power Training Examples

In addition to the **Push-Up Exercise Series** in figure 8.7, the following examples typify exercises that should be included in virtually every power training program for gymnasts.

A. Running and Jumping

Sprint speed and vertical jumping ability are, without question, two of the most important power indices in gymnastics. As with all power-oriented activities, high-level performance in these movement parameters requires the ability to achieve maximum acceleration in minimal time. Generating great sprint speed and height in a vertical jump is directly related to success in tumbling and vaulting skills, particularly at the elite level. In addition, these indices directly reflect *leg power*, an axiomatic variable significantly enhancing one's ability to stick landings. Consequently, *exercises designed to improve sprint speed and vertical jumping should be an integral part of the power training program throughout the career of every gymnast.* (See chapter 11, “Concepts of Vaulting.”)

B. Frontal (Flexor) Muscles

Power training for the muscles on the entire front-side of the body is another area of prime importance. Because gravity is forever present in everyday life, we are naturally better equipped to perform push-oriented movements than pull or flexor-oriented movements. However, the nature of gymnastics requires higher-than-ordinary strength and power in the muscles that serve to “curl,” or flex the total body. Every snap-down action in tumbling and vaulting, every tuck, puck, and pike action in somersaulting, and every major swing element on uneven bars requires extremely high levels of power in the frontal flexors. Consequently, it is wise to include power training exercises specifically designed to target aggregate muscle action on the front-side of the body.

Figure 8.8 shows three *core power training exercises designed to target aggregate muscle power progressively in flexor-oriented movements*. In a variation of the basic sit-up, performer A lies supine on the floor with arms overhead and feet raised well above the ground, resting against a wall. This start position not only slackens (and mostly takes out-of-play) the hip joint flexors, but more importantly targets the abdominals to accomplish the sit-up. *The higher the feet are up the wall, the greater the role played by the abdominals in the sit-up.*

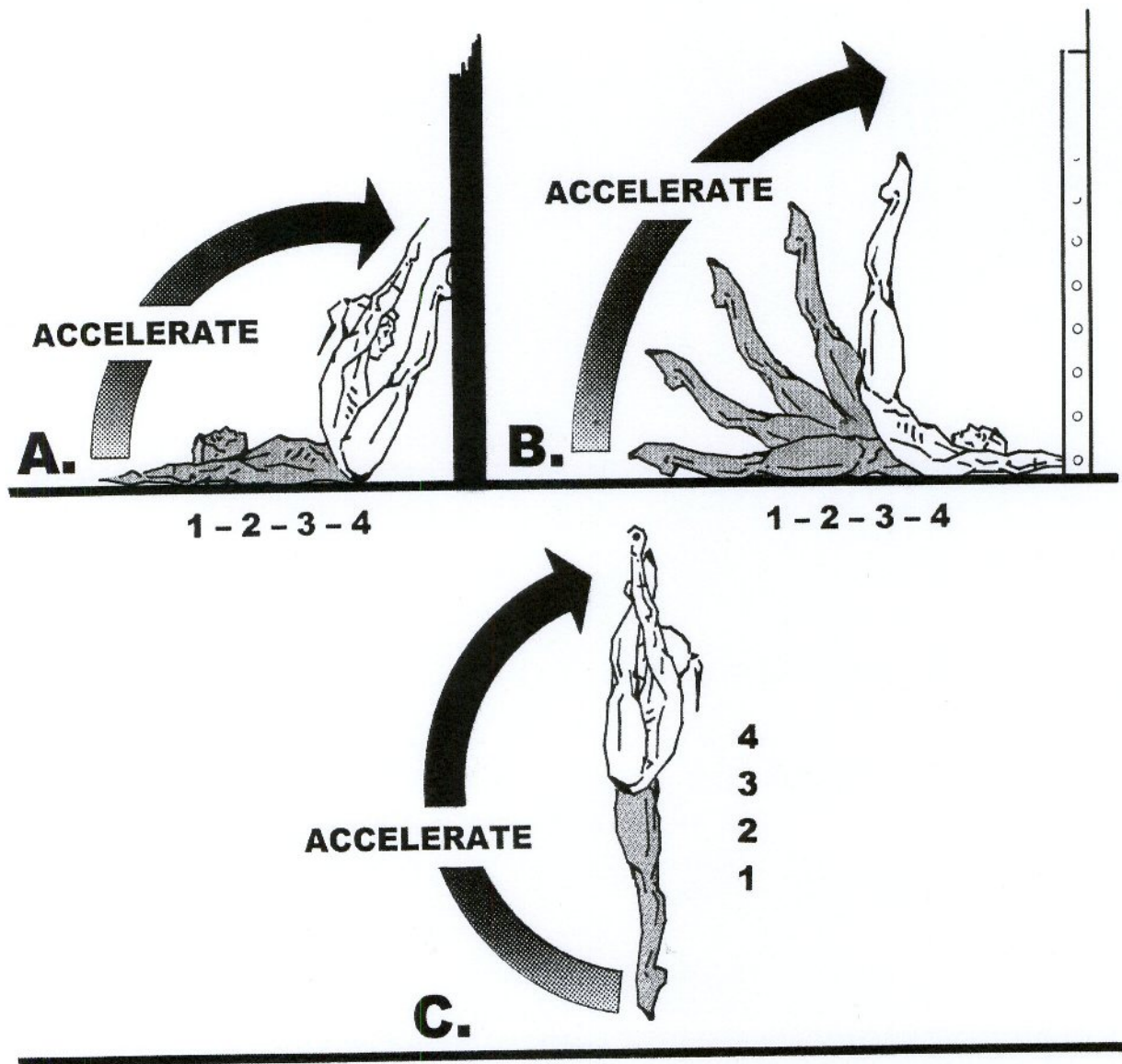


Figure 8.8. Power training exercises targeting aggregate muscle power on the front-side of the body: (A) raised-leg sit-up; (B) horizontal body-lift; and (C) bar-hang leg-lift.

Performer B assumes a fully extended, supine start position, hands overhead and firmly anchored about a wall-bar (or any stable surface). Using the muscles on the front of the body, she executes a progressive curling action to lift the legs, then legs/hips, and finally legs/hips/trunk. Performer C employs the same frontal muscles for a leg-lift in long-hang position on the upper rail of the uneven bars.

As emphasized in chapter 7, "Patterns of Motion," notice how all three performers bend in the proper 1-2-3-4 kinetic chain sequence for the up-phase, and then return to the ground by unfolding the curled body shape in the mirror image 4-3-2-1 sequence for the down-phase. *Once the proper movement pattern is achieved, the number of repetitions (and ultimately sets) should be increased, with particular emphasis on maximizing acceleration during the "lift" phase.*

Because the fundamental parameter in every power training exercise centers upon achieving maximum acceleration, *it is wise to employ speed of movement in the exercise's "lift" phase as a barometer to determine number of repetitions per set.* Performer C, for instance, should *strive to increase the number of repetitions per set as long as the actual rate of acceleration per repetition does not noticeably decline.* The ultimate objective is the ability to maintain maximum, or at least near-maximum, acceleration in the lift phase for 10–12 repetitions. Or to put it another way, it is more effective from a power training perspective to perform two separate sets of six maximum or near-maximum acceleratory leg lifts than to perform one set of 12 with the last six slow and labored.

C. Pull-Through Exercise

Figure 8.9 depicts another *very important frontal-power exercise, the pull-through from a long-hang to a front-support position.* This exercise involves more than a series of pull-ups from a dead hang to the traditional chin-level position—it *requires the ability to pull-through to a full-support position in one fell swoop!* In initial training, the gymnast might only be able to "pull-to" (illustration 3). However, every effort should be made to achieve illustration 4 and ultimately 5 by maximizing acceleration in the pull phase of each repetition. Rather than using a pull-push action, *the movement should be achieved primarily by a "pure pulling action," accelerating the body to a near front-support position above the bar.*

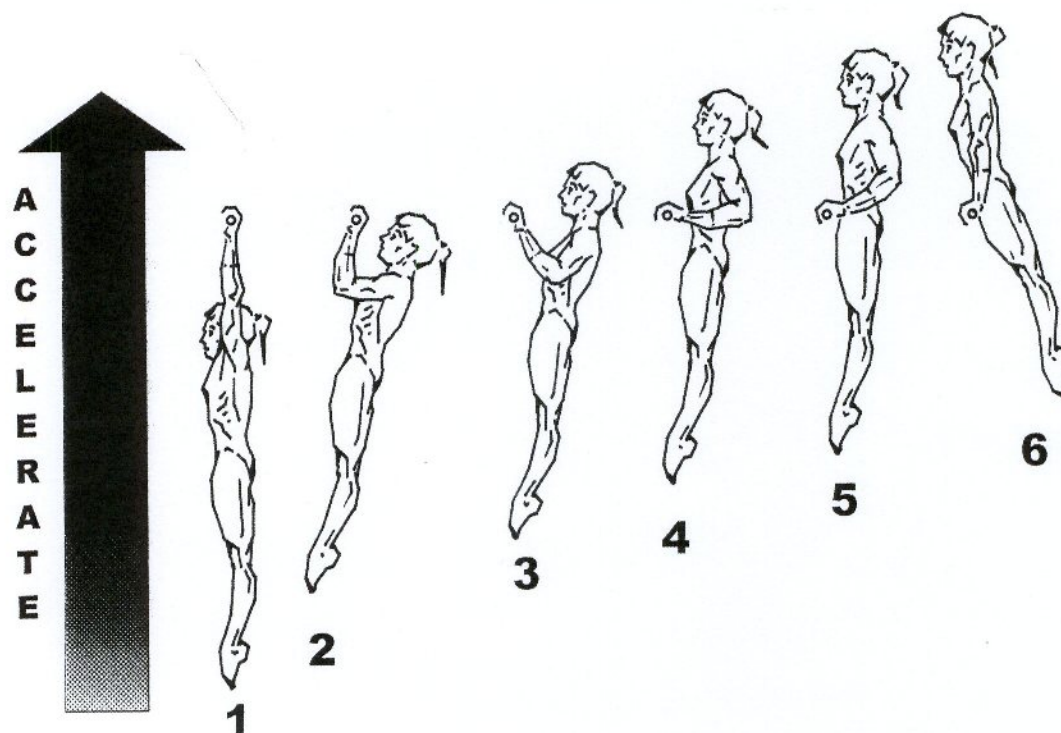


Figure 8.9. The "Pull-Through" power training exercise.

It should be noted that the pull-through exercise may encompass a bit of a kip action to facilitate the body's transition from below to above the bar. This is perfectly normal and actually helps simulate the timing and feel of kip-related skills traditionally associated with uneven-bar skills.

D. Core Muscle Training

As discussed in chapter 7, the performer's midsection is the area through which momentum is transferred to and from the upper and lower halves of the body. The muscles across the core—connecting the pelvic girdle with the trunk—must be particularly strong to be an effective conduit for momentum transfer. *Inadequate "core conditioning" inevitably leads to kinetic-chain breakdown, loss of momentum, and compromised skill technique* (review figures 7.18 and 7.19).

Figure 8.10 illustrates two *power training exercises that are specifically designed to target the core area*.⁴ *These exercises simulate the dynamic kick-back actions of the total body* that universally occur during typical tumbling and vaulting skills (see figures 7.3, 7.5, and 7.9) as well as virtually all long-hang swing skills on the uneven bars (figures 7.6 and 7.8). Notice the starting point for

⁴In addition to prone and supine, this exercise can also be performed lying on one's side.

both is a uniformly curved body shape in the "up-position," against the pull of gravity. *This start position is achieved by static (isometric) muscle contraction on the front (example A) and the back (B) of the body.*

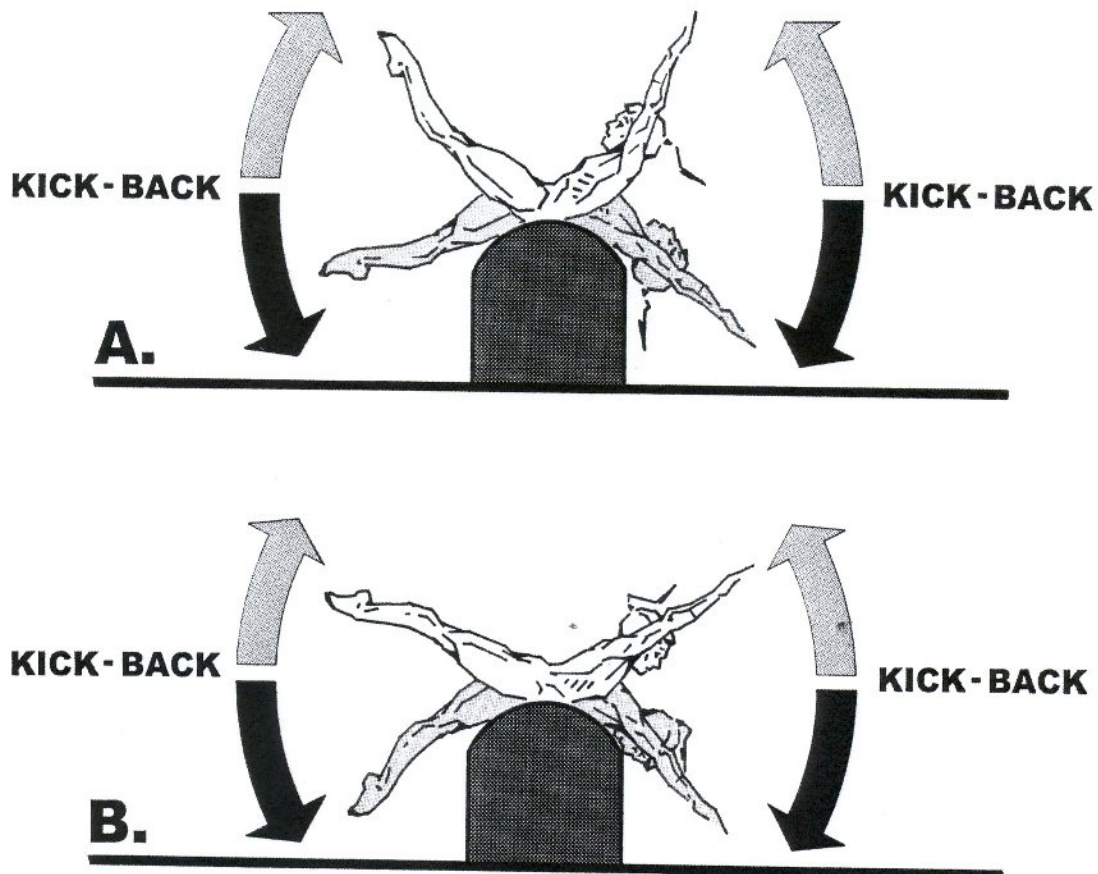


Figure 8.10. Power training exercises targeting the body's core, with a dynamic kick-back action in the muscles most involved: (A) frontal muscles; and (B) posterior muscles.

To begin, the performer lessens the tension (eccentric contraction) in the target muscles, causing her curved shape to unfold and bend in the opposite direction (about the rounded mat surface). While the body unfolds, the target muscles undergo a dynamic stretch. *As this stretch effect is occurring, the performer instantaneously and forcefully contracts the same muscles, causing a "kick-back" to the original up-position.*

Consequently, both the start and finish of these exercises originate and terminate in their same up-position, while the actual power training component involves a rapid "down-up" movement tempo of the total body.⁵ This ballistic

⁵ This technique of starting in the up-position and then employing the down-up ballistic kick-back action can be used in virtually any power training exercise, but should be reserved as the ultimate power training technique.

kick-back to the original shape is similar to what occurs when executing repetitive squat jumps and, as such, can be performed using multiple repetitions and sets.

These examples of power training exercises are just that—examples. Innumerable specificity exercises can be created for each individual gymnast to accomplish a particular objective. Carefully evaluate the gymnast's unique needs and follow the power training specificity guidelines earlier in this chapter.

4. **Power Training Intensity**

Precisely how many sets of exercises, how many repetitions per set, and how much resistance to employ are inevitable questions when embarking on any exercise program, and power training is no exception. As with flexibility training, the power training literature is replete with a wide range of recommendations, some of which directly contradict one another. All proponents agree, however, with a basic premise: *the human body must experience a sufficient level of "overload" on a regular and consistent basis to reap gains in performance.* And with all other things being equal, the more "specific" the overload is to the desired objective, the better the realized outcome.

In any case, it is wise to start power training with a low-intensity program that the performer can readily accomplish. Strive first to increase rate of movement in the "lift" phase for the prescribed range of motion. Over time, modify relative body position to increase resistance. Read the performer's response to the given exercise carefully, and make adjustments accordingly. *The barometer for shaping the type, level, and intensity of any exercise program centers upon how the individual performer responds to it.* True gains in muscular power are much like human growth, a phenomenon which occurs gradually and slowly over an extended time. Without persistence, attention to detail, and an unyielding work ethic, there can be no lasting improvement.

*Tend carefully your garden,
and the fruits of your labor
will surely blossom with the coming seasons*

THE TRAINING PYRAMID

At first blush, *flexibility training and power training* may appear to serve entirely different objectives. After all, one type of training centers on increasing joint range of motion, whereas the other seeks to increase muscular strength and speed of movement. However, when a third ingredient, *skill simulation*, is factored into the mix, the protocols employed to increase both flexibility and power begin to evolve into nearly identical movement parameters until *they become one and the same training method, which ultimately reveals itself as the "actual skill."*

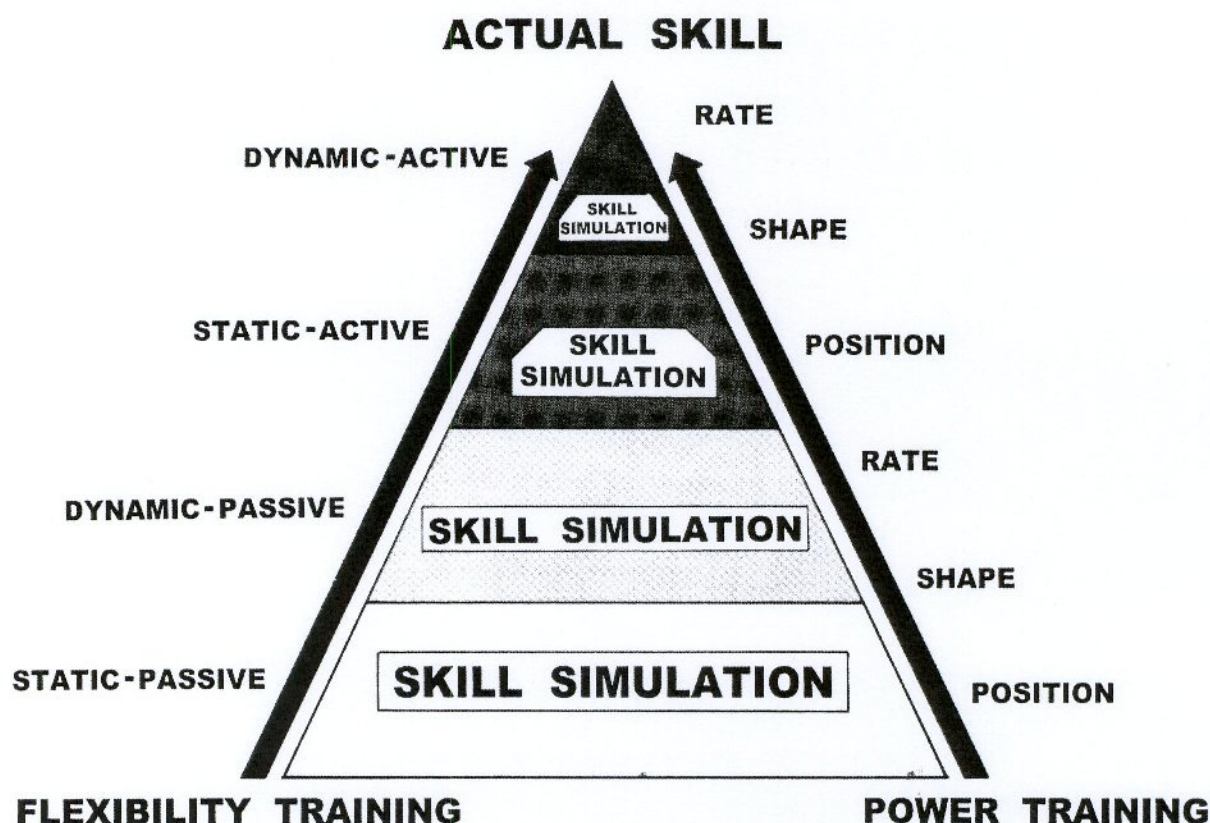


Figure 8.11. The Training Pyramid.

As indicated by the Training Pyramid in figure 8.11, flexibility training and power training both employ "skill simulation"—the seemingly invisible "third wall"—as the underlying basis of their technique. And as the performer ascends to the advanced levels of technique on both sides of the pyramid, the more closely these protocols parallel each other as well as the skill's actual objective. For example, the ultimate form of flexibility training, the Dynamic-Active Method, employs the target muscles to accelerate the limb or body part rapidly through its range of motion under conditions of skill simulation. And is that not precisely the same protocol as for power training? This three-pronged approach to gymnastics training inevitably leads to successful attainment of the actual skill.

The ability to accelerate one's limbs and body dynamically through the prescribed range of motion under conditions of skill simulation is as close as it gets to the actual performance of the skill.

FUNDAMENTAL CONCEPTS OF FLEXIBILITY TRAINING

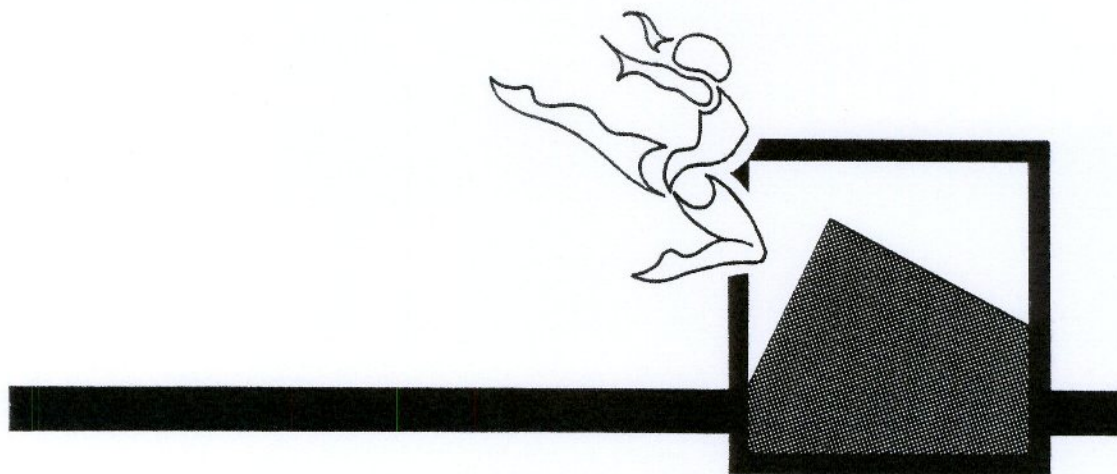
1. Because flexibility is joint-specific, carefully evaluate the ranges of motion in the critical joint areas of each individual performer.
2. "Passive" flexibility reveals the uppermost limits in your ranges of motion, whereas "active" flexibility reveals the true extent to which these ranges of motion can be achieved by the target muscles.
3. Strive to achieve a "balance" in range of motion for the more critical joint areas.
4. Priority training should be afforded to those joint areas applicable to the broadest category of gymnastics skills.
5. The selected flexibility exercises should, to the extent possible, simulate movement patterns commonly employed in typical gymnastics skills.
6. Give particular attention to flexibility training of the vertebral column and shoulder girdle, followed by the shoulder and hip joints.
7. Flexibility training should proceed in a slow, graded fashion and be consistently applied over extended periods of time, gradually increasing the ranges of motion.
8. Achieving a physical sensation of "mild discomfort" in the stretched position is an excellent measure of proper intensity.
9. The intensity level should allow you to tolerate repeated applications of the flexibility protocol on a daily basis.
10. Remember to "ask your body often and ask it gently"!

FUNDAMENTAL CONCEPTS OF POWER TRAINING

1. The selected exercises should be designed for close simulation of the basic movement patterns typically observed in elite-level gymnastics.
2. Carefully evaluate the unique physical capabilities of each individual performer relative to the desired objective.
3. The selected simulation exercises should be progressive in nature and designed "specifically" to achieve the desired performance objective.
4. To achieve a "balance" in muscular strength, additional emphasis should be placed on training the "flexor muscles" of the body.
5. The underlying objective in power training involves gradually and progressively increasing the "rate" at which the performer can move "her own body weight."
6. First achieve the proper shape and pattern of movement for each exercise. Using proper technique, gradually increase the number of repetitions. Over time, increase the number of sets per exercise as tolerated.
7. Strive to achieve "maximum acceleration" during the up or "lift phase" of the movement.
8. An exercise bout (set) is best determined by using the number of repetitions that can be achieved while still maintaining maximum or near-maximum acceleration.
9. Once success in the given exercise bout can be readily achieved, gradually modify body position relative to the ground to further increase the resistance.
10. The ultimate objective centers upon the performer's ability to generate maximum acceleration in her body under skill conditions specific to elite-level gymnastics.

CHAPTER NINE

CONCEPTS OF FLOOR EXERCISE



I hope you truly dance...

Of all the events in artistic gymnastics, none allows the opportunity for self-expression more than Floor Exercise, for in this venue, the performer tells her unique story primarily through the medium of dance. Ever-changing, often unexpected, but always sequentially related movement patterns are tactically choreographed to music, and the gymnast strives to display the widest range of shapes and movement patterns over as much of the performing area as possible. Speed, force, shape, rhythm, flow, direction, level, range, and transition are some of the more common factors that must be carefully and strategically interwoven into this tapestry of artistic movement.¹

However, true success in Floor Exercise requires more than mere expressive dance—it requires “flight”! Complex acrobatic maneuvers designed to propel the body high into the air must also be liberally applied in the telling of “the rest of the story.” For after all, the ability to execute elite-level tumbling maneuvers with absolute precision remains the axiomatic litmus test for championship performance.

Excuse me while I touch the sky!

THREE-DIMENSIONAL SPACE

Most coaches agree a gymnast’s competency in tumbling serves as “the great separator” between champion and would-be champion. And tumbling excellence is predicated on the

¹Refer to Diversification Principle in chapter 2.

ability to achieve greater-than-ordinary "height" in complex somersault-oriented skills. The more a performer can call upon advanced maneuvers to explore the upper dimensions of the tumbling space, the greater her potential for success, particularly at the elite level. Be aware that the hidden question secretly lurking in the mind's eye of every judge centers on *to what extent was the story told in that most difficult of dimensions—the third dimension.*

*Only the mightiest of eagles
soar
where the air is thinnest...*

Figure 9.1 provides a conceptual model of three-dimensional space as applied to the Floor Exercise area. Although this performing surface is delimited to approximately 40 feet long by 40 feet wide, no restriction is placed on potential "height"—and rightly so, as height is steadfastly governed by that most impartial of sentries, "gravity." Confined by regulations in two dimensions, yet free to ascend to whatever heights that can be generated, the aspiring gymnast intuitively knows *the ultimate key to championship performance is spending as much time as possible in the upper levels of the third dimension.*

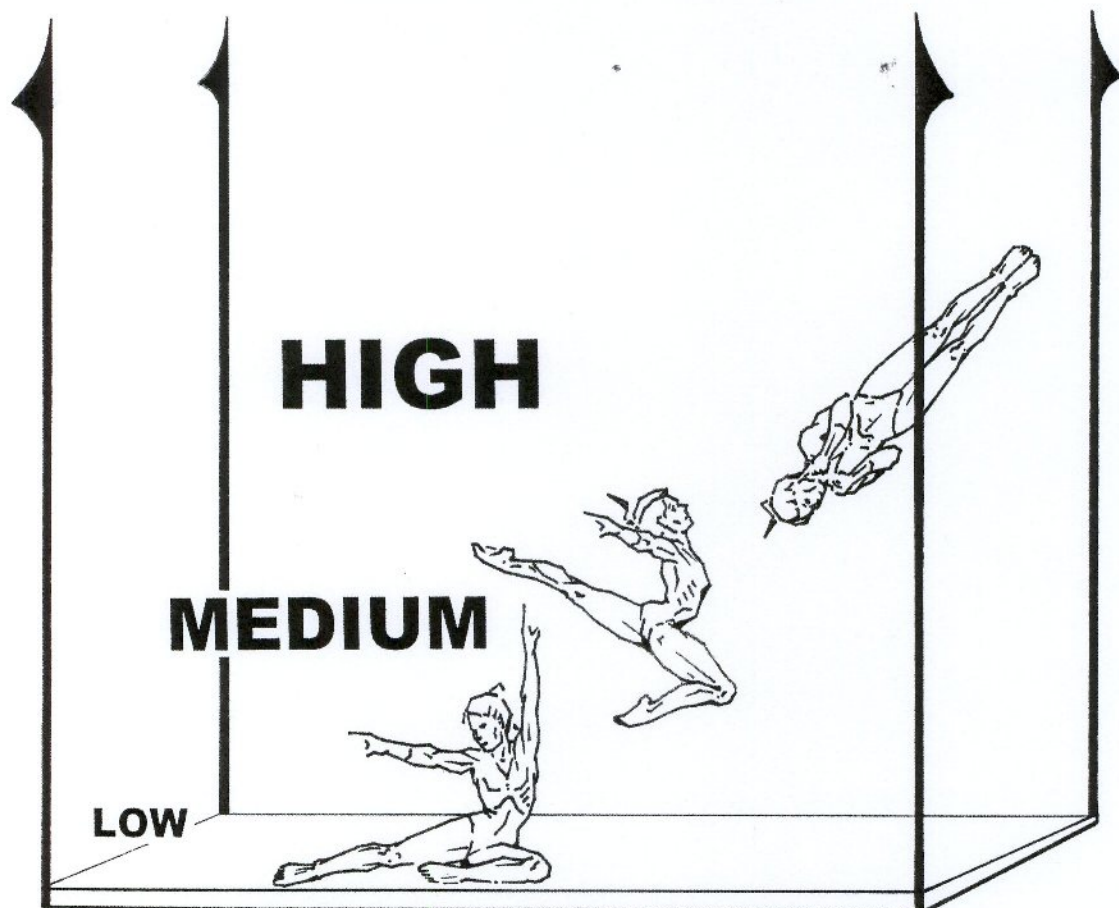


Figure 9.1. A conceptual model of the three-dimensional space in Floor Exercise.

In the Floor Exercise event, achieving "volume" of space rather than mere "area" establishes a new dimension of excellence!

THE SPRING FLOOR

In "the good old days," tumbling was performed on a relatively hard surface such as a wood floor or even concrete. These mediums were quite rigid and unforgiving in that little or no deflection/restitution occurred upon impact. With the advent of closed-cell cross-linked fiber-foam mats, a more pliable, resilient surface became available to help attenuate some of the shock commonly associated with take-offs and landings. Then with the introduction of the "spring-loaded floor," an enhanced medium having an even greater "elasticity component" for performing tumbling was added to the mix. *As tumbling mediums evolved from non-elastic into highly elastic systems, the degree of body-shape change needed to execute impact-oriented skills progressively decreased.* This meant the gymnast could employ more extended—and therefore more powerful—body shapes in the impact phases of a tumbling sequence.

<u>PERFORMANCE MEDIUMS AND IMPACT</u>	
<u>Performance Medium</u>	<u>Degree of Body-Shape Change at Impact</u>
Hard, rigid system (wood floor)	= significant bending of the arms and legs
Resilient system (mats)	= less bending of the arms and legs
Elastic system (spring floor)	= minimal bending of the arms and legs
Highly elastic system (trampoline)	= near-zero bending of the arms and legs

Table 9.1. Performance mediums and impact: comparative effects on the degree of body-shape change needed to execute the "impact phases" in tumbling.

As indicated in Table 9.1, the more the system is designed to "give-in" at impact, the less the gymnast's body parts must bend to accomplish the intended result. Since the performing surface of today's Floor Exercise area comes equipped with a spring-loaded system, the observed degree of body-shape change at impact should be minimal. For example, *in a repetitive tumbling series, the best performers employ significantly more-extended shapes in their arms and legs for virtually all impacts* (e.g., in a Backward Handspring Series). Because the spring floor can momentarily store energy for immediate use, it gives the performer an opportunity to employ a more extended body during impact, thereby maximizing her available forces.

*The more elastic the performing surface,
the more the body can—and should—be extended upon impact.*

Figure 9.2 compares the effect of two floor systems on the “degree” of body-shape change that occurs at impact when setting-up for a Backward Somersault out of a traditional tumbling series. Since the typical matted floor (example 1) provides precious little deflection/restitution, the performer’s arms and legs must bend-in more deeply to deal effectively with the forces at impact.

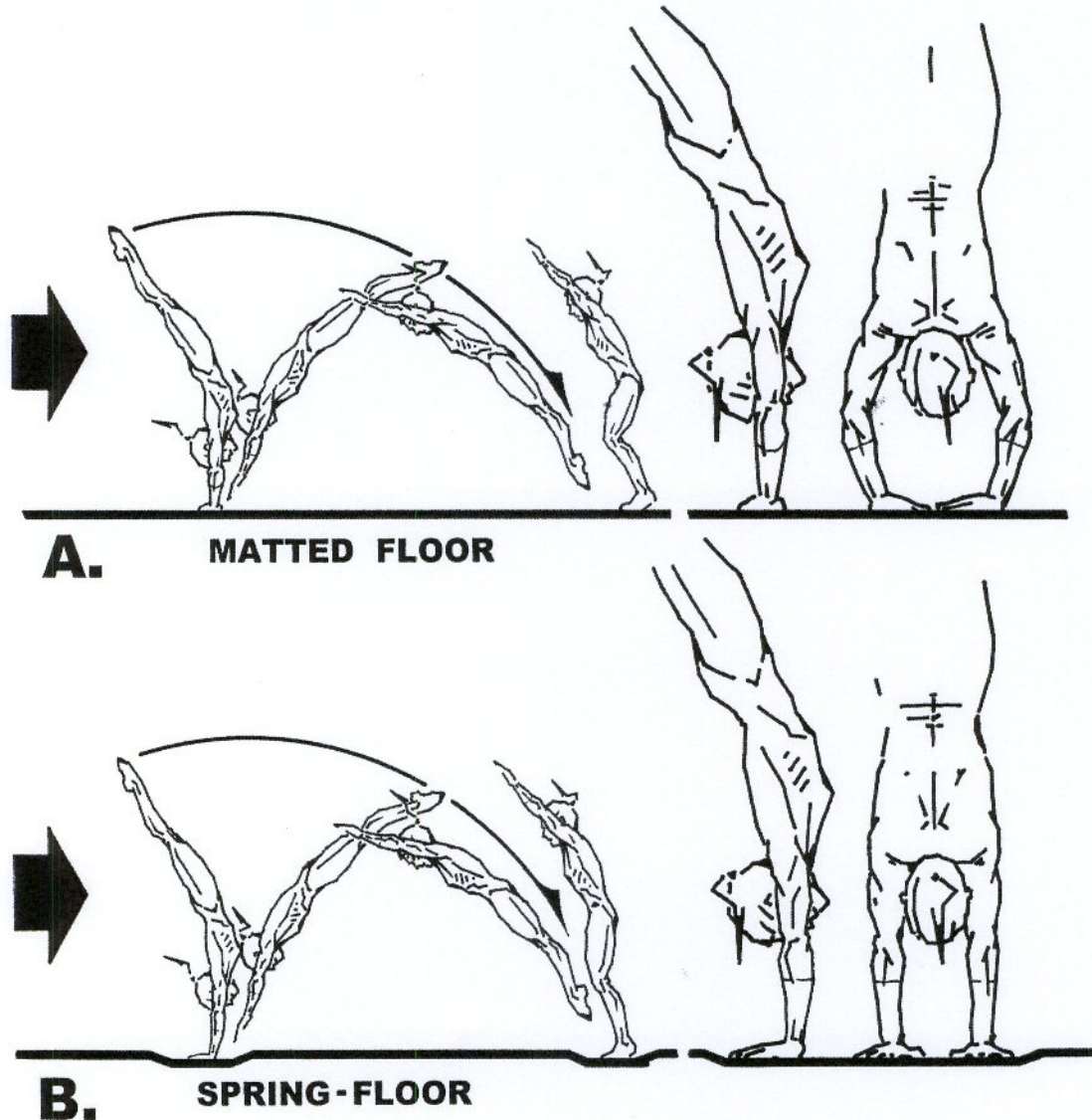


Figure 9.2. Comparative effects of floor systems on the “degree” of body-shape change at hand impact (Backward Handspring) into foot impact (Backward Somersault): (1) matted floor = less-extended body shape; and (2) spring floor = more-extended body shape.

By comparison, performer 2 is tumbling on a spring floor, which not only bends (deflection) upon impact—momentarily storing energy—but also instantaneously returns to its original shape (restitution) during the subsequent take-off. The net effect of this deflection/restitution characteristic is twofold: 1) the “spring action” provides for greater “lift”; and 2) because the performer can push “into” the floor at impact, a more extended positioning of both arms and legs can be achieved to maximize impact force, further enhancing the “lift” component of the somersault.

*Bend mightily the archer's bow,
that its arrow might go swift and far...*

It must be pointed out, however, that for any impact terminating a tumbling sequence (final landing), the precise opposite is true. As the ultimate objective of sticking the landing centers on reducing the body's motions to zero, the wise performer stretches for the ground immediately prior to landing, and then bends-in significantly at the ankles, knees, and hips upon actual touch-down. These actions not only attenuate the shock of the landing but also dampen the spring floor's recoil, thereby ensuring a more controlled “landing.”²

FUNDAMENTAL TUMBLING CONCEPTS

1. Dynamic Tension

Tumbling not only involves moving into and out of specifically timed body shapes in the skill series, but also *requires maintaining an active (dynamic) tension in the muscles on both sides of the body to render a quasi-elastic property of the total body unit.* To develop the concept, example 1 in figure 9.3 illustrates the reaction of an elastic ruler when held vertically at one end and moved quickly back and forth. Observe its reactionary bowing, a bending under tension—precisely what the gymnast should attempt to achieve throughout a tumbling sequence.

In example 2, note the shape similarity between an oscillating ruler and a gymnast during the inverted phase of a Backward Handspring. The idea here is to *maintain a dynamic tension throughout the body as it moves through its intended shapes.* Establishing active muscle tension on both sides of the body provides for more efficient momentum transfers, improves movement time within and between each skill, and renders an all-around smoother flow throughout the tumbling performance.

²Refer to *Leg Impact upon Landing* in chapter 5.

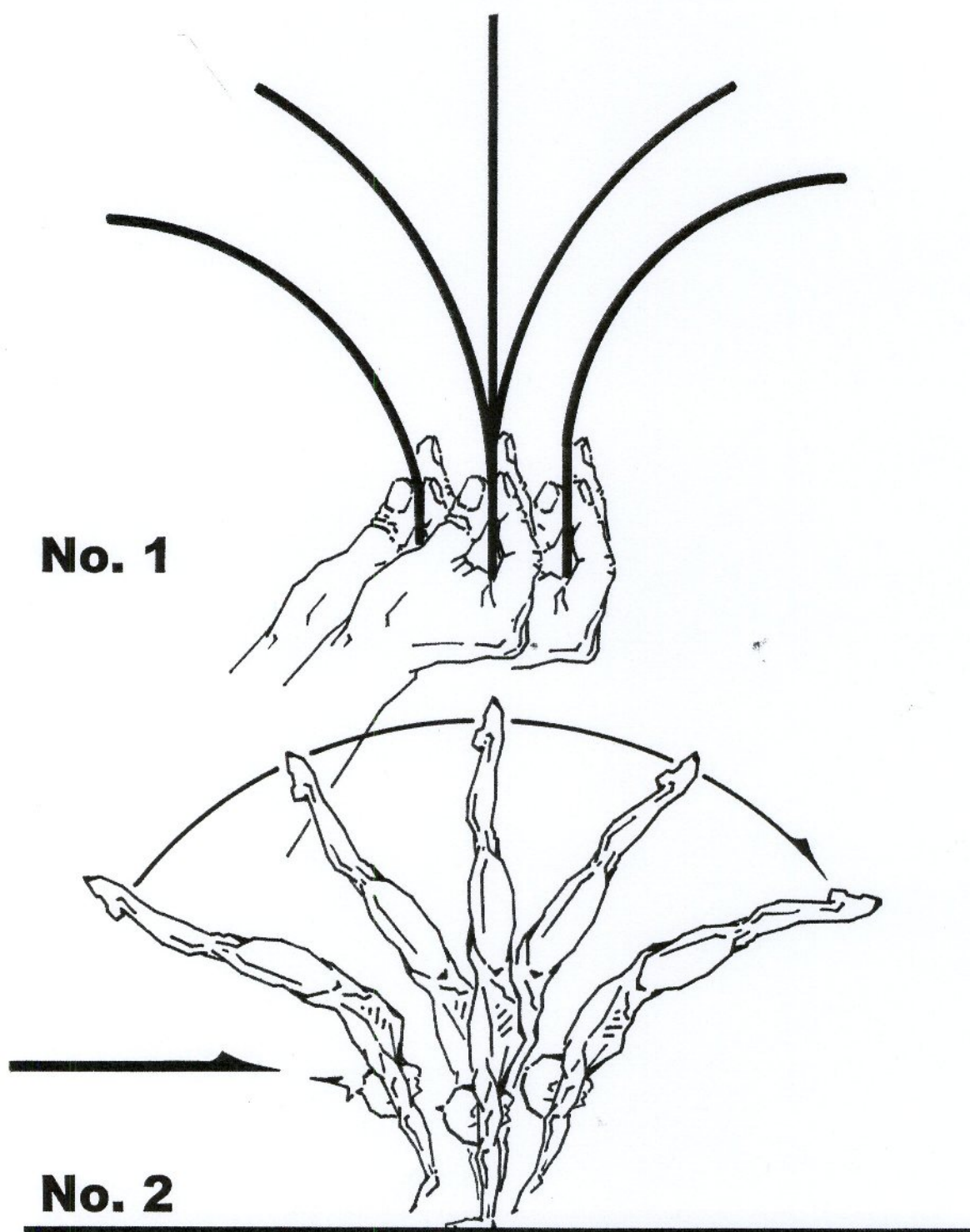


Figure 9.3. Comparative examples of retaining proper shape under stress: (1) oscillating elastic ruler; and (2) inverted phase of a Backward Handspring.

Many specificity exercises can be employed to help gymnasts gain a feel for the development of aggregate muscle tension. The Body-Tilt Training Technique and the Bar-Hang Method, presented in chapter 3, are good starting points. Remember:

*Your partner in this dance is gravity.
Sometimes you must lead, sometimes you must follow.
Champions "feel" the difference!*

2. Maximum Horizontal Velocity at Impact

*The development of maximum horizontal velocity at impact is essential, as it sets the stage to optimize both "lift" and "rotation" in the somersault phase of every multiple-tumbling series.*³ To accomplish this, a gymnast can call upon two techniques: 1) employ a larger run-up distance to maximize horizontal velocity for the input phase of the first skill; and 2) *develop progressively greater quantities of horizontal motion within the series.* The second technique is clearly more difficult to achieve but by far more important to master. Let's take a closer look.

Because the performing surface in Floor Exercise is only 40 feet square, precious little area is available for a large run-up distance with sufficient space left over for the tumbling series. Even if additional space were somehow available, this fact remains: without the ability to increase or at least maintain the horizontal speed accrued in the run-up, the tumbling series will decelerate, sorely compromising both lift and rotation in the somersault phase of the sequence. And this is precisely why *having the ability to generate ever greater quantities of horizontal motion within the tumbling series itself is so important for success, particularly as it relates to executing multiple-somersault/twist-oriented skills.*

*Even in tumbling,
true greatness comes from
within.*

3. Accelerating the Rotation

The rotational components of the individual skills that comprise any tumbling series can be described as speeding up (accelerating), slowing down (decelerating), or simply moving along at a steady clip. Of these three options, *the ability to accelerate rotary motion progressively through the entire series is fundamental to success, particularly at the elite level.* Each successive skill should build upon the preceding skill. For example, in the Round-Off into Three Backward Handsprings shown in figure 9.4, the first handspring should be rotating faster than the Round-Off, the second faster than the first, and the third even faster than the second. A

³Refer to chapter 5 – The Mechanics of Impact.

fundamental determinant to ultimate success in elite-level tumbling is the ability to answer "yes" to the following question:

Does each skill in the tumbling sequence progressively accelerate?

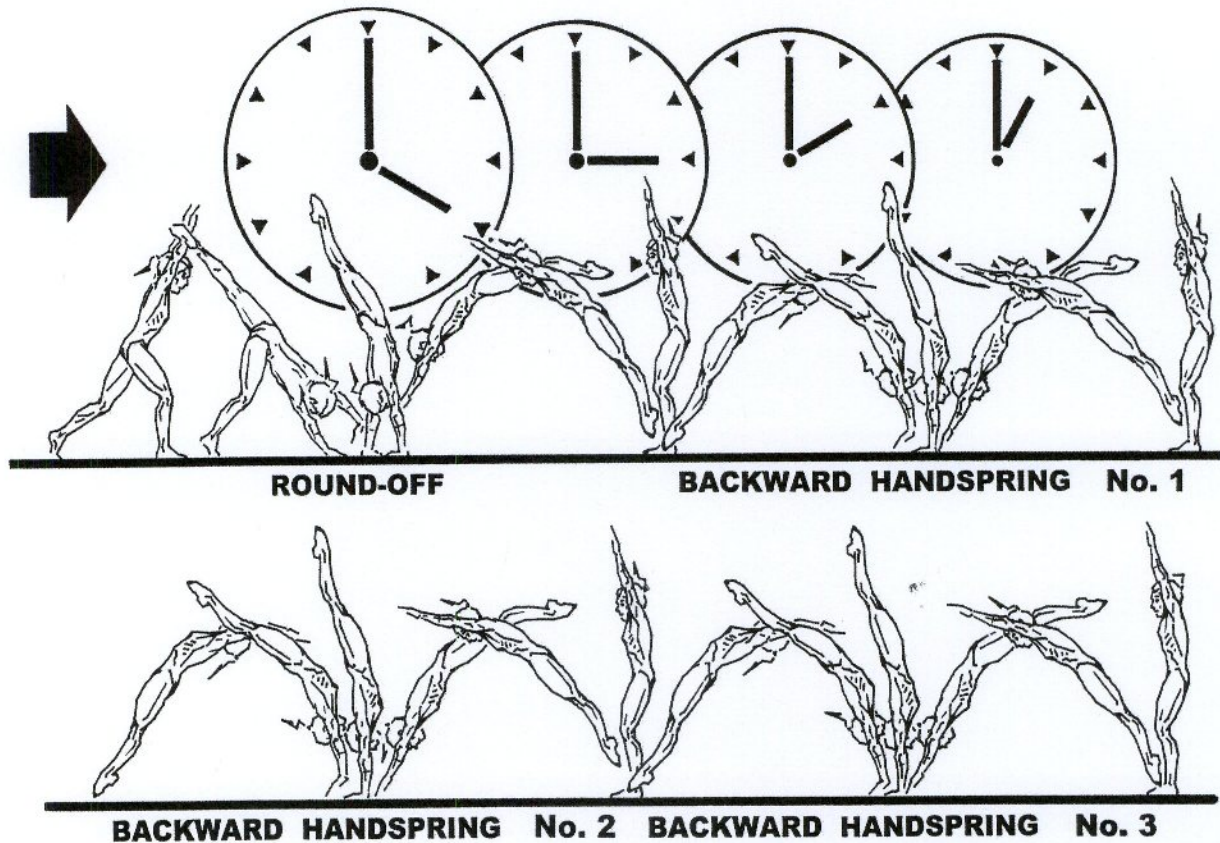


Figure 9.4. A Round-Off into Three Backward Handsprings: in terms of rotary motion, each successive skill in the tumbling series should progressively "accelerate."

4. Sounding the Rhythm

While considerable training is required to achieve a progressive acceleration throughout a tumbling series, its effect is easily recognizable. One need only listen carefully to the sounds produced by the "hands-then-feet-then-hands-then-feet" contact with the mat (see figure 9.4) to determine whether the performer's rotary motion is speeding up, staying the same, or—worse—slowing down.

If the interval between successive contacts gets progressively longer, it indicates the "tempo" of the sequence is decelerating, a clearly undesirable performance characteristic. This scenario generally signifies the performer lacks the internal capability to increase, or at least maintain, rotary velocity. It also reveals she has traded-off, to whatever extent possible, some amount of the horizontal motion initially achieved in the run-up for that much-needed rotary motion in the actual tumbling series.

By comparison, *if the interval between successive contacts gets progressively shorter, it indicates the tempo is accelerating, a desirable performance characteristic which sets the stage to maximize the ultimate somersault/twist phase.* Simply put, the series is speeding up. Table 9.2 outlines the criteria for evaluating the rhythm in multiple-tumbling series.

*Listen carefully to the beat...
The cadence should be accelerating!*

SOUNDING THE RHYTHM

Time interval between hands (H) and feet (F):

POOR

H...F.....H.....F.....H.....F.....H.....F.....H.....F

The tempo is decelerating because the performer relies primarily on the run and lacks the internal capability to increase, or at least maintain, rotary motion.

AVERAGE

H.....F.....H.....F.....H.....F.....H.....F.....H.....F

The tempo from hands-to-feet-to-hands-to-feet is maintained.

GOOD

H.....F.....H.....F.....H.....F.....H.....F.....H.....F

The tempo accelerates because the performer initiates the Round-Off from a comparatively slow run and then progressively increases rotary motion *within* each successive element by virtue of her own internal power.

Table 9.2. Comparison between poor, average, and good tempos in executing a Round-Off into Three Backward Handsprings.

It must be emphasized, however, that the first order of business is achieving and maintaining sufficient horizontal velocity prior to progressively increasing rotary velocity of each skill in the tumbling series. Otherwise, it would be like the wheels of a drag racer spinning out at the starting line but going nowhere fast!

5. Rapid Inversion of the Total Body Unit at Input

Although there are a number of skills that can be used to set-up a multiple tumbling series, the *Round-Off for backward tumbling* and the *Forward Handspring for forward tumbling* are, without question, the more commonly employed choices. Interestingly, *the input mechanics for initiating these two skills are strikingly similar.* For example, in order to ensure a most effective "input," both require

achieving a fully extended body shape at the peak of the hurdle trajectory; followed by a quick, forceful step-out to establish sufficient horizontal motion; and then to accrue a large quantity of rotary motion during the initial input, i.e., from the peak of the hurdle trajectory to hand contact with the mat. *However, it is this latter point, the establishment of a large quantity of rotary motion during initial input that most performers fail to achieve.*

In both Round-Offs and Forward Handsprings, one often observes the performer's upper body gliding fore-downward into the initial input phase, a slow placement of the hands onto the mat with noticeably flexed hip joints...and then relying primarily on the "kick action" of the lead-leg to initiate rotary motion for the actual input. This is particularly true when the performer relies on the speed of the run-up, hoping to transfer a portion of accrued horizontal motion into rotary motion—which is a distinctly disadvantageous compensatory technique.

To demonstrate, figure 9.5 compares two techniques for the initial input phase of a Forward Handspring. Because performer 1 erroneously leads with her midsection into the input (a common tendency), her total body unit cannot execute the proper bending sequence (kinetic chain) necessary for generating the much-needed rotary motion. As a result, the inversion action of the "upper body and lead leg" is labored, slow and incomplete, resulting in less-than-adequate rotary motion being generated at input.

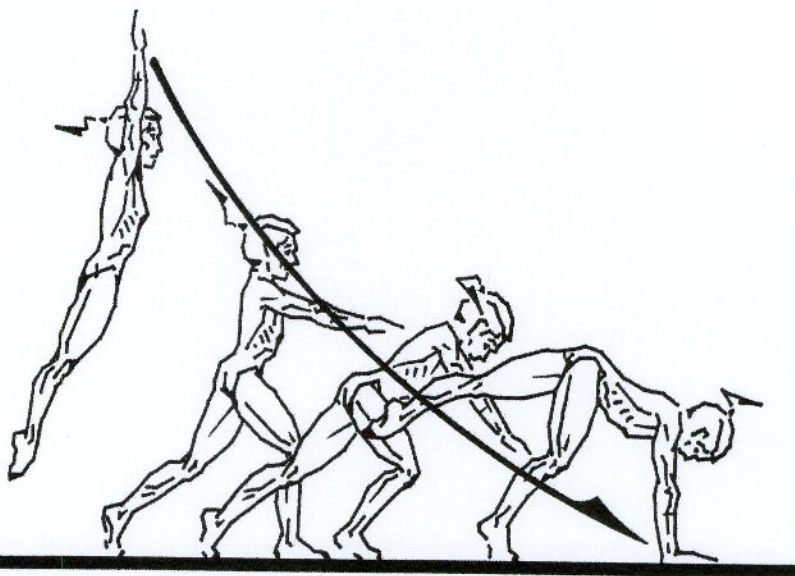
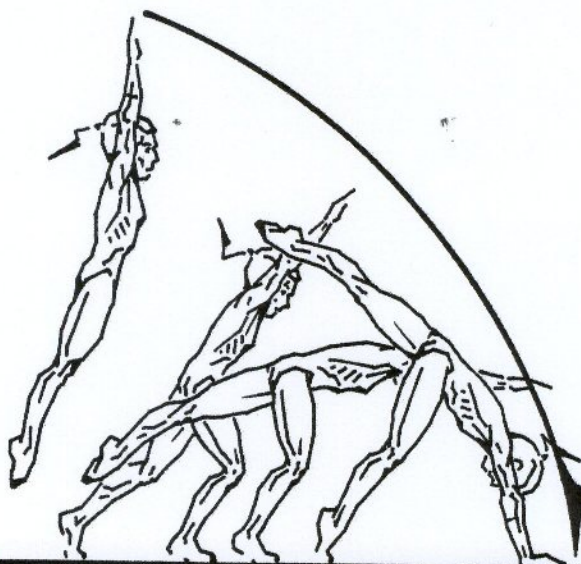
No. 1**No. 2**

Figure 9.5. Comparative techniques for the "initial input phase" of a Forward Handspring: (1) improper technique; and (2) proper technique.

Performer 2, however, initiates the proper "rapid inversion-action" by bending first from a region of higher location (shoulders and upper trunk) and then rapidly down through the lumbar region and hips until a hollowed total body shape (excluding the push leg) is achieved. *By rapidly driving the hands over the top and directly to the mat* (see shape of arrow), *a large quantity of rotary motion is established at the onset of the skill.* The fundamental objective is to maximize rotary motion by generating a rapid inversion of the total body unit at the start of the input phase.⁴

⁴The input techniques for both a Forward Handspring and a Round-Off are essentially the same.

Compare, too, the body shapes of these gymnasts at the moment of hand-contact with the mat. *Notice performer 2 has not only generated more rotation earlier in the skill, but is also in a more advantageous position to initiate a very fast, and therefore more effective, "push action" with her support leg.* By comparison, performer 1 looks more like a sprinter in the starting blocks than a tumbler with already-existing rotary motion!

6. The Snap-Up

Many coaches emphasize the importance of the snap-down in Round-Offs as well as in Backward and Forward Handsprings—and rightly so, for one cannot tumble effectively without executing a powerful snap-down. However what is oftentimes overlooked centers upon the relative position and movement of the "total body unit" during the time in which the "snap-down" is actually occurring. For you see, *a key consideration in effective tumbling is not simply a powerful snap-down, but rather the amount of rotary motion occurring in the total body unit as the performer is executing the snap-down.* And the greater the body's rotation during the snap-down, the more quickly the arms, head, and trunk will be rising—the *snap-up phase*—as the feet contact the mat for the next skill. *A rapidly rising trunk immediately after hand contact with the mat is critical for accelerating out of virtually any Round-Off or Front Handspring-oriented series.*

In ensuring an effective snap-up action from a hand-support position, two crucial, interrelated factors come into play: 1) the amount of existing rotary motion developed during the input phase to the hand-support position; and 2) the mechanics employed to execute the snap-up from the hand-support position. Let's take a closer look.

A. Rotary Motion at Input

To see precisely why *establishing sufficient rotary motion initially is so important*, compare the techniques for a basic Round-Off presented in figure 9.6. Although both gymnasts execute a vigorous, forceful snap-down with the legs and feet, the net effects are decidedly different. This is because performer 1 fails to generate sufficient backward rotary motion during the initial input phase. As a result, there is little lift and rotation in her upper body, regardless of how forceful her snap-down may have been. Consequently, she lands in a low, forward-leaning position with a relatively closed or compressed body shape (see direction and shape of arrows).

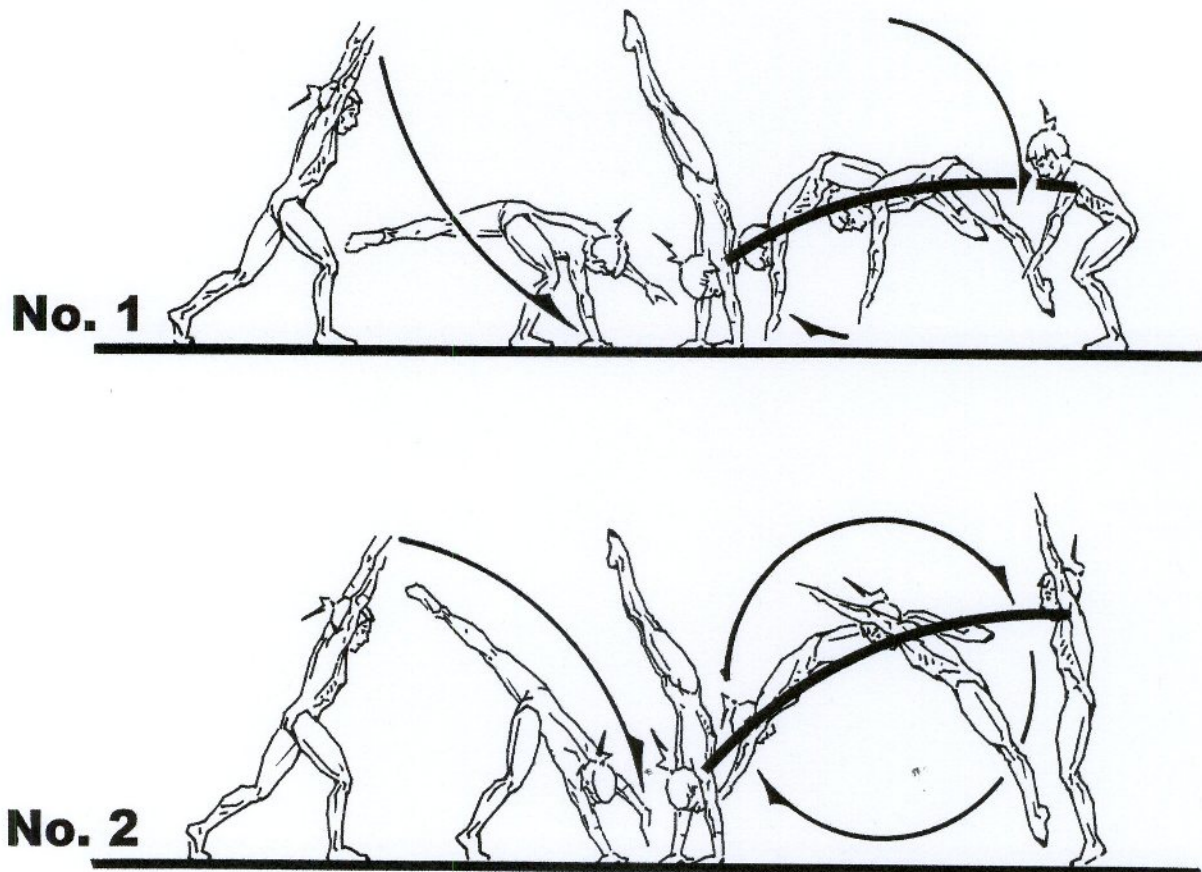


Figure 9.6. Comparative techniques in executing a Round-Off: (1) insufficient rotary motion = poor technique; and (2) sufficient rotary motion = good technique.

By rapidly inverting her total body during the initial input phase, performer 2 generates a large quantity of rotary motion. This already-existing momentum can then be effectively transferred at hand contact with the mat, so even larger quantity of rotary motion develops during the snap-down. As a result, the total body continues to accelerate while a more vigorous "snap-up" of the arms, head, and trunk is achieved (see direction and shape of arrows).

*In Round-Offs and Handsprings,
it's not simply a matter of how strongly one's legs snap-down,
but rather
how quickly one's trunk snaps-up!*

B. Mechanics of the Snap-Up

In addition, a proper snap-up out of a hand-support position requires effective transfer of momentum from the legs into the total body, as well as timely recoil (push action) in the arms and shoulder girdle just as this

momentum is being transferred. Figure 9.7 illustrates the interplay between proper shoulder girdle action and momentum transfer during the hand-support phase of a Backward Handspring.⁵

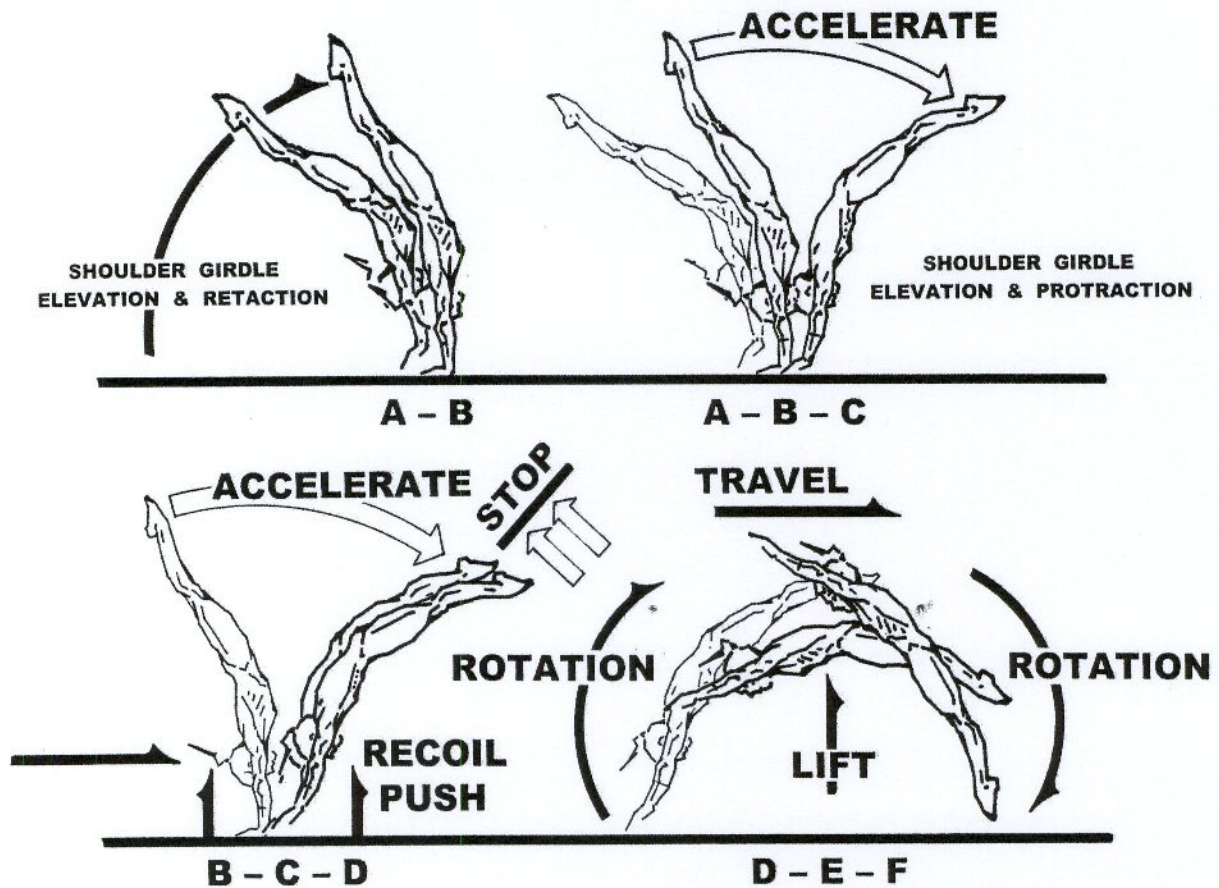


Figure 9.7. The mechanics of the snap-up technique in executing a Backward Handspring.

As shown in illustrations A and B, the total body unit is rapidly rotating backward. Notice *the performer's shoulder girdle is in the fully elevated and retracted position, while her hands are vigorously reaching for the mat.* This body shape helps ensure the earliest possible contact with the mat in the descent phase, thereby minimizing unwarranted downward motion. Also notice the body is slightly arched, or "cocked" like an archer's bow, ready to release its potential energy for the impending "snap-up" action.

Immediately upon hand contact, the performer forcefully accelerates her legs and feet over the top to form a hollowed total body shape (B, C). But rather than continuing to accelerate the legs and feet toward the ground (snap-down), she

⁵ Refer to chapter 5 for additional discussion of *Shoulder Girdle Action*.

instantaneously stops this leg drive, transferring its momentum into the total body unit.⁶

Simply put, *the "stopping action" of the legs and feet relative to the upper body while still in the hand-support phase (C, D) causes an increase in the backward rotary motion of the total body unit.* And it is this instantaneous transfer of momentum from the legs into the total body that allows the gymnast to maximize the actual "snap-up" (E, F).

Another important action occurs simultaneously during the hand-support phase, i.e., the recoil-push action in the shoulder girdle. Immediately prior to the hand-support phase, the shoulder girdle should be fully elevated. Although the force of each hand impact momentarily causes slight depression, the performer should strive to maintain full shoulder girdle elevation continuously. As a result, the shoulder girdle's "recoil-push action" at impact is both automatic and instantaneous.

At initial hand contact with the ground, the performer's *elevated* shoulder girdle is also in the *retracted* position (illustrations A, B). However, as her hands leave the ground, notice her *elevated* shoulder girdle is now in the "*protracted*" position (C, D). In other words, *as the force of impact causes the fully elevated shoulder girdle to undergo momentary depression before returning to full elevation (recoil-push action), the shoulder girdle also vigorously hollows from full retraction to full protraction (B, C, D).* The net effects of these timely actions are lift, travel, and rotation of the total body unit in the desired backward direction (E, F).

7. Standing Tall and Skimming the Stone

In a traditional multiple-tumbling series, the trajectories of each sequential handspring-oriented skill should be fast and flat, emphasizing horizontal amplitude. To help accomplish this, *the performer should stand as tall as possible through each phase of the entire tumbling sequence.* This concept's importance is demonstrated in figure 9.8, depicting comparative techniques for multiple Backward Handsprings.

Notice the posture of performer 2 is noticeably taller than that of performer 1 for the entire series. Employing this extended tumbling posture minimizes unwarranted upward/downward movement in favor of a faster, flatter horizontal pattern. Standing tall throughout the series helps ensure: 1) the resulting trajectories will be smoother and therefore more efficient; 2) the impact times of hands and feet

⁶ Refer to chapters 4 and 5 for additional information on transfer of momentum.

respectively will be shorter in duration and therefore more effective; and 3) a comparatively greater amount of horizontal velocity will be achieved as a result. Keep in mind that *attaining great horizontal velocity in the handspring series sets the stage for maximizing both lift and rotation in the ultimate somersault phase.*

*Tumble swiftly, like you're
"skimming a flat stone across the water."*

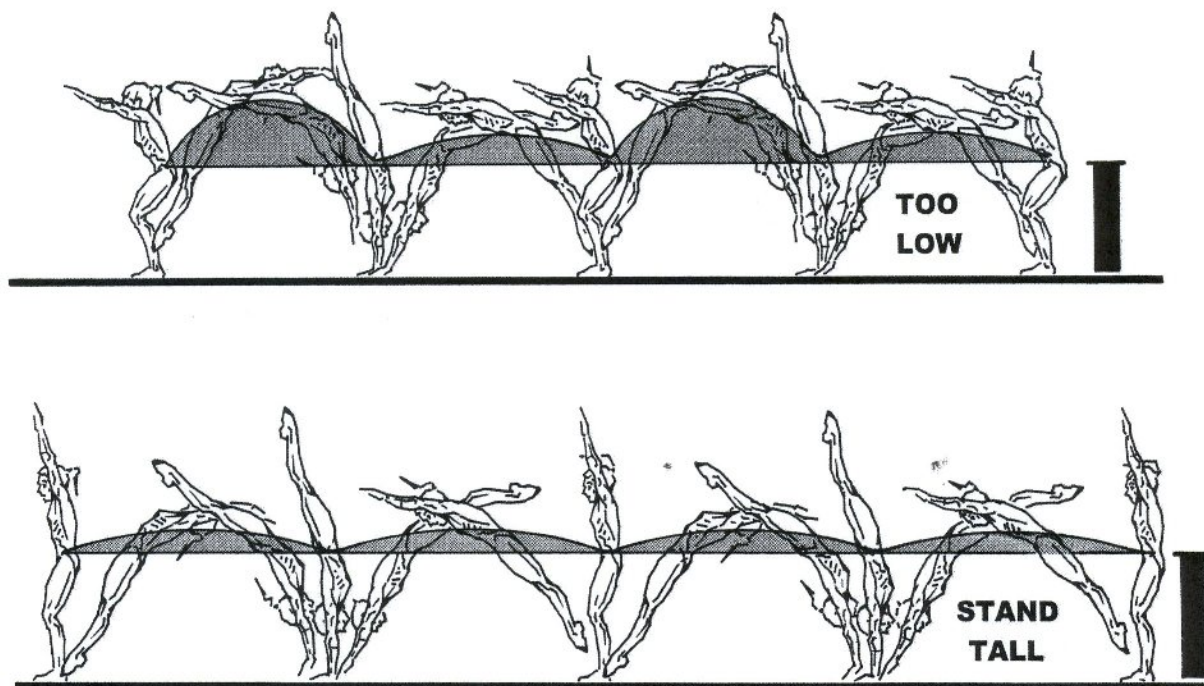


Figure 9.8. Comparative trajectories in executing multiple Backward Handsprings: (1) non-extended posture = inefficient technique; and (2) extended posture = efficient technique.

Perhaps another way to conceptualize the shape of the resulting trajectories for this Backward Handspring series is to observe that *the performer's center of mass is always as high as possible relative to the ground during all impact phases, and is always as low as possible relative to the ground during all airborne phases.*

8. Shoulder Girdle Range and Power

In the normal course of physical maturation, humans learn to balance upright on their feet, then walk, and finally run and jump. In virtually all these stages of development, it is the larger and stronger legs (as opposed to the arms) do the lion's share of the work. Consequently, and almost without exception, it is fair to say that *for any given performer, the lower body is significantly more powerful than the upper body.*

Round-Offs and handsprings are some of the transitional skills most commonly used to set-up the ultimate tumbling element, the somersault. Because these maneuvers require landing on and rebounding from the hands with impact-rebound forces comparable to those realized by the feet, *it is imperative for the performer to possess great strength and explosive power in her arms, shoulder joints, and especially her shoulder girdle.* This "balancing the power component" between arms and legs becomes particularly critical in all tumbling skills having a hand-impact phase.

*The shoulder girdle is to arm power
what
the pelvic girdle is to leg power!*

Specificity exercises to increase shoulder girdle strength and flexibility go a long way toward achieving this balance of power. In addition to the push-up examples presented in chapter 8, the wise gymnast should employ training exercises that emphasize "rebounding" in the inverted hand-support position.⁷ *More often than not, the ability to move explosively through a wide range of shoulder girdle motions specific to elevation/depression and protraction/retraction is a hidden component of success in elite-level tumbling.*

9. Whipback Handspring—Skewing the Curve

To garner additional "punch power" in the leg-impact phase immediately prior to the ultimate somersault, elite-level performers often modify their final Backward Handspring by slightly "lifting slightly" the trajectory's vertical component at take-off. As illustrated in figure 9.9, the observed movement pattern falls somewhere between a traditional Backward Handspring and a low, fast Whipback Somersault. As a result, the movement tempo from hands-to-feet in the snap-down phase occurs somewhat quicker and more forceful than it normally would, causing a sort of "ka-boom" effect. Properly executed, *this action serves to lessen the hand-impact phase of the handspring in favor of a more powerful leg impact, thereby creating potentially greater lift in the somersault.*

Slightly lifting the vertical component of the final Backward Handspring skews its rotational timing in favor of a more pronounced "punch-action" for the ultimate somersault. However, this is a very advanced technique, requiring absolute control of the movement pattern as well as a heightened awareness of the timing accuracy necessary for successful execution. The concept is similar to "advancing the spark timing" in a Model-A Ford hoping to achieve an additional measure of power—*keep in mind though that it only works in finely tuned engines!*

⁷ Refer to *Specificity for Power Training and Resistance Techniques* in chapter 8.

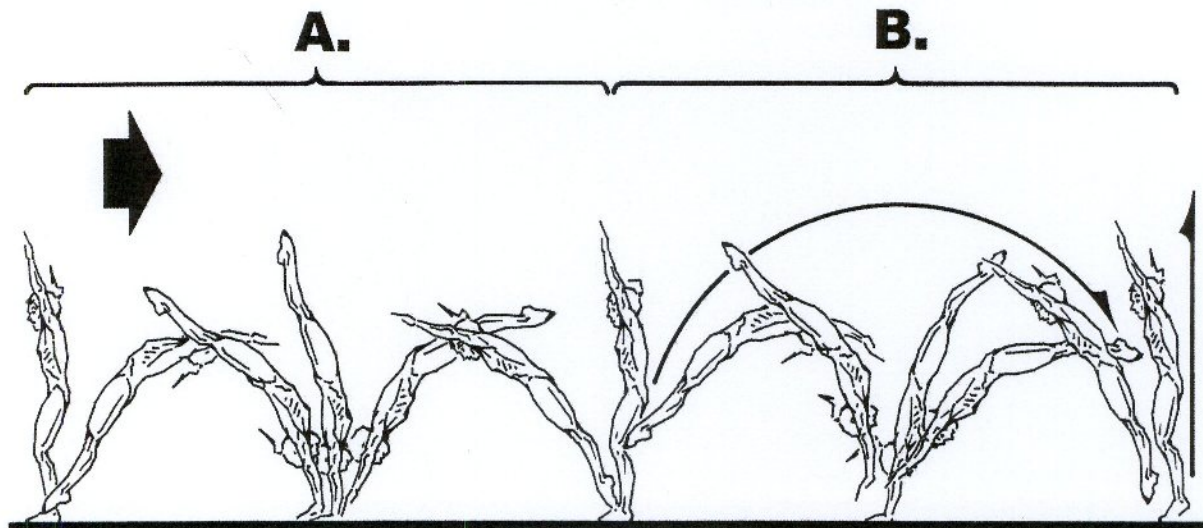


Figure 9.9. Comparative examples of successive Backward Handsprings: (A) Backward Handspring; and (B) into a Whipback Handspring.

10. Kinesthetic Awareness—Eye of the Storm

Kinesthetic awareness is the degree to which a performer is aware of her body parts relative to one another, and also of her total body's position and orientation relative to the ground. It involves the ability to accurately interpret and respond to sensory feedback as the body moves through space. A highly developed level of kinesthetic awareness is essential in gymnastics, not only for skill consistency and accuracy but also in terms of safety. To put it another way, movement skills of greater complexity, difficulty, and risk require correspondingly greater levels of kinesthetic awareness. Anything short of this symbiotic relationship is doomed to failure.

Although spatial orientation is an unconscious event initially, it can be enhanced markedly by training. Practicing with correct technique, employing proper skill progressions, and ensuring ample repetitions over extended time periods are key ingredients for developing and improving kinesthetic awareness. However, *these training protocols alone hold limited value without a conscious effort by the gymnast to "visually focus" on the task at hand.* This type of focusing requires "active" concentration specific to the way the various body parts are moving relative to one another as well as the total body unit's position and motion relative to the ground. At every turn, the wise performer assimilates each movement pattern, not only through her sense of "feel," but also through "sight." Just ask any airline pilot!

*The "eyes" serve as infrared radar beams
to establish and maintain a precise "fix"
on the body's location relative to the ground.*

In an earlier section, it was discussed that sensory feedback is derived from three closely interrelated receptor systems, i.e. vestibular, proprioceptive and ocular.⁸ Although development of the vestibular and proprioceptive systems tends to occur naturally under conditions of skill repetition and progression, *performers often fail to take full advantage of the ocular (visual) system.* To maximize spatial awareness, the gymnast must learn precisely when, where, and how long to sight specific reference points during complex aerial maneuvers. Generally speaking, the preferred frames of reference relative to the body are the ground, the apparatus, and some pre-established points on the wall and/or ceiling of the gymnasium. Although visual reference points vary from skill to skill, *the ground inevitably serves as the most important frame of reference.*

*Look directly into the "eye" of the storm
to find clarity and calm...*

To demonstrate the point, figure 9.10 depicts three typical techniques employed to execute a Full-Twisting Double Backward Somersault. Although all of these techniques result in the performance of the same skill, they differ significantly in terms of "when" the twist is initiated as well as "how much" twist (if any) is accomplished in each somersault.

Performer 1 completes the full twist during the first somersault, with no twist at all in the second (a Full In-Back Out). Because the entire twist occurs during the first somersault, the performer can achieve brief visual contact with the ground at this time. However, as the second (non-twisting) somersault occurs, visual contact is momentarily lost and cannot be restored until later in the descent phase, after about 1½ somersaults. With such limited time in which to process and react to one's body position relative to the ground, the potential for a controlled landing is somewhat reduced.

Performer 2 enacts a ½-twist in the first somersault followed by a ½-twist in the second (a Half In-Half Out). Although visual contact with the ground is achieved in the initial phase of the first somersault, it is momentarily interrupted as the performer transitions into the second. But because the second somersault is actually a Barani, visual contact with the ground can be restored comparatively early in the descent phase, i.e. at the beginning of the second somersault. This added time in which to sight the ground improves the potential for a more controlled landing.

In the third example, no twist whatsoever occurs during the first somersault—the entire twist is accomplished in the second somersault (a Back In-Full Out). This technique for a Full Twisting Double Backward Somersault provides the best

⁸ Refer to *The Sixth Sense* in chapter 3.

opportunity to *establish and then maintain continuous visual contact with the ground* quite early in the airborne trajectory, i.e. immediately upon completing the first-half of the first somersault. As a result, the potential to control the descent phase of the skill as well as the landing is markedly increased. All other things being equal, *an "early and continuous" visual fix on the ground affords the best opportunity to make adjustments during execution, particularly as related to ensuring a proper landing.*

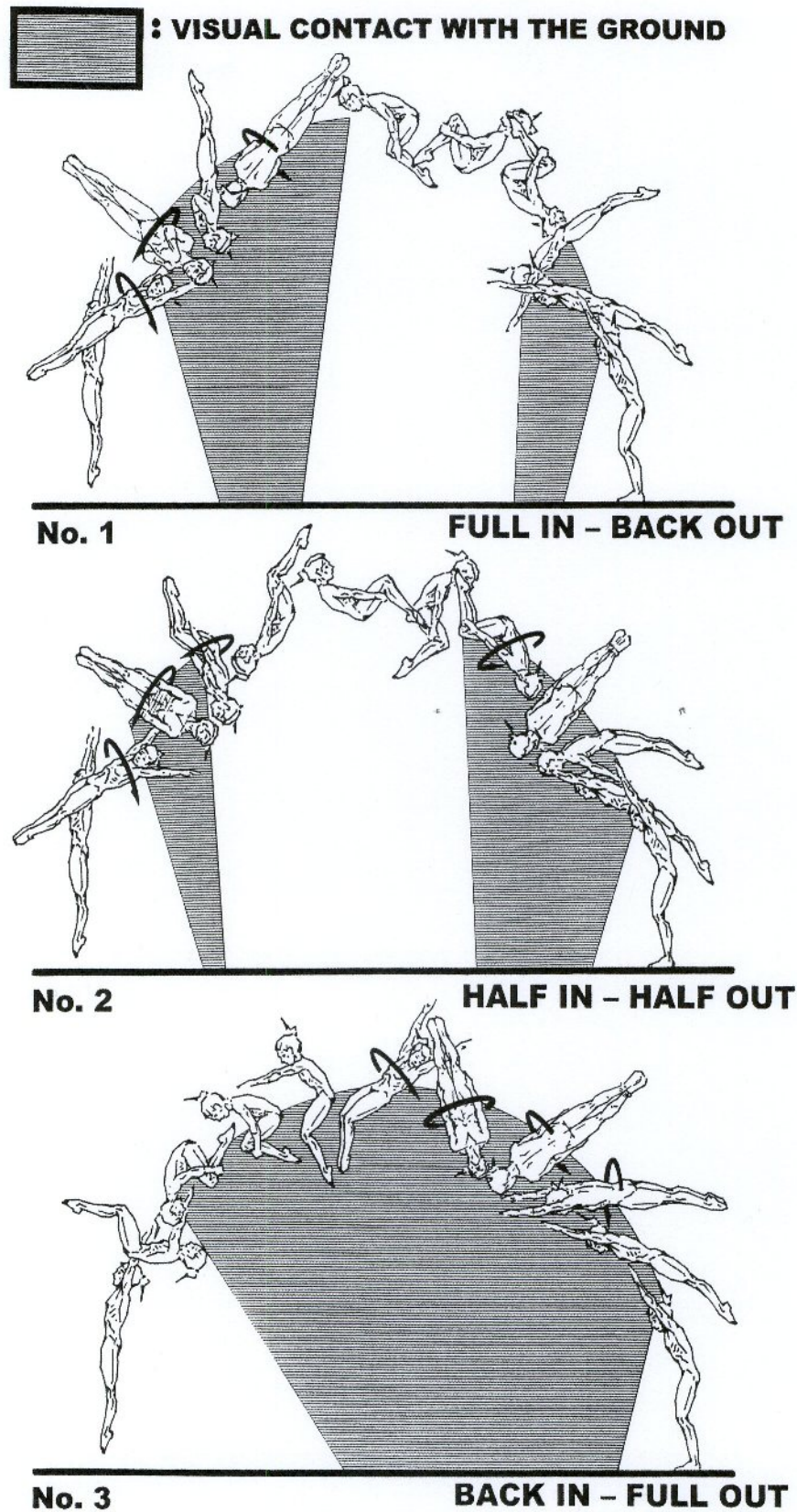
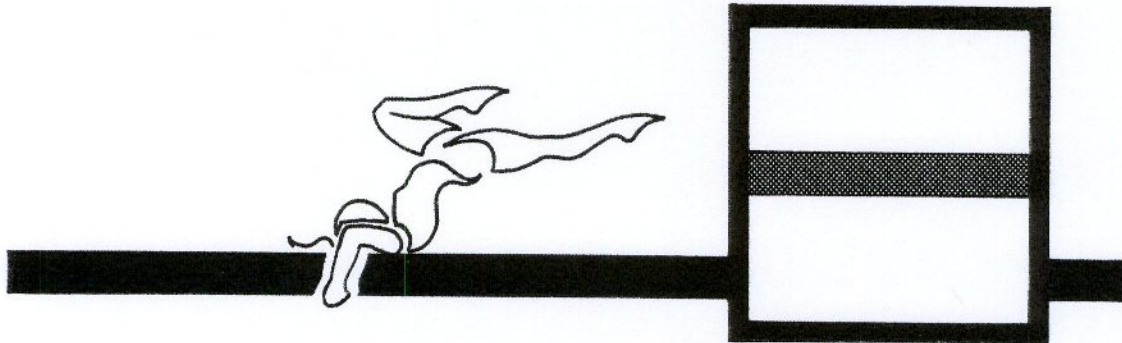


Figure 9.10. Comparative "sighting" characteristics in executing a Full Twisting Double Backward Somersault: (1) Full In-Back Out; (2) Half In-Half Out; and (3) Back In-Full Out.

Although it might be argued that one technique is easier to accomplish than another for some physical or mechanical reason unique to a given gymnast, the fact remains that *in the performance of a Full-Twisting Double Backward Somersault, the Back In-Full Out technique reigns supreme* when it comes to early ground sighting with an increased potential to stick the landing. Always remember:

The eye never sleeps...

CHAPTER TEN

CONCEPTS OF BALANCE BEAM

*Absolute balance is to experience a
"moment of ecstasy"...*

Like Floor Exercise, the Balance Beam event provides a unique venue for each performer to tell her story through complex maneuvers combined with classical ballet and expressive dance elements. Although these skills are in effect no different from those in Floor Exercise, the physical constraints of the Balance Beam, coupled with its added dimension of height, demand significantly higher levels of technical exactness and balance, and entail greater risk.¹ Seemingly minor miscalculations in skill execution that would be scarcely discernable on the floor often manifest themselves as gross errors in performance on the beam. Consequently it would be fair to say that the beam's narrow performing surface and greater height give this event an unforgiving nature, which ruthlessly exploits and sorely magnifies even the smallest of mistakes.

IN-LINE SPACE

Imagine the surface area of the beam extending directly outward and upward and then returning in a giant circle, as illustrated in figure 10.1. Gymnasts should use this "in-line space" as the conceptual framework for the execution of all beam skills. While the height dimension is limited solely by the gymnast's capability, the forward/backward and particularly the side-to-side dimensions of the beam require uncompromising technical excellence. And as in Floor Exercise, *the more a gymnast can call upon advanced tumbling maneuvers to explore the upper range of this "in-line" space, the greater the potential for success, particularly at the elite level.*

¹ The performing surface of the competitive beam is only 4 inches wide by 16 feet long and is raised approximately 4 feet above ground level.

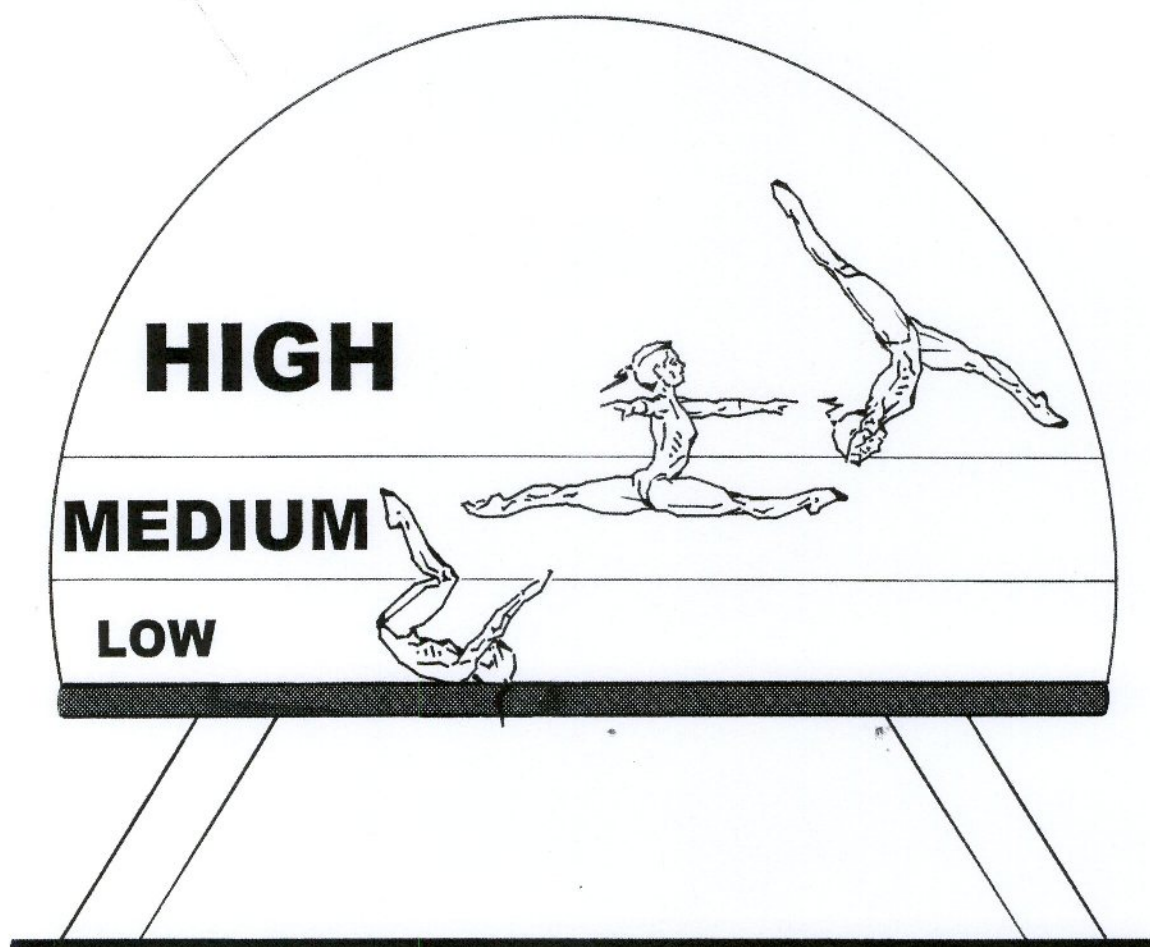


Figure 10.1. In-line space dimensions for the Balance Beam event.

FUNDAMENTAL BALANCE BEAM CONCEPTS

1. Mastering Skills at Ground Level

Many factors come into play when learning to control one's balance. As already discussed, mastering correct body shape and developing proper muscular tension in basic movements are important first steps.² *However a second and equally important consideration for the beam centers upon ensuring that the intended skills are first mastered on the ground, with particular attention to exactness in technique as well as precise in-line accuracy.*

All too often, one observes performers attempting skills and combinations on the balance beam that are only half-mastered at ground level. Worse yet, performers then strive to achieve full mastery of these skills while training on the beam, only to ingrain

² Refer to *The Handstand-Training Triad* in chapter 3.

incorrect movement patterns, resulting in decreased performance consistency. Consequently it is important to stress that *without first achieving mastery at ground level, the probability of successfully executing the same skills on the beam becomes less than remote.*

Let's start with level flight...

2. Training the Core

The act of balancing is basically a matter of maintaining the effective weight of the body directly over the base of support. Keeping one's center of mass within the confines of one's base of support to maintain equilibrium appears relatively simple, at least from a conceptual perspective. However, as most performers and coaches agree, the accomplishment of this feat "reads easier than it lives"! In fact, many performers execute skills on the beam with a hope and a prayer that Lady Luck might somehow prevail. While it might be argued that "good luck beats skill every time," always keep in mind:

Good luck is about as reliable as winning the lottery.

Whether one is inverted, upright, or in transition, the principles involved in maintaining balance are one and the same. The concepts presented in chapter 3, "The Common Denominator—The Handstand," should therefore be directly applied to all beam skills. For example, just as the shoulder girdle helps maintain stability when balancing on one's hands, so too does the pelvic girdle help control, guide and regulate stability when standing, walking, running, and jumping. And this is precisely why *training for core body power and flexibility is so vitally important to success in balancing.*³

It is important, however, to appreciate that the physical characteristics of the apparatus impose a unique set of constraints on the gymnast. Because the beam's performing surface is some 16 feet long but only 4 inches wide, *the "ease" of maintaining balance varies according to the body's orientation relative to the beam.* As depicted in illustration A of figure 10.2, side-to-side stability is more difficult to maintain when the performer is oriented forward/backward on the beam. Conversely, when positioned sideways to the length of the beam (B), forward/backward stability is more difficult. And because the typical beam routine involves various turns as well as numerous changes in position, direction, and location, maintaining balance in this ever-changing environment is particularly challenging.

³ Refer to chapter 8.

To become familiar and therefore comfortable with this unique environment, *it is essential that performers first spend considerable time performing core motor skills on a regulation-height beam, e.g., walking forward and backward, basic turns, jumps, and so forth.* Only through time, repetition, and tedious attention to detail can performers develop sufficient confidence, ease, and familiarity with the beam. Once these basic movement patterns are confidently and consistently demonstrated over time, the next step centers upon gradually introducing "already-learned" floor skills at levels of increased difficulty and complexity.

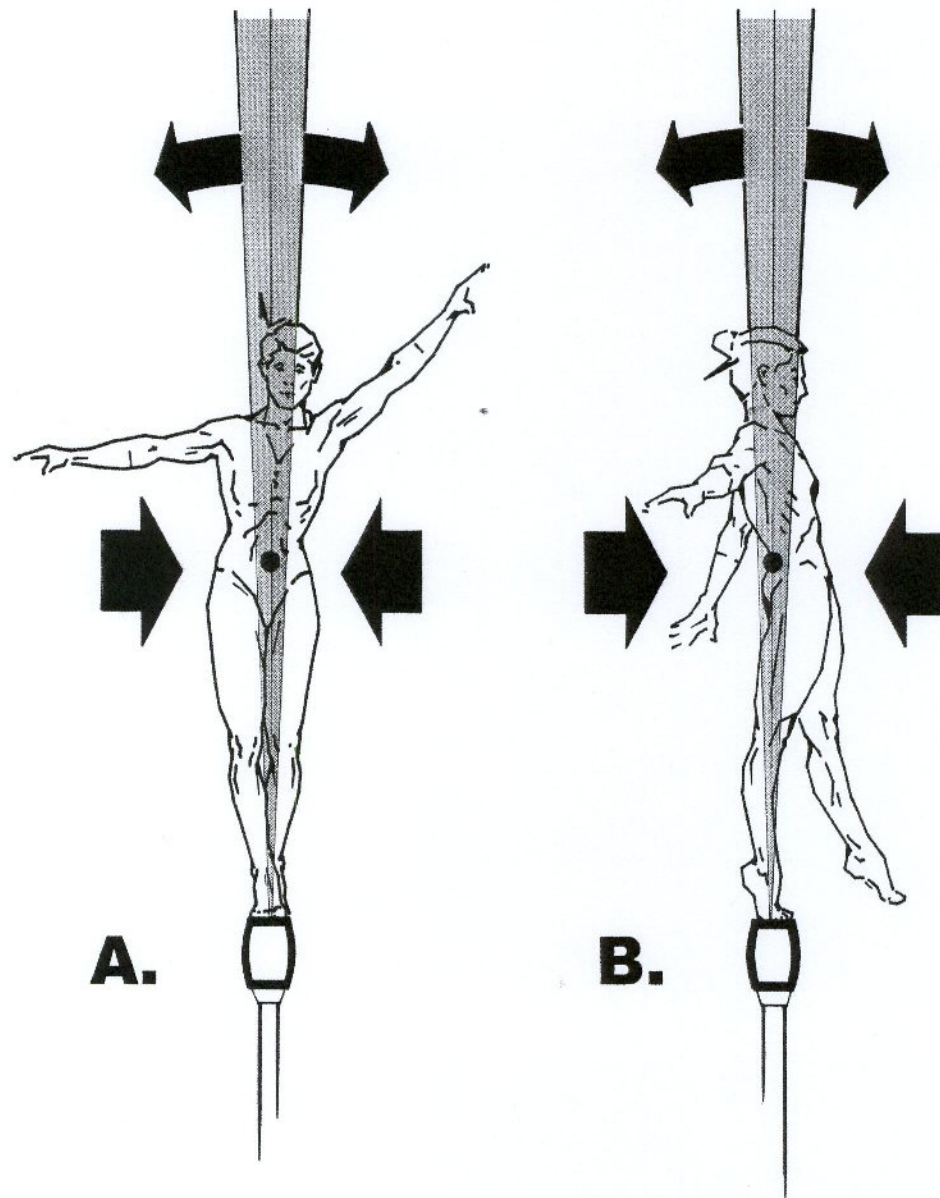


Figure 10.2. The relationship between body orientation and stability on the beam: (A) facing longways = greater side-to-side instability; and (B) facing sideways = greater forward/backward instability.

It is important to emphasize that the most effective training sessions are those dominated by successful executions rather than by failed attempts. Or to put it another way, *the key that ultimately unlocks the door to championship performance is a training environment characterized by a "consistent" history of successful repetitions.*

*Consistency must be a trait learned initially,
not finally.*

3. Stacking the Vertebrae

In any new environment, particularly one involving skill execution on a narrow, elevated surface, there is a natural tendency to proceed in a hesitant fashion. This uncertainty is often demonstrated by less-than-extended body shapes and tentative movements, as the gymnast hopes somehow to be better prepared for a potential loss of balance. And as a result, many gymnasts end up relying upon "counter-balancing," a rudimentary technique that, as we have discovered earlier, involves highly obvious and visually awkward changes in shape in order to maintain balance.

Although "counter-balancing" is a natural and therefore acceptable technique during initial skill learning at ground level, "on-line balancing" should be the primary technique when transferring these skills to the beam. Because skills intended for use on Balance Beam should already have been mastered in Floor Exercise, they should not require the gross body-shape changes characteristic to the "counter-balancing" technique. Or to put it another way, when a beam performer relies primarily on counterbalancing techniques, it implies the skills-in-question were not adequately mastered at ground level.

As with body-alignment techniques for a handstand, *proper posture on the beam requires the performer to stand as tall as possible during the execution of all upright skills.* Particular emphasis should be placed on ensuring the vertebrae are positioned directly on top of each other during upright balancing. *"Stacking the vertebrae" renders the longest possible body shape and thereby sets the stage to employ "on-line balancing," the technique ensuring maximum control of balance.*⁴

4. Strong Ankles/Wrists and Pliable Feet/Hands

As depicted in figure 10.3, *just as the wrist joints serve as control centers for inverted balancing, so too do the ankle joints serve to control, guide and regulate the body when performing on one's feet.* Having exceptionally *strong wrists and ankles* are an important prerequisite to controlling one's balance on the beam. Of equal importance, however, are exceptionally *pliable hands and feet.* And considering the anatomy of the foot, this pliability component becomes particularly critical in all leg-oriented beam skills.

⁴ Refer to *On-Line Balancing* in chapter 3.

To the extent possible, the feet control upright balance in much the same way as the hands do for inverted balance. For this reason, *performing barefoot is normally preferable to performing in any type of shoes*. The more pliable the feet, the better their ability to “feel” and “grasp” the beam, which gives the gymnast a measure of control and body awareness she would not otherwise enjoy. This is why *it is so important to have ankles that are unusually strong, controlling feet that are extremely pliable*.

*Strong ankles controlling pliable feet
are
the genesis of upright balance.*

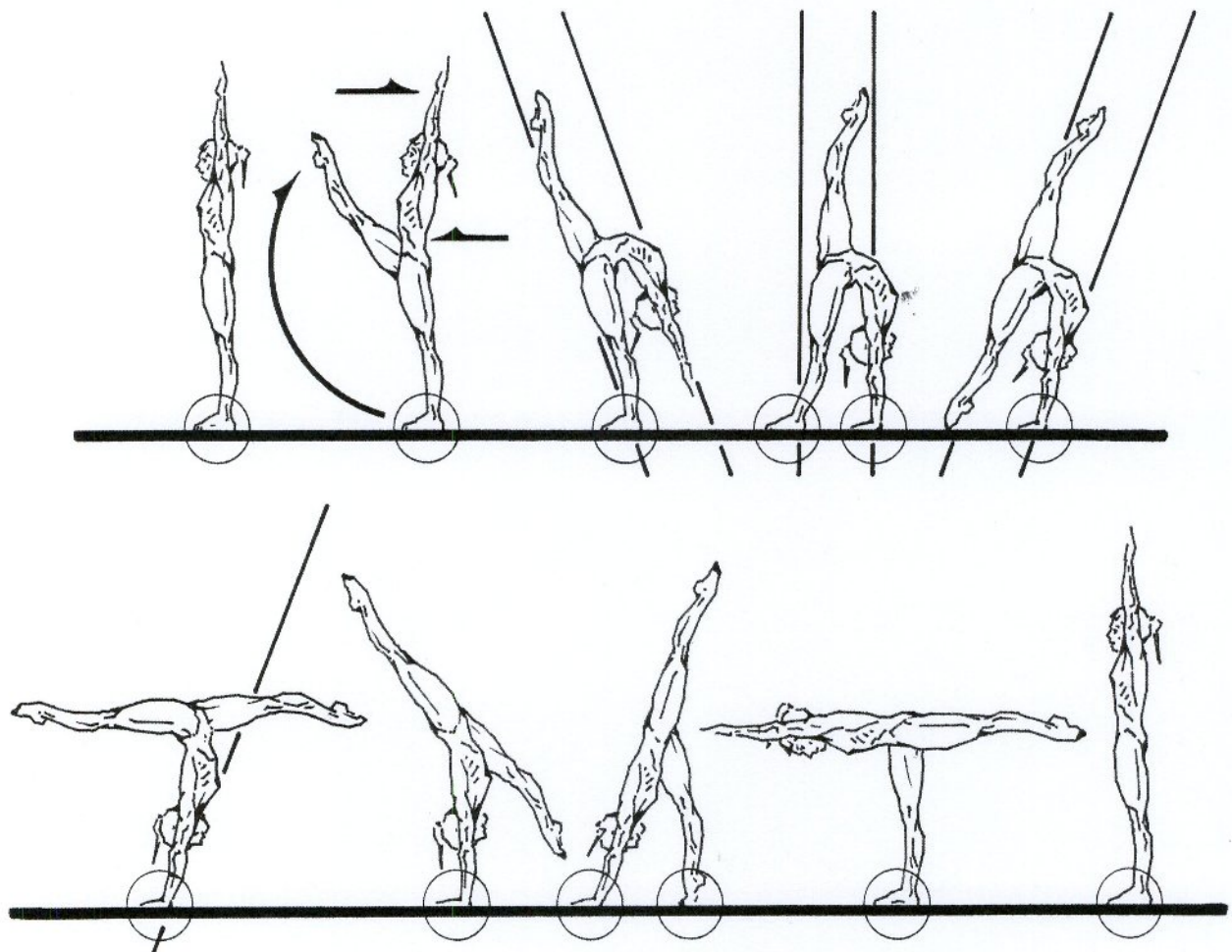


Figure 10.3. The “control centers of balance” in the Backward Walkover consist of the “ankles” for upright balancing and the “wrists” for inverted balancing.

Note *proper placement of the hands and feet relative to the beam directly affects the performer's body alignment and is a critical variable in terms of controlling and maintaining balance.* This is particularly true for situations wherein the gymnast must transition in a dynamic feet-then-hands-then-feet fashion, as in the performance of a multiple-tumbling series.

For example, figure 10.4 depicts the proper orientation of the hands relative to the beam's surface in the execution of a Round-Off.⁵ Notice the performer places her lead (left) hand crossways, and her trail (right) hand inward—and therefore parallel to the beam's surface—for the input phase of the Round-Off. *The crossways orientation of the lead hand enhances directional stability, while the inward orientation of the trail hand maximizes the potential push-off for the oncoming snap-down phase.*

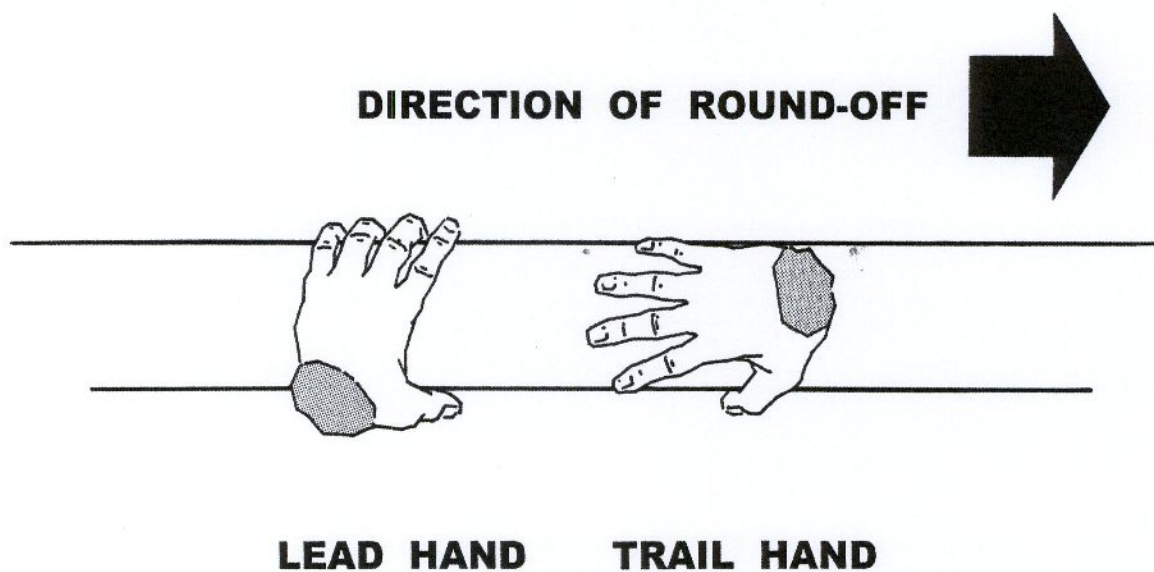


Figure 10.4. Proper hand orientation relative to the beam in executing a "left-hand" Round-Off.

5. The Cross-Extensor Reflex

The cross-extensor reflex refers to the "reciprocal movement patterns" that instinctively occur in the upper and lower limbs whenever a person is in a walking, running, kicking, throwing, or similar mode. In the sprint run example depicted in figure 10.5, notice the movements of both sets of limbs are reciprocal to one another in nature and function. As the left leg pushes backward, the right leg swings forward; at the same time, the right arm moves backward while the left arm swings forward. The upper and lower limbs also act in a crossover fashion with respect to each other, i.e., as the left lower limb pushes backward, the left upper limb swings forward.

⁵ This example uses the left hand as the lead hand for the input phase of the Round-Off. If the right hand initiates the input phase, the orientation of the hands is reversed.

This "cross-extensor" swing pattern between the upper and lower limbs is not only reflexive in nature, but more importantly *its effect serves to minimize the body's tendency to twist or turn during locomotor activities, regardless of type.* Therefore, *its application becomes particularly important in all tumbling skills on beam characterized by sequential placement of strided hands and feet.* When determining the proper placement of one's hands and feet:

*Be not a solver of riddles...
only look at any child learning to crawl,
and she will show you the way.*

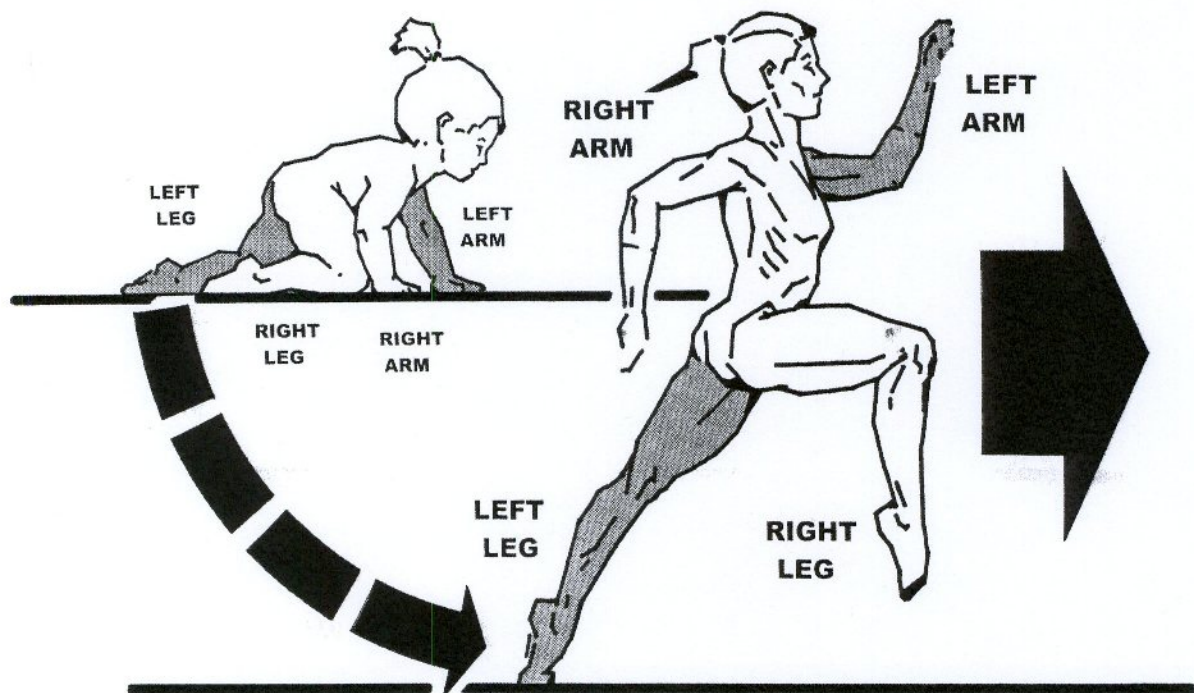


Figure 10.5. The cross-extensor reflex in sprint running.

Applying the cross-extensor concept to the beam, figure 10.6 depicts the natural sequential placement of hands and feet during the execution of a Round-Off-Backward Handspring-Layout Backward Somersault. Because the performer steps into the Round-Off using a *right-then-left* sequence with her feet, the oncoming hand input should follow the mirror-image *left-then-right* sequence. And as the feet make contact with the beam's surface for the snap-down phase of the Round-Off, notice the leg orientation has the *right foot positioned slightly forward of the left foot.*

In other words, *the strided orientation of the feet is opposite that of the hands as they contact the beam*. Because the left hand preceded the right for the Round-Off input phase, the right foot should precede the left for the snap-down phase. This reciprocal orientation of hands and feet (cross-extensor reflex) should continue throughout the handspring and somersault phases.⁶ *Such a sequencing order of the hands and feet minimizes the body's tendency to twist about its longitudinal axis and therefore serves to better maintain total body alignment throughout the execution of the entire tumbling sequence.*

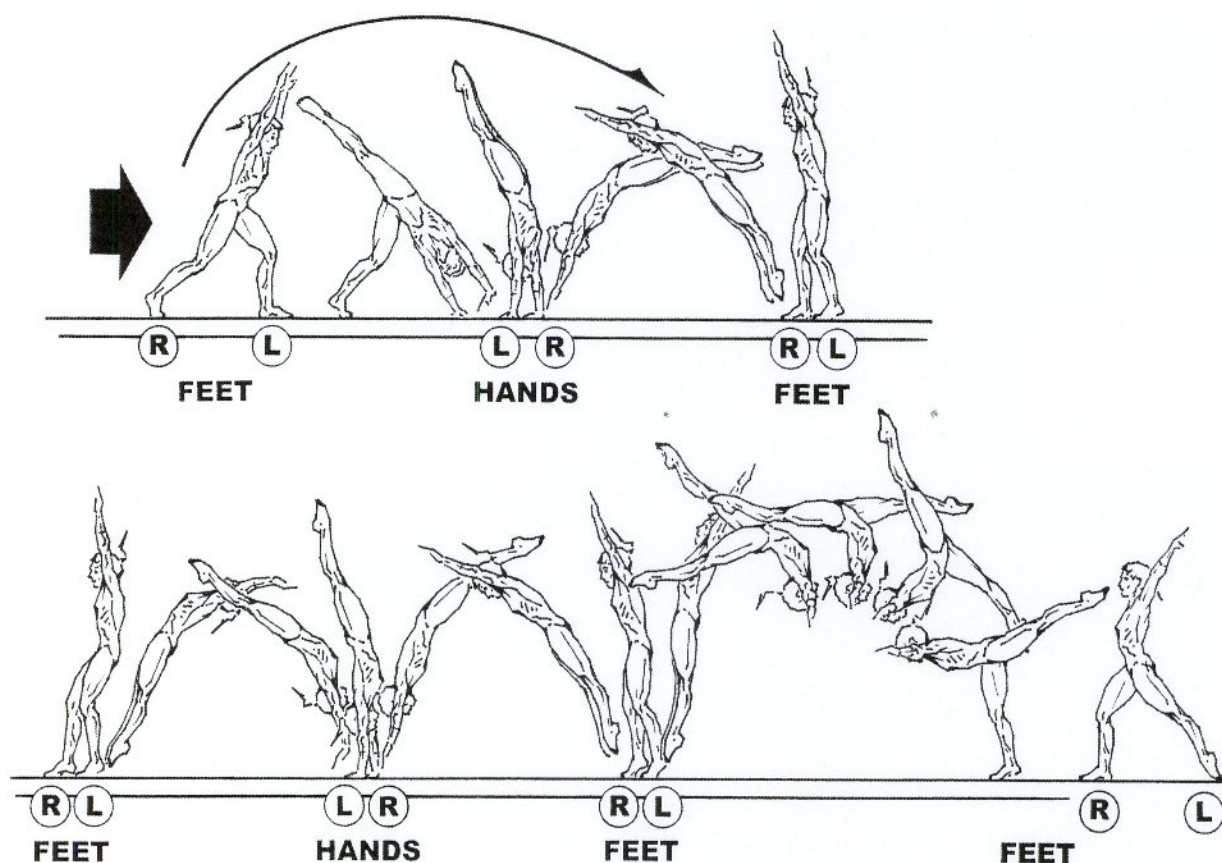


Figure 10.6. Proper sequencing of strided hands and feet in executing a Round-Off-Backward Handspring-Layout Backward Somersault on the beam.

6. Follow-Through to Completion

"Stationary" balance entails maintaining equilibrium with a stable, unchanging base of support, e.g., in standing poses, scales, handstand variations, and the like. By comparison, "dynamic" balance deals with maintaining equilibrium in skills involving motion, rotation, and translation of the total body above and along the

⁶In some situations, the gymnast may elect to contact the beam with feet directly aligned to each other (held together), e.g., for a snap-down immediately prior to dismount.

surface of the beam. In these scenarios, the base of support is intermittent and momentary and can change from one body part to another, e.g., in jumps, leaps, turns, pirouettes, tumbling, and so forth. Additional factors such as "upright" versus "inverted" body orientation are also in the mix. As a result, maintaining "absolute control" on the beam becomes a difficult, complex challenge for any performer. This realization further supports the need to *first ensure unconditional mastery of the intended skills and sequences on the ground before attempting them on the beam.*

Perhaps *the greatest challenge in dynamic balancing for the elite-level gymnast arises in the performance of "multiple-tumbling sequences" on the beam.* These tumbling maneuvers not only involve lift, travel, and rotation in a precise straight-line direction along a precariously narrow surface, but also require multiple changes in the gymnast's base of support, i.e., feet-to-hands-to-feet. To maximize control, balance, and consistency, *multiple-tumbling sequences should be viewed and executed collectively from beginning-to-end as a single movement component, with emphasis on "following-through" to full completion.*

Particularly important to any successful tumbling sequence on the beam is the ability to begin from and end in a position of controlled balance. To accomplish this, the wise performer should always start from a position of "absolute control," visualize an accurate in-line frame of reference for the intended sequence, execute the entire sequence as if it were a single movement, and end in a position of "absolute control." Remember *it is the stability and control displayed at the beginning and ending phases that serve to define and accentuate the very excellence of the dynamic tumbling sequence contained therein!*

7. Focusing on the Target

An earlier chapter discussed the gymnast's reliance on sensory feedback from three closely interrelated receptor systems: vestibular, proprioceptive, and ocular.⁷ And this sensory interplay holds true for all dynamic balance situations, regardless of type. *While all three systems are vital to success, it is the ocular (visual) system that plays the preeminent role in successful execution of Balance Beam skills.* Let's take a closer look.

Consider how a bird darts across the sky in rapid flight and then alights in perfect balance and control on the smallest of tree limbs, as if this complex landing maneuver had been practiced many times on that particular limb. However, we know this cannot be the case, as the many tree limbs present random environments to the bird, which must therefore employ ever-changing flight patterns in each new landing situation. Surely the bird relies heavily on vestibular (spatial orientation)

⁷ Refer to *Kinesthetic Awareness—Eye of the Storm* in chapter 9.

and proprioceptive (speed, timing, force, pressure, tension, position) feedback to accomplish these intricate tasks. However, *it is uniquely the "eyes" of the bird focusing on the intended target that provide the critical feedback for landing.* Or to put it another way, the accuracy and response of the bird's vestibular and proprioceptive systems are directly dependent upon that which the "eyes" of the bird have fixated upon. *Without first establishing the proper aim or visual frame of reference, the bird's vestibular and proprioceptive systems have a limited basis from which to respond accurately.*

This concept of first "taking aim" on the intended target also holds true for skills on the beam. The wise performer uses her eyes to "zero-in" on the proper visual frame of reference for each specific skill or sequence prior to actual execution. *Visually targeting "specific" frames of reference prior to and during execution becomes essential to ensuring accuracy of movement and absolute control of balance.*

8. Consistent Environmental Perspective

As previously noted, *it is imperative that those skills a performer anticipates using on the beam should first be thoroughly mastered on the ground.* Subsequently, many coaches and gymnasts elect to practice these skills first on a low beam and then, as the performer gains confidence, progressively raise the beam to regulation height. *Keeping the beam's height relatively close to the ground during initial skill performance appears at first blush to be a reasonable concept, as it serves to enhance not only performer confidence but also safety in the event of a mishap.*

Progressively changing the height of the beam may not, however, be the most effective training method, because it also forces the gymnast to readjust to differing environmental (height) settings throughout the learning process. As depicted in figure 10.7, *altering the beam's height during the learning process changes the performer's visual perspective and orientation relative to the ground, and thus may prove counterproductive.* Surely there must be a better way to maintain performer confidence and safety while still ensuring a consistent environmental perspective...

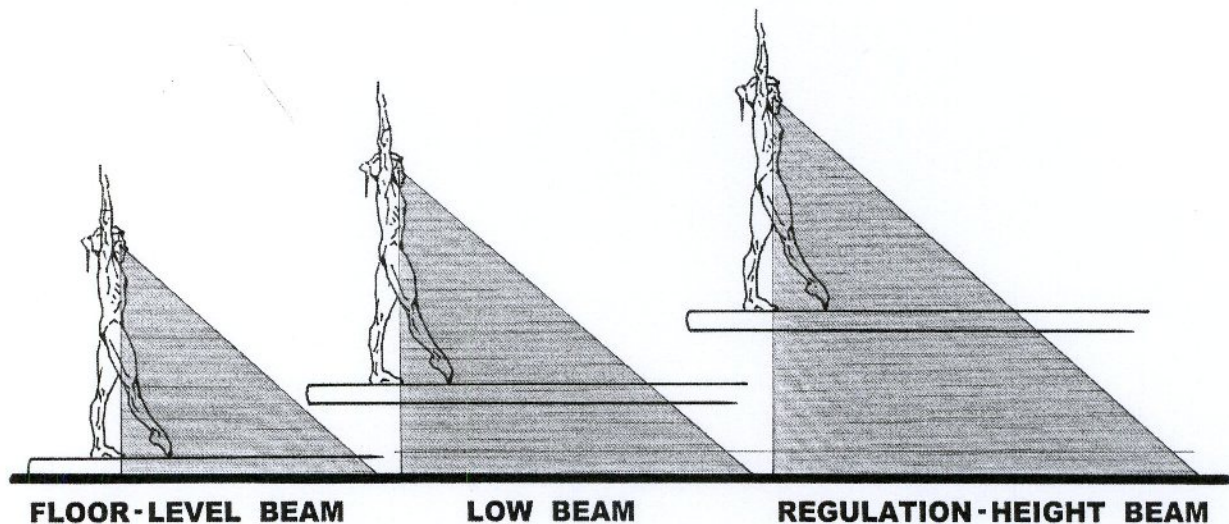


Figure 10.7. The effect of beam height on visual perspective and spatial orientation.

For example, figure 10.8 depicts a Forward Aerial Walkover on a regulation-height beam. Notice how, rather than lowering the beam to position the gymnast closer to the ground, mats are stacked longitudinally under the performing surface. *This raising of the mat surface accomplishes the same objectives (confidence and safety) as that of a lowered beam, but without significantly compromising the gymnast's environmental perspective!* As confidence and consistency in execution are achieved, the additional mats can be gradually removed until regulation mat set-up is restored.

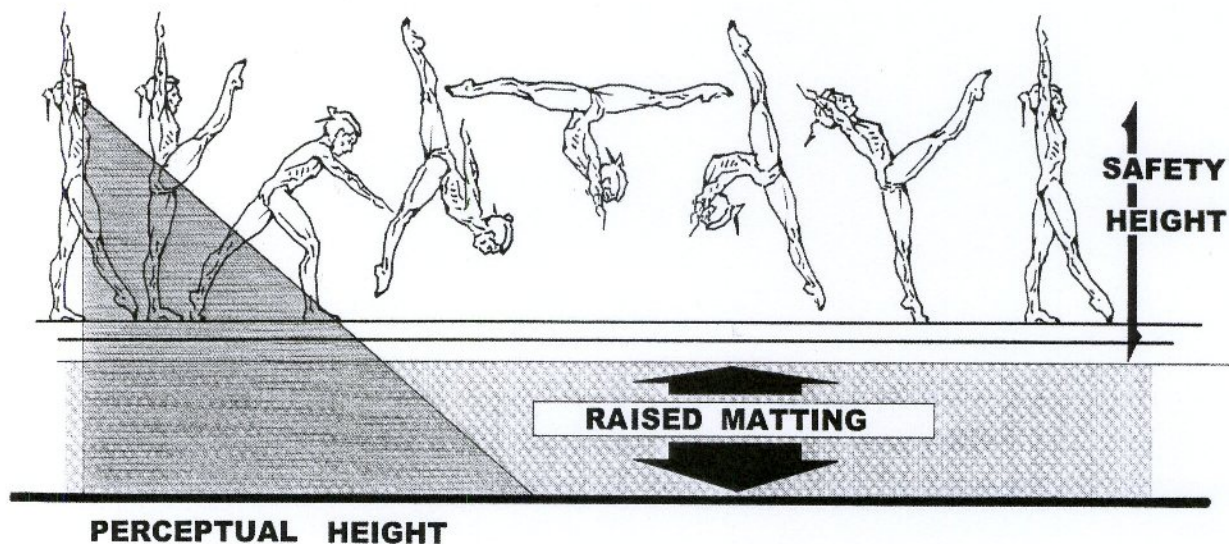


Figure 10.8. Raising the mats maintains performer confidence and safety without significantly compromising visual perspective and spatial orientation.

It is quite important for gymnasts to gain a deep-seated familiarity with the actual environment (regulation-height beam) in which the intended skills will ultimately be performed. Exposing performers to the competitive-height environment initially, rather than finally, eases the transfer of already-learned floor-level skills to the beam. By employing a regulation-height beam from the outset, the number of perceptual adjustments a performer has to make is markedly reduced. Remember: it is always more difficult to relearn that which has already been learned.

Organization hampers reorganization.

9. Progressions and Repetitions

For virtually all motor skills, *"proper selection" of progressions along with "adequate" repetitions are fundamental ingredients to successful learning.* However, the mere use of progressions and repetitions in general is not enough. Proper progressions must be carefully selected and accurately matched to the skill's objectives as well as to the unique needs of the individual performer. This implies a direct application of the *specificity-training concept, i.e., progressions and subsequent repetitions should be based on a simple-to-complex, building-block approach precisely targeted toward effective learning of the intended skill or series.* Each stage up the progressional ladder should be designed to more closely "simulate" the actual movement profile of the intended skill.

*Skill simulators
are
the infallible badge of effective learning.*

In addition, *proper skill learning on the beam requires that a significant number of successful repetitions be consistently demonstrated over extended periods of time at each progressional stage.* Consequently, a performer's "readiness" to advance to the next stage of development is not defined simply by a series of successful performances on a given day, rather it is determined by the gymnast's ability to consistently demonstrate technical excellence over an extended period of time at each stage of development. Absolute excellence in skill technique, coupled with accuracy and consistency at each progressional stage, are the only reliable litmus tests. The idea here is to *ensure learning has occurred to a point such that the actual performance reveals itself as an "unconscious habit."*

10. Smoothing the Transitions

Successful performance on the beam requires not only that the routine contain the requisite elements and sequences, but also that the performer be able to weave these movements together in a "seamless" fashion. All too often, Balance Beam performers project an unnatural, somewhat stilted style, similar to a wooden toy

soldier marching in a parade. Many of the movement sequences appear to be executed in a "cut-and-paste" fashion, like so many fragmented parts, sorely compromising the tempo and flow of the routine. And much like a very nervous guest speaker who stutters at every turn, too much time is spent "announcing" the set-up for tumbling passes and dismounts, creating "gaps" in the total performance. Worse yet, some performers even employ this "pause" between sequences to telegraph to the audience that "what you are about to witness" will be particularly difficult or spectacular! Meanwhile, the faces of the judges seem to call out:

Don't tell me what you hope to show me.

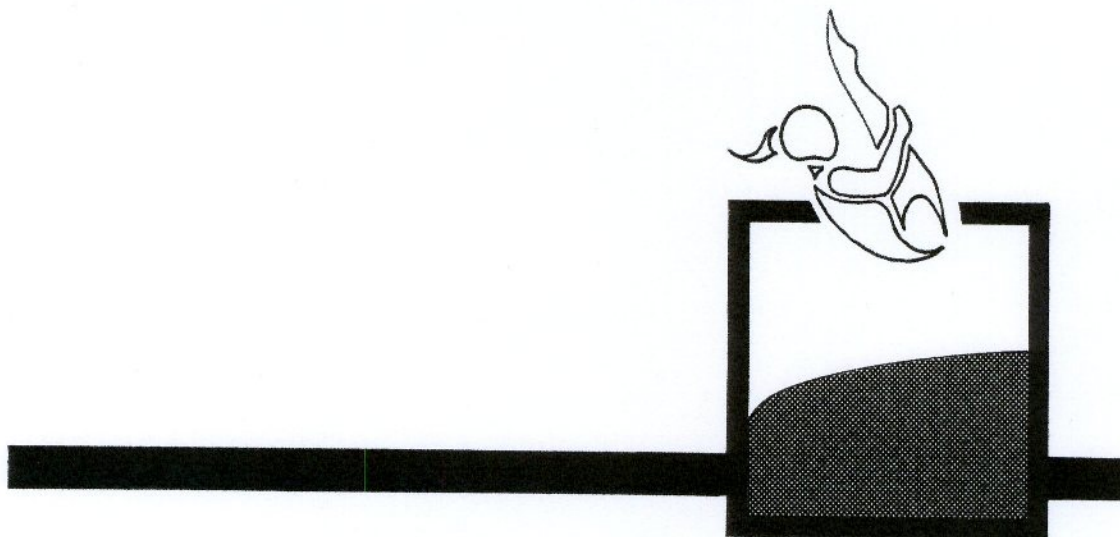
*Show me,
and let it tell its own story...*

The ability to properly connect the various sequences of a beam routine in a seamless manner can be directly attributed to "good transition skills." It is therefore imperative that gymnasts become well-grounded in dance, particularly classical ballet. In fact, *classical ballet should be an integral part of every gymnastics training program, regardless of level.* Always remember: gymnastics is dance, in a different medium.

*The next generation of Balance Beam champions
will seamlessly "weave together"
an unbroken tapestry of skills and sequences.*

CHAPTER ELEVEN

CONCEPTS OF VAULTING



*"A moment of flight filled with sound and fury,"
and then
the story is told...*

Like Balance Beam, Vaulting also has an unforgiving nature, but for different reasons. As a vault essentially involves one element, the gymnast has precious little—if any—opportunity to make corrections or adjustments during actual execution. Watching a performer accelerate down the runway, spring from the board to the vault table, and then propel herself high in the air for this “one shot” attempt at a complex multiple-somersault/twist maneuver can be breathtaking, even for the seasoned observer. Because it involves outright sprinting, immediately followed by tumbling “uphill” and the ultimate task of sticking the landing, Vaulting is considered by many to be the most exciting event in elite-level gymnastics!

*Success in Vaulting requires
the “skills” of an advanced tumbler
as well as
the “running speed” of a champion sprinter!*

Successful vaults depend fundamentally on impacting the board, the vault table, and the ground in proper sequential fashion. For this reason, *careful review of chapter 5, “The Mechanics of Impact,” cannot be overemphasized.* It provides a basic conceptual framework for optimizing execution in tumbling and vaults, with numerous examples

and illustrations of mechanical technique, e.g., trajectories, momentum, and impact for take-off, repulsion, and landing. Its review will ensure better understanding of the following.

FUNDAMENTAL VAULTING CONCEPTS

1. Minimizing the Board Setting

In the execution of any vault, the performer must pass through three airborne trajectories—hurdle, pre-flight, and post-flight—each inextricably related to the next in an immediate cause/effect fashion. Simply put, the nature and function of the hurdle trajectory directly influences the pre-flight, which in turn sets the stage for the post-flight. Because any performer, regardless of ability, has only a finite amount of energy to impart into the intended vault, it would be wise to *direct the lion's share of this energy toward maximizing amplitude in that most important of trajectories, i.e., the post-flight.*

To establish favorable environmental conditions for this endeavor, board placement in relation to the vault table is a vital consideration. Within a reasonable performance window, *the closer the board can be placed to the table, the greater the opportunity to maximize vertical and horizontal amplitude in the post-flight phase.*

Figure 11.1 shows the effect of board placement on post-flight amplitude. Because performer 1's board-to-table setting is comparatively large, some of her energy must be spent negotiating a longer-than-necessary pre-flight. As a result, her post-flight amplitude will always be something less than it could have been, regardless of her efforts. With a shorter board setting, performer 2 can better build upon the energy developed in the hurdle and pre-flight phases for that all-important post-flight phase. *The basic idea is to "squeeze down" the hurdle and pre-flight trajectories (to whatever extent possible) so that maximum amplitude in the post-flight trajectory can be achieved!*

*Vaulting trajectories are classical examples
of
"robbing Peter to pay Paul"!*

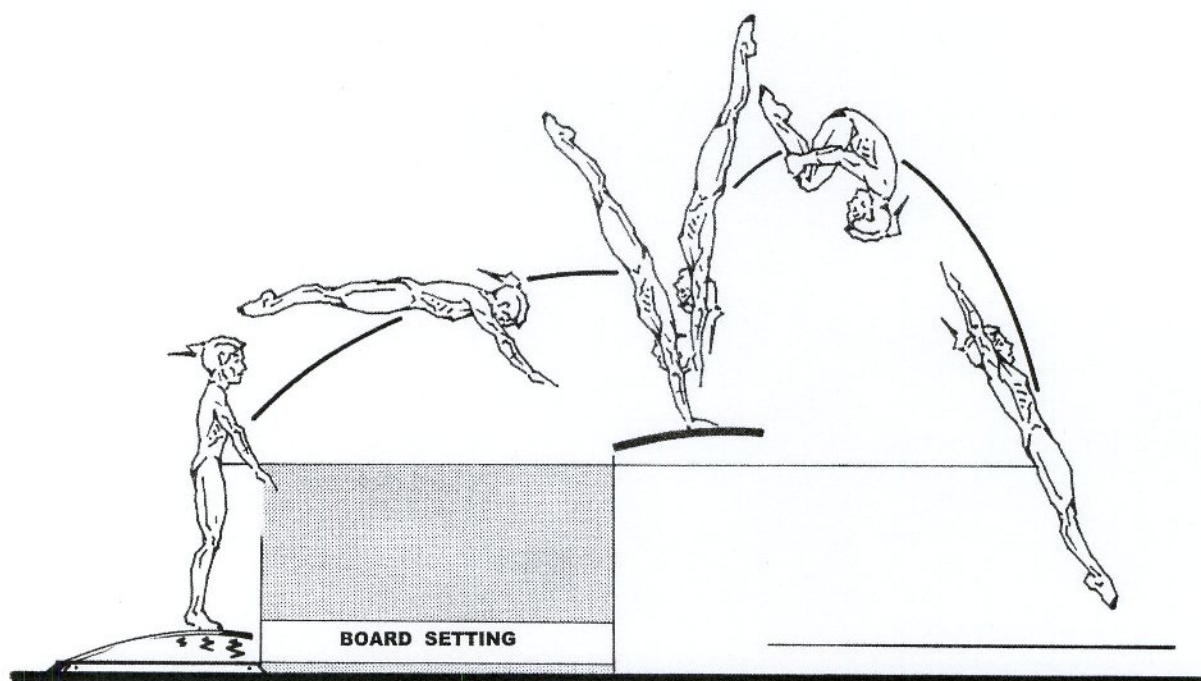
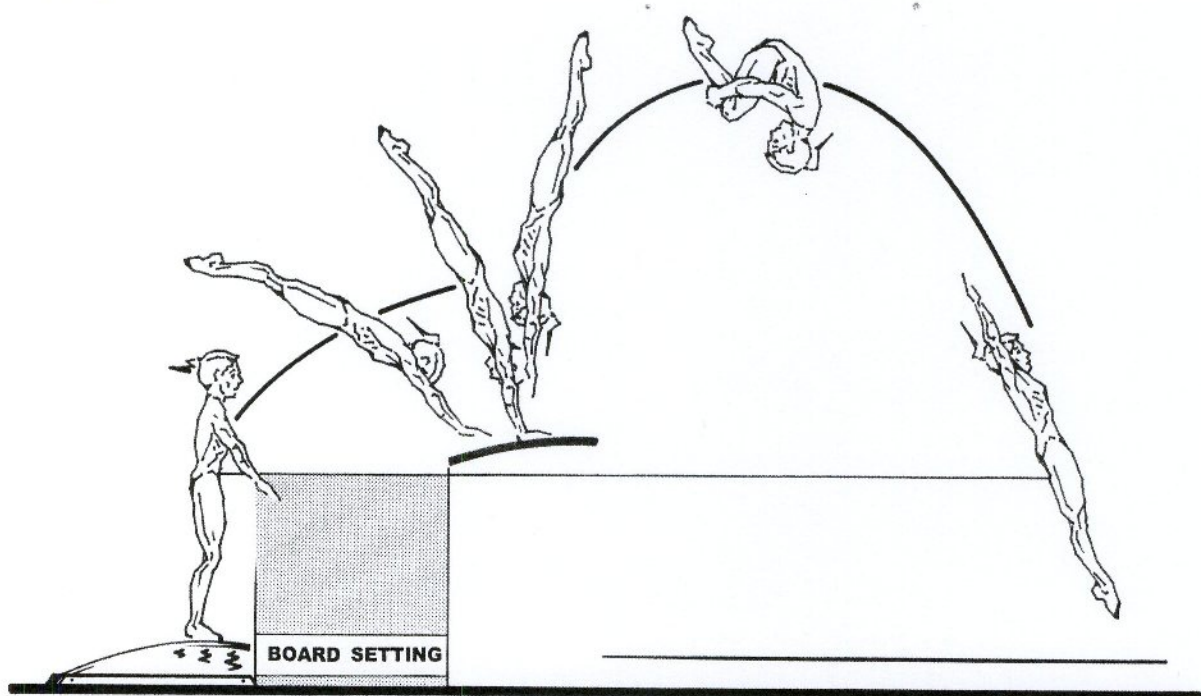
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Figure 11.1. Comparative effects of board-to-vault-table placement on post-flight amplitude in Vaulting: (1) more distance = less amplitude; and (2) less distance = more amplitude.

However it must be realized that the closer the board/vault table relationship, the faster the performer must rotate during the pre-flight phase to successfully accomplish the vault. Perhaps this explains why many performers who lack the ability to achieve sufficient pre-flight rotation compensate by positioning the board farther from the table, in an effort to garner more time for that rotation—and, perhaps, also explains why these performers find themselves unable to execute multiple-somersault/twist vaults successfully!

2. The Staircase Effect

Although Vaulting can be conceived of as a specialized form of tumbling, their mechanics are essentially the same. However, Vaulting is distinctive in that, for any given vault element, the performer is required to travel from a region of lower location (floor), to a region of higher one (board), to one of even higher (vault table) prior to landing. Just as a runner attempting to ascend a flight of stairs with great speed would want to contact each oncoming step while still rising from the preceding step, so too should the vaulter *attempt to contact the board as well as the vault table while the body is still rising in the ascent phase of the respective trajectories*, i.e., the hurdle trajectory to the board and the pre-flight trajectory to the table.

This *Staircase Effect* is readily observed in figure 11.2 by comparing the hurdle, pre-flight, and post-flight trajectories. Notice the performer makes foot contact with the board while her mass center is at—or at least very near—the apex of a short, flat, and fast hurdle trajectory. *The earlier in the hurdle trajectory the performer impacts the board, the less unwarranted downward motion she has to contend with during take-off.*

The same principle holds true for pre-flight. *The earlier in the pre-flight trajectory the performer impacts the vault table, the less unwarranted downward motion she has to contend with during actual "repulsion."* Notice the hands contact the table during the ascent of the pre-flight, so repulsion can occur while her center of mass is still rising!

*Adding an impulse to an already-rising body
is
the hidden component to championship Vaulting.*

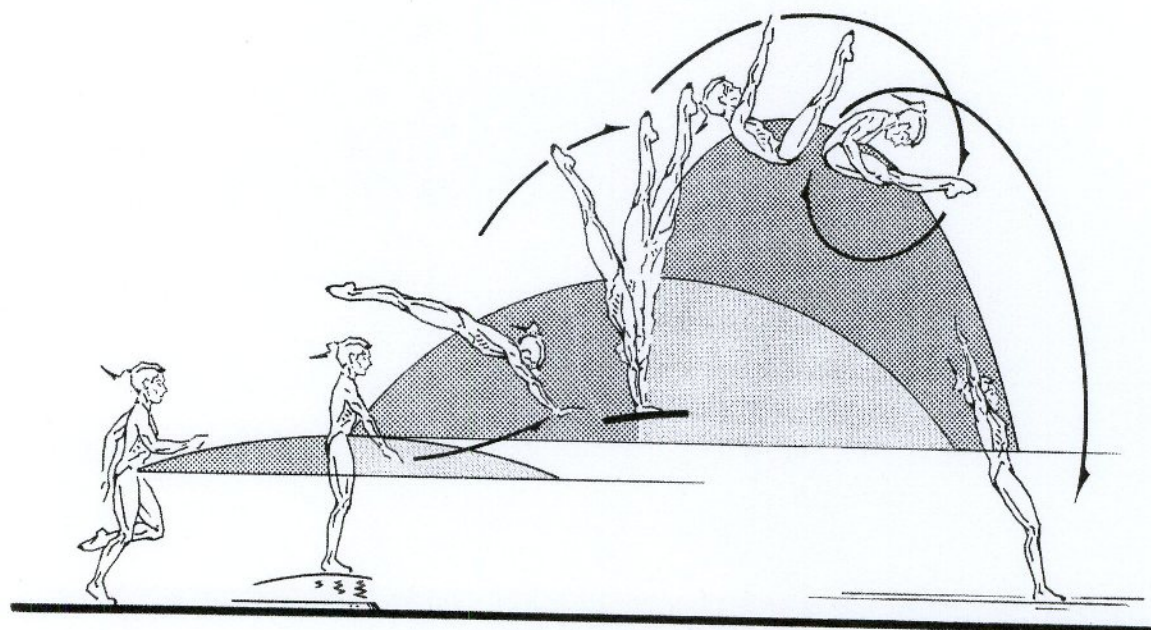


Figure 11.2. The Staircase Effect in Vaulting: adding an impulse to an already-rising body.

3. Maximizing the Run-Up Distance

The ability to accrue a large quantity of rotary motion upon board impact is an essential ingredient for successful execution of all somersault-oriented vault skills, particularly multiple-somersault/twists. As already discussed, several techniques can help to accomplish this. However, none is more effective than converting a portion of already-existing horizontal motion from the run and hurdle phases into that much-needed rotary motion for the upcoming pre-flight and post-flight phases. To put it another way, without an extremely fast run-up, there is little or no potential to generate the necessary rotation for a multiple-somersault/twist vault. Therefore, *a wise performer should achieve as much horizontal velocity as possible at the moment of board contact.*¹

One variable critical to maximizing horizontal velocity at board impact is the running distance. As depicted in figure 11.3, the vaulter should take advantage of the entire runway in her approach. By fully using the runway, she has more distance and therefore more time to maximize her run speed. Considering world-class sprinters are unable to achieve top speeds in less than 30 meters, gymnasts obviously cannot accomplish their maximum sprint speeds when confined (by the rules) to a runway of some 25 meters! However, *by using the largest-allowed runway distance, the performer at least enjoys the best opportunity to maximize her horizontal velocity at impact.*²

¹ Refer to *Converting Horizontal Motion into Rotary Motion* in chapter 5.

² The actual "start position" for the run-up will vary slightly for each individual performer so that an accurate step-up and impact with the board can be achieved.

Go the distance!

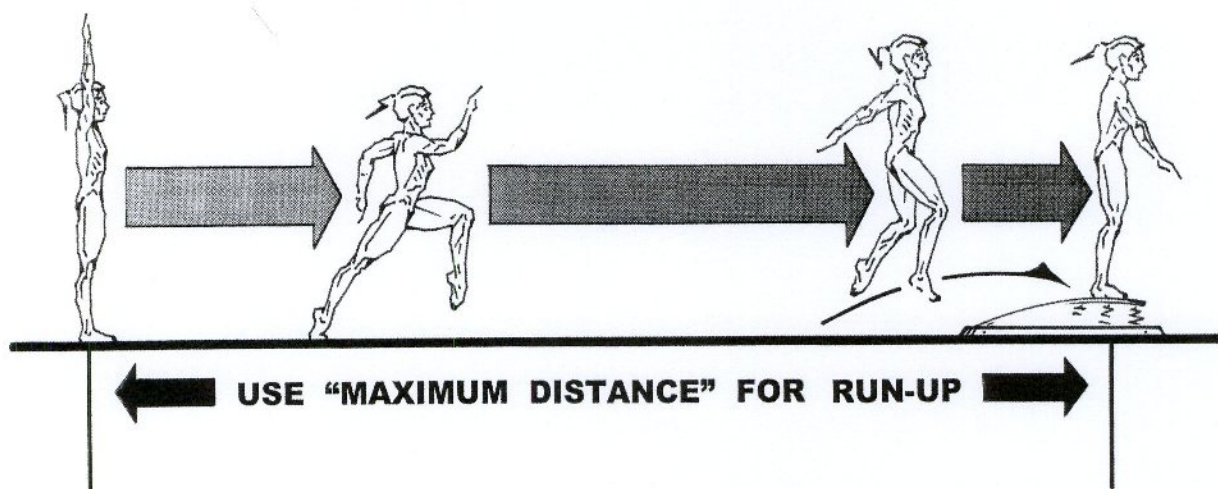


Figure 11.3. Employing a large run-up distance in Vaulting provides the best opportunity to maximize horizontal velocity at impact.

However, some performers elect to shorten the run-up distance, hoping to gain an additional measure of control during the hurdle onto the board. This compensatory technique may ease the burden of kinesthetic awareness and thus improve board-contact accuracy, but always at the expense of reducing that most critical variable—running speed. All things considered, it is more important to recognize that *employing less than the maximum run-up distance indicates insufficient training and experience in all-out sprinting, a fundamental prerequisite to transcend current levels of championship Vaulting.*

4. Training for Sprint Speed

Because *ultimate success in vaulting requires maximum controlled horizontal velocity at take-off*, it seems reasonable that gymnasts would therefore strive to run as fast as mechanically possible during the approach to the board. However, they seldom do. Besides having to deal with maximizing speed within a restricted runway distance, the gymnast is also confronted with the daunting task of accurate foot impact with the board. And failing to ensure proper board contact—or worse, missing it entirely—is an insidious safety concern that looms heavy in the psyche of gymnasts at all levels.

Vaulters instinctively know that as their running speed “increases,” their awareness and/or accuracy of board contact “decreases.” However, those fortunate gymnasts who specifically train to become intimately familiar with all-out sprinting develop an increased kinesthetic awareness of precisely “where their feet are” at every phase in the run, and therefore tend to run closer to their maximum capability.

Consequently, this "speed-versus-accuracy" dilemma can be significantly remedied by emphasizing sprint running as an integral component of every gymnastics training program.

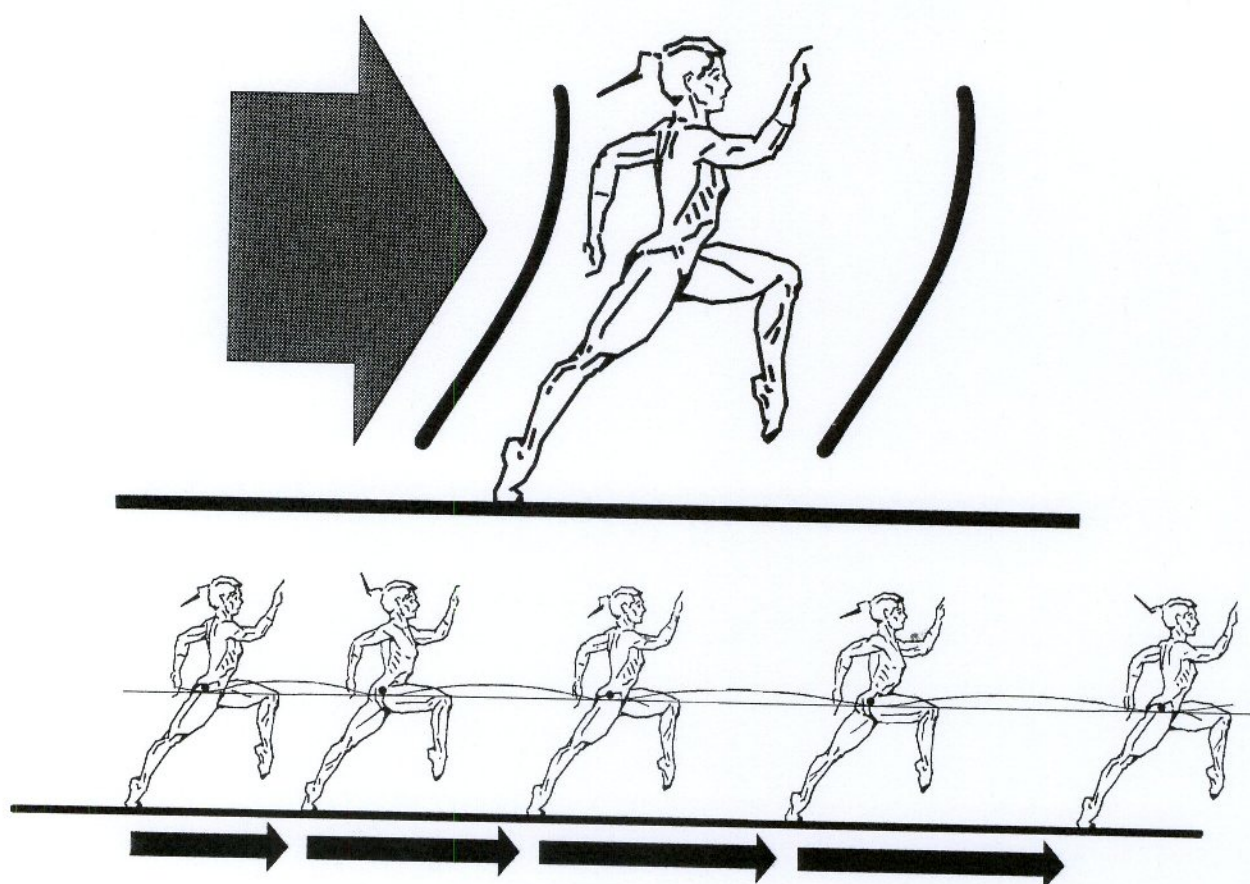


Figure 11.4. The classic running posture of an elite-level sprinter.

An ongoing program of outright sprint running (40-yard dashes) is perhaps the least employed yet most effective training protocol for improving running speed while also enhancing kinesthetic awareness of legs and feet. Figure 11.4 illustrates the classic running posture of an elite-level sprinter. Although every attempt should be made to stand as tall as possible during the run phase of a vault, notice the *airborne trajectory of each stride is very flat relative to the horizontal*. It is true that sprinting style varies and is performer-specific—however, the techniques for effective sprinting provided in table 11.1 are applicable to all athletes.

TECHNIQUES FOR EFFECTIVE SPRINTING

- Stand tall with a slight forward lean when sprinting;
- Keep head and trunk upright. Lead with the mid-section of the body;
- Keep elbows flexed (approximately 90°) and churning;
- Relax the head, neck, upper torso, shoulders and arms;
- For each successive drive-leg, the foot should contact the ground "almost" directly underneath body.
- Push through to full extension with drive-leg while simultaneously swinging recovery-leg forward with deeply flexed knee; and
- Make every effort to keep the successive airborne trajectories flat and smooth.

Table 11.1. Techniques for effective sprinting.

5. Hitting the Mark

An already-established, reliable run pattern is a fundamental prerequisite to "accuracy" of board-contact. Without this attribute already in place, "the best-laid plans of mice and men" will not ensure consistently accurate contact with the board. Consequently, the wise coach requires performers first to demonstrate a consistent, and therefore predictable, high-speed run pattern, which can then be used to establish specific "start" and "hurdle" locations on the runway for the intended vault. In so doing, the probability of consistent, accurate board contact markedly increases.

Depending on the nature of the intended vault, figure 11.5 depicts *the two basic approaches employed: the forward (traditional) approach*—from a run and hurdle onto the board; and *the backward (Round-Off or Yurchenko) approach*—from a run, hurdle, and Round-Off onto the board. Although the outcomes are diametrically opposed body orientations relative to the vault table, *a number of set-up techniques can enhance board-contact accuracy in both approaches*, as listed in table 11.2.

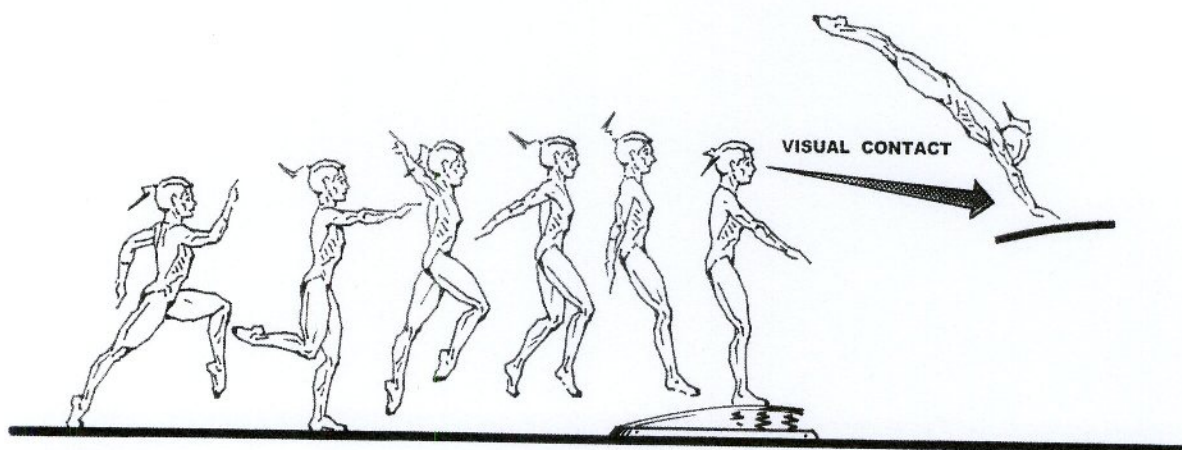
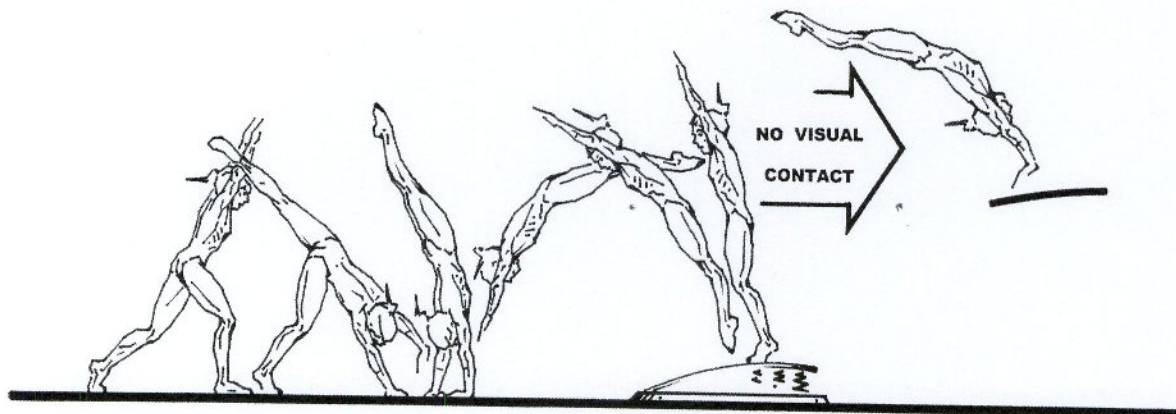
**No. 1****No. 2**

Figure 11.5. The two basic approaches in Vaulting: (1) forward (traditional) approach; and (2) backward (Round-Off or Yurchenko) approach.

While these techniques to enhance board contact should be applied to both approaches, the Yurchenko entry is clearly the more complex and challenging in that it entails having to execute a Round-Off accurately onto the vaulting board from a high-velocity run. A Round-Off entry involves not only a complete change in direction (backward instead of forward) but also an inversion of the body (feet-to-hands-to-feet) to make contact with the board.

Although the introduction of the new "vault table" in place of the old "side-horse" allows for a significantly greater margin of error, the fact remains that the backward entry not only makes accuracy of board contact more difficult to achieve but also it involves a "blind" pre-flight phase. Consequently, *the Round-Off entry requires an extensive series of relevant lead-up progressions normally reserved for the more advanced gymnast.*

TECHNIQUES TO ENHANCE ACCURACY OF BOARD CONTACT

- Establish a consistent “stride-length/stride-frequency” leg pattern that is most efficient for your particular style of sprinting;
- Carefully mark-off and employ specific “start,” “hurdle” and/or “hand placement” locations relative to the board that compliment your running profile;
- Always initiate the run off the same foot;
- Carefully determine the optimum number of sprint-steps needed to insure maximum execution of the run and hurdle phases;
- Initiate the run using a “soft” but deliberate approach, gradually accelerating at a smooth, even rate into an all-out sprint;
- Remember the objective at board contact is not to simply achieve maximum sprint velocity, but rather to achieve a maximum controlled sprint velocity.

Table 11.2. Techniques to enhance accuracy of board contact in Vaulting.

6. Board-Impact Techniques

Regardless of the approach type, it is interesting to discover *striking similarities in body carriage as well as angles of input (blocking angles) upon board impact*. In both examples in figure 11.6, notice the performer’s body shape upon impact has her trunk (upper body) assuming an upright posture, with her mass center positioned at an angle “short” of the vertical as her legs and feet (lower body) make board contact. *The optimum blocking angle depends on several factors, including the vaulter’s relative size and capability, hurdle trajectory shape, and realized running speed at impact.*³

Although establishing the proper angle of input appears to be confounding, with judicious practice it becomes quite simplistic. For example, if a performer achieves the desired—short, flat, and fast—hurdle trajectory but then employs a comparatively large blocking angle at board contact, this not only contributes to a higher-than-necessary pre-flight but also costs precious pre-flight rotation. However, if the angle of input is incrementally decreased over time, the pre-flight trajectory becomes comparatively flatter, while the resulting rotary motion markedly increases.

³ Refer to *Optimizing the Angle of Input for Take-Off* and *The Angle of Input* in chapter 5.

And achieving a "rapidly rotating total body unit" traveling through a "short, flat, and fast pre-flight trajectory" is the essential set-up for optimizing virtually all elite-level vaults!

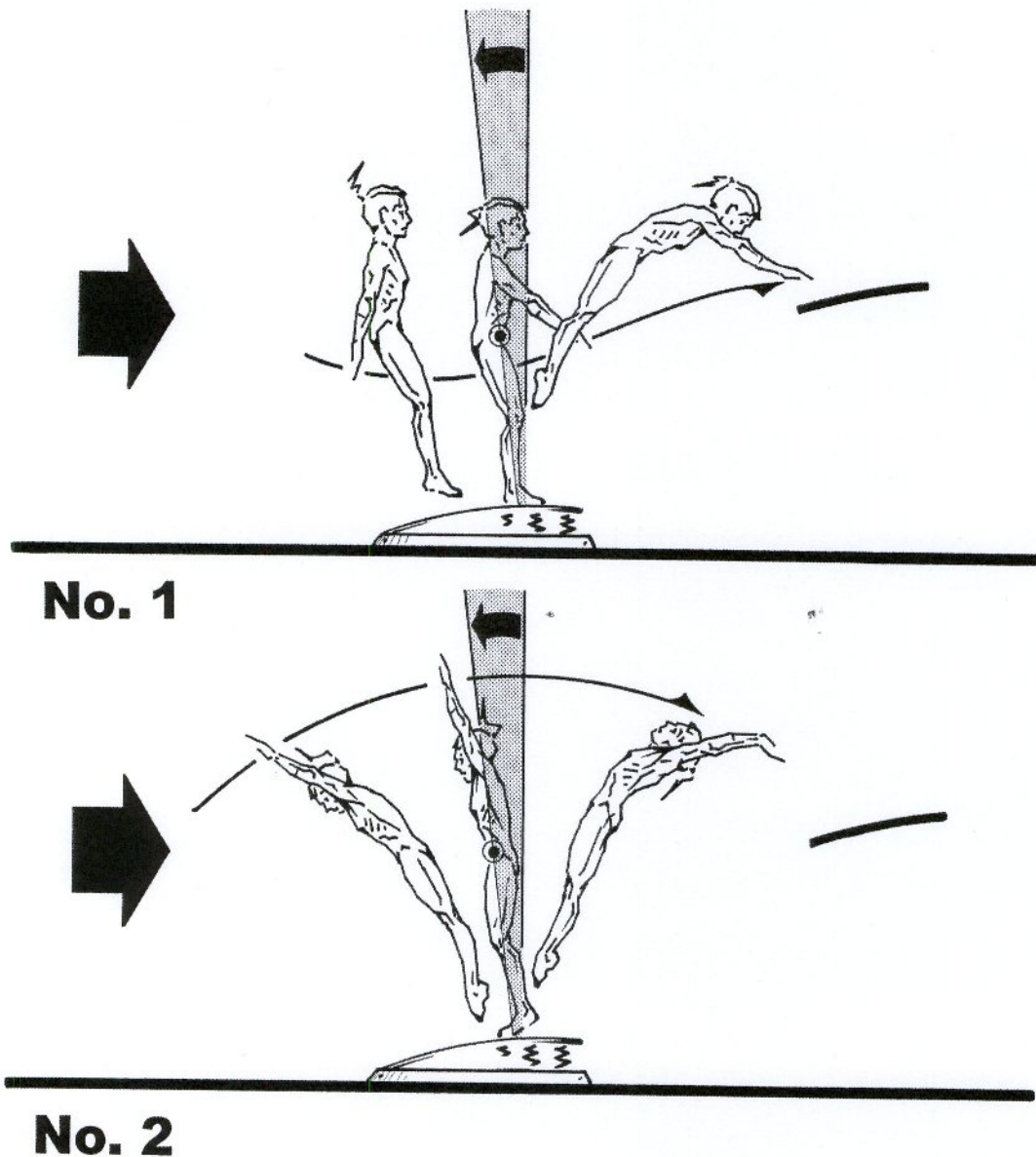
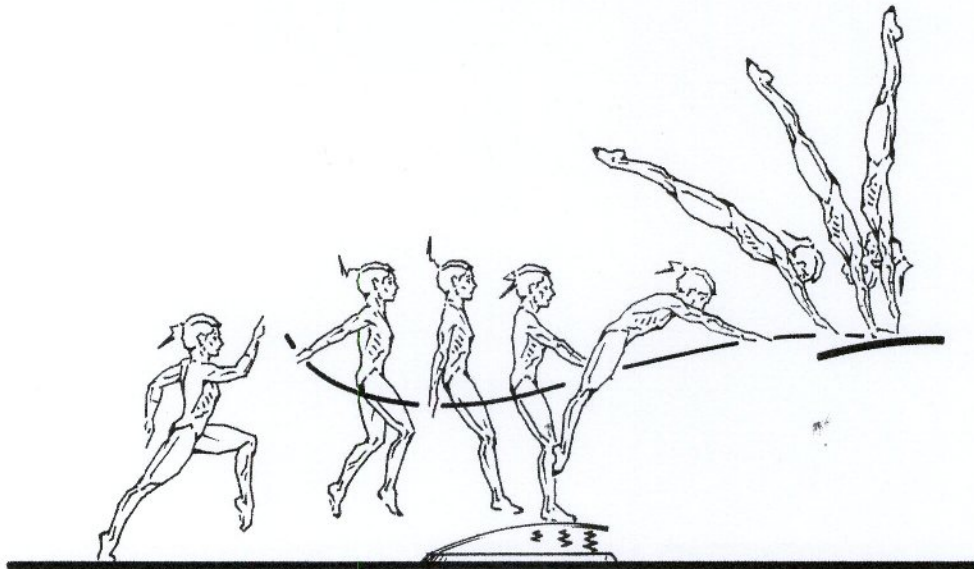


Figure 11.6. Body posture and angle of input at board contact in Vaulting: (1) forward (traditional) approach; and (2) backward (Round-Off or Yurchenko) approach.

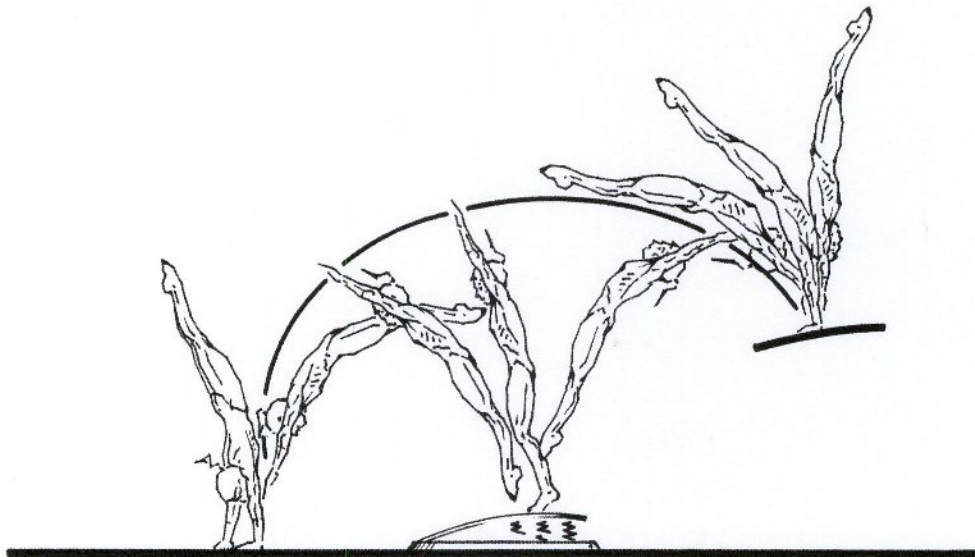
During the impact, every effort should be made to stand as tall as possible while exploding into the board using a rapid and forceful extension of the hips, legs, and feet. Rather than simply landing on the board, the idea is to deflect it as deeply as possible within the shortest period of time, so its momentarily-stored energy can be instantaneously employed to facilitate "lift." Notice also the vigorous arm-swing action to the vault table is initiated prior to board contact in both the forward and backward approaches.

7. Take-Off and Pre-Flight

As we have discovered, the four primary factors that serve to establish an effective take-off are: 1) a short, flat, fast hurdle trajectory onto the board; 2) minimizing the angle of input; 3) standing tall and exploding into the board at contact; and 4) initiating a vigorous arm swing directly to the vault table prior to board contact. These motion characteristics are the primary building blocks for maximizing the "Staircase Effect," an effect so essential to optimum execution of every vault.



No. 1



No. 2

Figure 11.7. Proper take-off and pre-flight mechanics in Vaulting: (1) forward (traditional) approach; and (2) backward (Round-Off or Yurchenko) approach.

Figure 11.7 compares take-off and pre-flight mechanics for both vault approaches. In the forward approach, notice how performer 1 gathers her arms during the hurdle phase and continues driving them directly to the vault table. In the backward approach, notice how performer 2 lifts her arms off the runway and continues driving them directly to the table. Of particular interest are the timing, speed, and direction of these arm-swings. Regardless of approach, *the arm-swing action: 1) actually begins early in the hurdle; 2) is forceful and deliberate; and 3) travels directly to the table.* The basic concept of "early vault-table arrival with the hands for effective take-offs" is parallel to "early ground arrival with the feet for effective landings." Champion vaulters become well aware that:

*Every effort must be made to get one's hands to the vault table
before the rest of the body actually arrives!*

8. Hand Impact and Repulsion

With a short, flat, fast pre-flight trajectory, an instantaneous hand contact with the vault table, and a rapidly rotating total body unit, the stage is set for optimum execution of the most important phase—the post-flight. Optimizing post-flight now depends on what occurs during the hand impact and repulsion from the vault table.

To demonstrate again how the similarities in gymnastics technique far outweigh the differences, figure 11.8 depicts hand impact and repulsion from the vault table in both the forward and backward approaches. Regardless of approach, notice that the hand-impact/repulsion phase is very much like the leg-impact/take-off phase—except, of course, the performer must use her upper limbs to exert the forces necessary for additional lift and rotation. And just as the pelvic girdle is the genesis of "lift" in all leg-oriented impacts, the shoulder girdle serves as the performer's prime mover for generating "lift" from the hands. Consequently, *every effort should be made to explode into the vault table primarily through rapid, forceful elevation of the shoulder girdle.* And like the leg action observed at take-off from the board, *this impact action should be hard and fast.*⁴

The lifting effect of explosive shoulder girdle elevation should be accompanied by a second, equally important action, i.e., retraction or protraction. Because performer 1 is rotating *forward* at hand impact, her shoulder girdle should move *from protraction into retraction*. By comparison, performer 2 is rotating *backward*, and therefore her shoulder girdle should move *from retraction into protraction*. This additional, yet subtle shoulder girdle action further enhances the already-existing rotary motion of the total body unit, setting the stage for maximum transfer of momentum.⁵

⁴ Refer to *Patterns of Motion—The Kinetic Chain* in chapter 7.

⁵ Refer to *Hand Impact and Repulsion* in chapter 5.

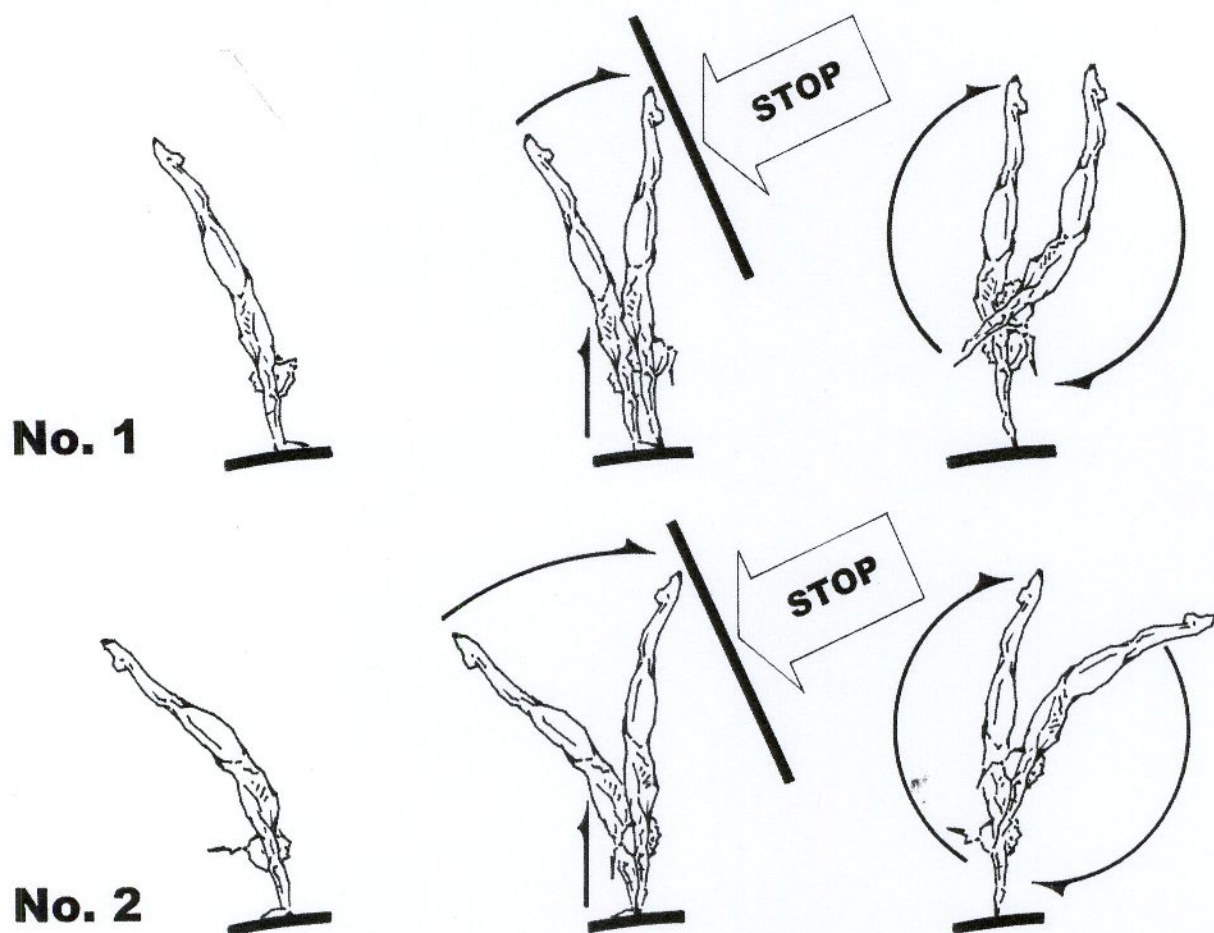


Figure 11.8. The hand-impact/repulsion phase in Vaulting: (1) forward (traditional) approach; and (2) backward (Round-Off or Yurchenko) approach.

It is also important to emphasize that the principles for *optimizing the angle of input at hand impact with the table are fundamentally the same as those presented earlier for foot impact with the board.*⁶ For example, notice that both performers assume a slightly curved body shape at initial contact, using an angle of input short of the vertical. Assuming optimal conditions are met in all the preceding phases, the actual amount or degree of blocking action becomes dependent on the nature and objective of the intended vault.

Simply put, in single-somersault vaults, the blocking angle should be comparatively large, thereby maximizing "lift." However, *for elite-level vaults, the blocking angle onto the vault table should be somewhat closer to vertical to ensure that a sufficient quantity of rotary motion is generated for effective for execution of multiple-somersaults.*

⁶ Refer to *Optimizing the Angle of Input for Take-Off* in chapter 5.

Although the duration of hand contact is quite brief, both performers in figure 11.8 employ the same techniques to ensure effective transfer of momentum. As the hands touch-down in the forward approach (example 1), the total body unit "swings" from a slightly hollowed to a slightly arched shape. The backward approach (2) uses the mirror-image action, swinging from a slightly arched to a slightly hollowed shape. For both examples, notice this quick swing is instantaneously "stopped" *while the hands are still in contact with the vault table*, thereby transferring momentum effectively from the hips, legs, and feet into the entire body. *This timely stopping of the leg drive relative to the body during hand contact maximizes the post-flight rotation of every vault.* Keep in mind:

*A rapidly rotating body, rising near-vertically off the vault table,
serves as compelling evidence that
the momentum has been effectively transferred!*

9. Shaping the Post-Flight Trajectory

As discussed, the shape of every parabolic trajectory is determined by the relative amounts of horizontal and vertical motion that it possesses.⁷ For example, a post-flight trajectory characterized by more horizontal than vertical motion prescribes a comparatively flat, long path, whereas with more vertical and less horizontal motion, the resulting trajectory prescribes a high, short path. And in terms of the ability to stick a dismount, *a post-flight trajectory characterized by less rather than more horizontal velocity is easier to control at touch-down.* Consequently, within the window of successful performances, *the shape of the post-flight trajectory has a direct bearing on the "ease" with which a performer can "stick" the landing.*

To demonstrate the concept, figure 11.9 compares two successful performances of a Forward Handspring-Double Forward Somersault Vault. Notice performer 1 employs a post-flight trajectory that is somewhat flatter and therefore longer than that of performer 2. Not only does this compromise the potential height in the post-flight phase, but it requires the performer to deal with an additional measure of unwarranted *horizontal motion* at actual touch-down. And *because horizontal motion increases rotary potential at touch-down, the ability to control and therefore "stick" the landing is compromised.*

By using a comparatively higher and therefore shorter trajectory, performer 2 is able to maximize the most important motion component, i.e., "height," while still landing beyond the required minimum clearance distance (1-meter) from the vault table. This realization becomes particularly compelling in light of the fact that vaulters are penalized more heavily for lack of height than for lack of distance in the

⁷ Refer to *Trajectory* in chapter 5.

post-flight phase—which makes perfect sense, as “height” is always more difficult to achieve than “distance.” Ask any high-jumper or long-jumper, for that matter!

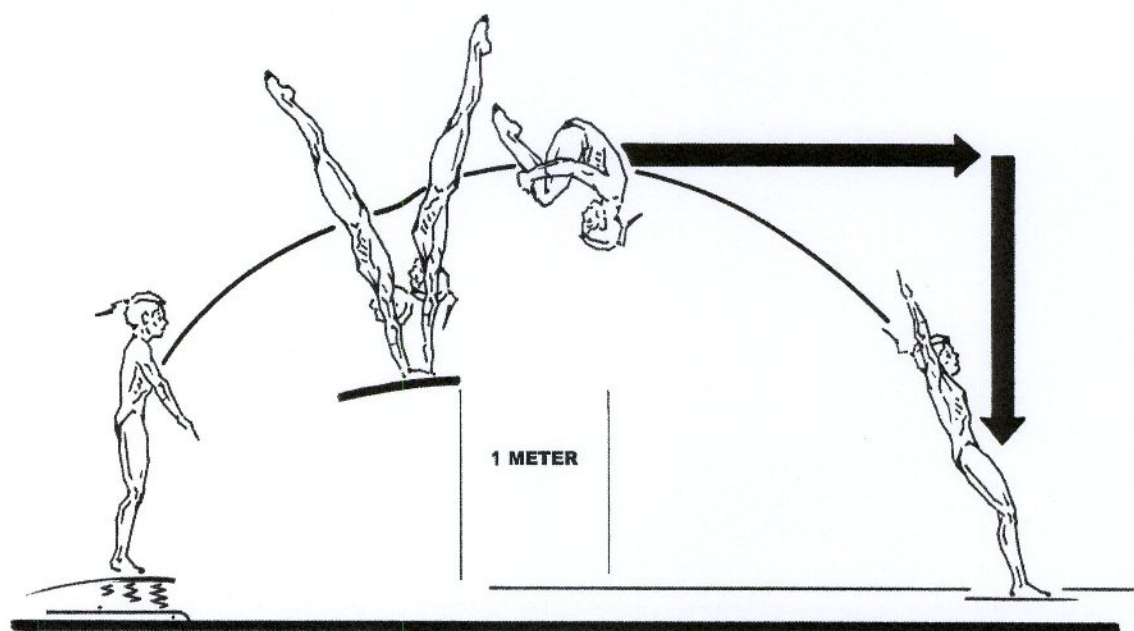
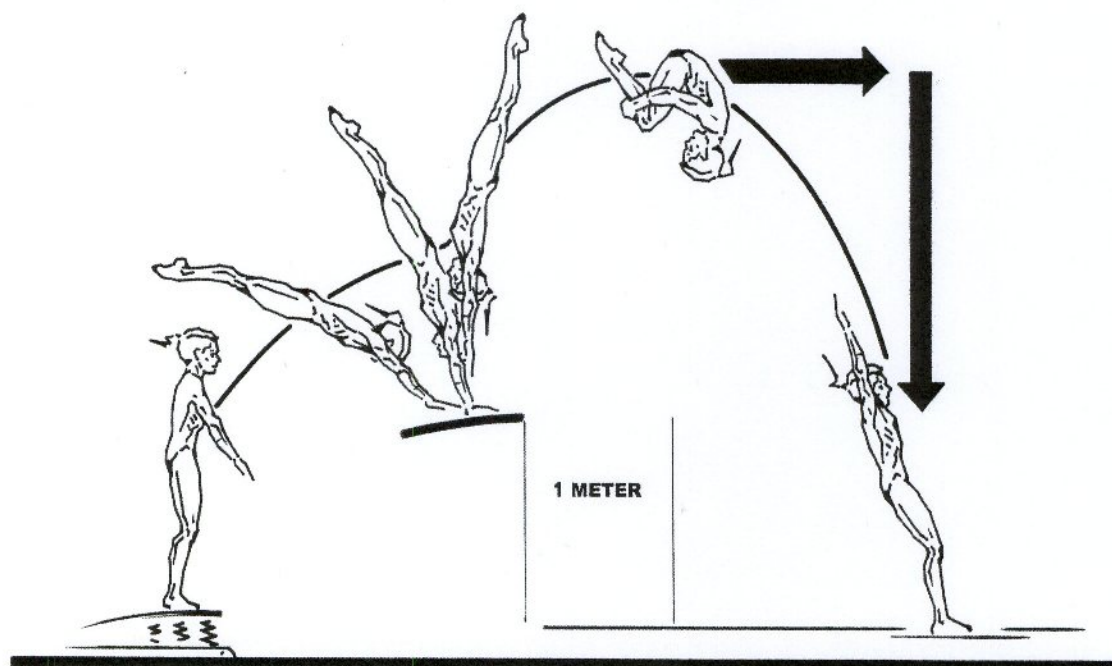
**No. 1****No. 2**

Figure 11.9. Comparative effects of post-flight trajectory on “ease” of sticking the landing for a Forward Handspring-Double Forward Somersault Vault: (1) flatter, longer trajectory = harder to stick; and (2) higher, shorter trajectory = easier to stick.

Remember, a trajectory that is comparatively "higher and shorter" allows the body to follow a more vertical path at touch-down, thereby minimizing unwarranted horizontal motion. And just as we have learned the importance of maximizing horizontal motion at impact to facilitate rotation at take-off, so too should we appreciate the importance of minimizing horizontal motion at final touch-down in order to better control the landing.⁸ With less horizontal motion at touch-down, the performer enjoys a better opportunity to stick the landing.

While it might be argued that employing a high, short trajectory causes the performer to land with greater vertical force upon impact, the fact remains that *when it comes to sticking an upright landing, the vertical component is always easier to control than the horizontal*. To the extent possible, every attempt should be made to:

*Shape the post-flight trajectory so the performer can
"drop into" rather than "breeze by"
the landing.*

10. Sounding the Rhythm

Every vault starts out "quietly," with the performer standing on the runway at considerable distance from the vault table. Initially slow and deliberate, the run quickly evolves into a uniformly accelerated sprint to the board. Properly executed, this run pattern accelerates to a maximum controlled velocity by the time the performer reaches the board. *By "listening carefully" to the cadence of the feet contacting the ground during the run-up, the quality of this effort becomes readily apparent.*

As depicted in table 11.3, if the tapping sounds occur further and further apart, the performer is decelerating—this is *not* characteristic of well-executed vaults. However, if the interval between the foot-impact sounds grows progressively shorter, the performer is accelerating. Simply put, *a properly executed run-up emits a tapping sound of the feet that occurs earlier with each successive step toward the board.*⁹

⁸ Refer to *Fundamental Tumbling Concepts* in chapter 9.

⁹ This assumes the performer is reasonably well-trained and is therefore not cutting or "chopping" her steps as she approaches the board.

SOUNDING THE CADENCE OF THE RUN-UP

- 1) poor - START...tap...tap.....tap.....tap.....tap.....tap.....tap.....BOARD
- 2) fair - START.....taptap.....tap.....tap.....tap.....tap.....tap.....BOARD
- 3) good - START.....tap.....tap.....tap.....tap.....tap.....tap.....tap...BOARD

Table 11.3. Sounding the cadence of the run-up to the board: (1) decelerating run-up = poor; (2) barely accelerating run-up = fair; and (3) accelerating run-up = good.

Furthermore, the quality and effectiveness of the actual vault itself can also be accurately evaluated simply by "listening carefully" to the specific cadence of the sounds produced as the performer contacts the board, then the vault table, and finally the landing mat. As depicted in table 11.4, the shorter the interval between board and vault-table contact and the longer the interval between vault-table and landing contact, the better the vault, regardless of kind.

SOUNDING THE CADENCE OF THE ACTUAL VAULT

- 1) poor - BOARD.....VAULT TABLE.....MAT
tap.....tap.....tap
- 2) fair - BOARD.....VAULT TABLE.....MAT
tap.....tap.....tap
- 3) good - BOARD.....VAULT TABLE.....MAT
tap.....tap.....tap

Table 11.4. Sounding the cadence of the actual vault, from board to vault table to mat: (1) too long in pre-flight = poor post-flight; (2) somewhat shorter pre-flight = fair post-flight; and (3) short pre-flight = good post-flight.

*Why, even a blind man can "see" the quality of execution
by simply listening
to the cadence of the movement sequence!*

For example in figure 11.10, proper execution of a basic Yurchenko Vault requires that the time interval between board contact and vault-table contact to be as small as possible so that the time interval between vault-table contact and mat contact can be as large as possible. Such a comparative tempo in these contact intervals reveals that the "Staircase Effect" has indeed occurred and that the post-flight has been blessed with that most important of qualities, i.e. "lift."

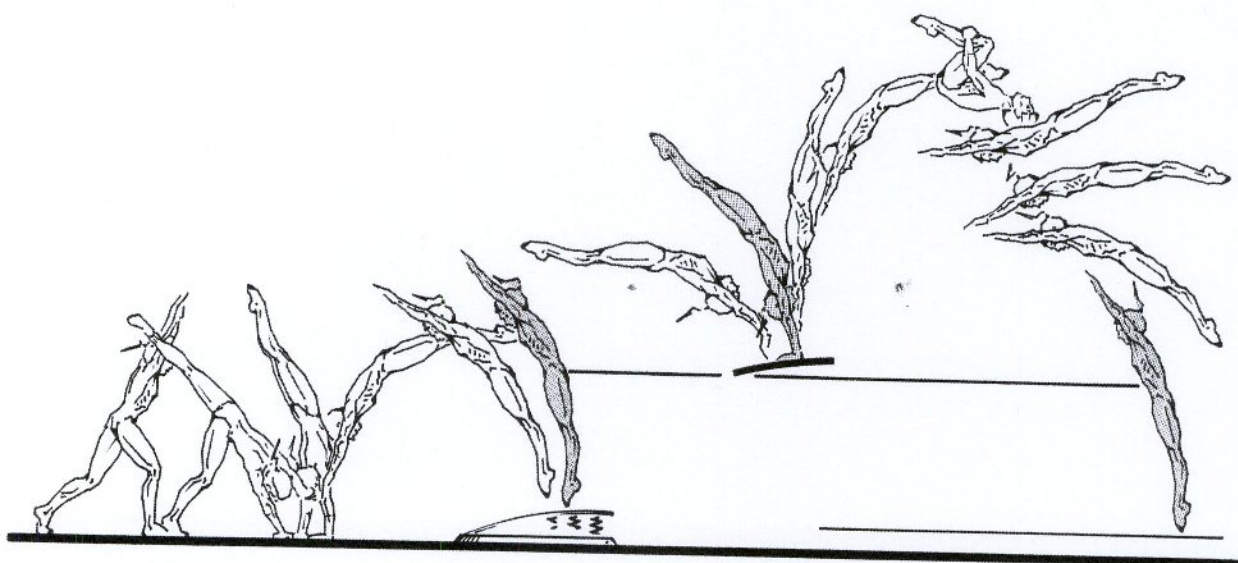


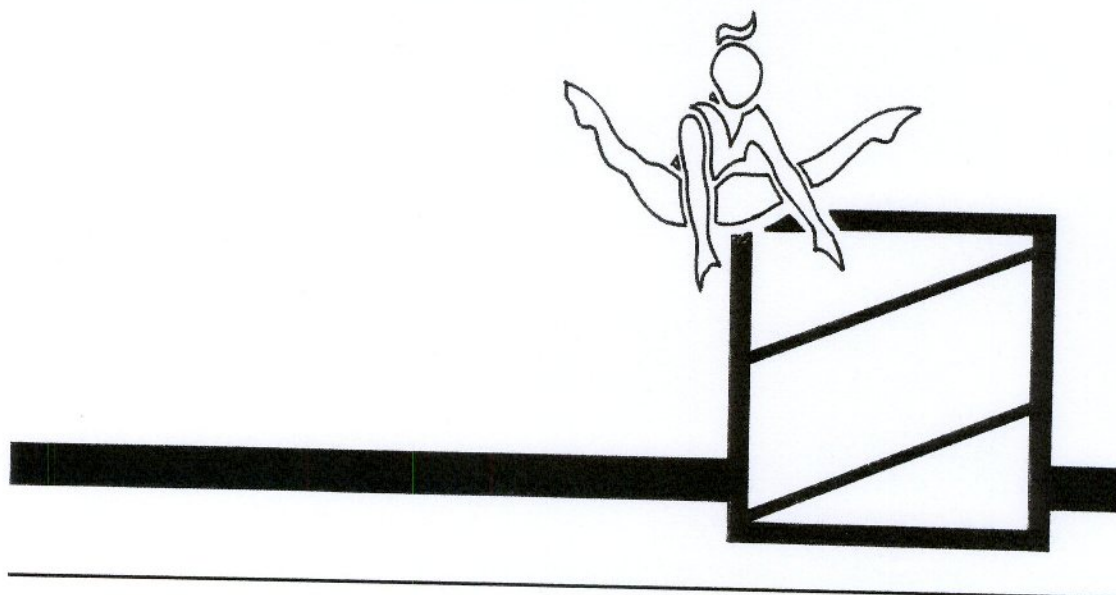
Figure 11.10. An ideal model for a Yurchenko Vault.

Always keep in mind:

*Each vaulter sounds out her own unique story
by the tapping rhythms produced
from start to finish.*

CHAPTER TWELVE

CONCEPTS OF UNEVEN BARS



*The farther away you get,
the closer you are to home...*

The women's Uneven Bars event is similar to the men's Horizontal Bar event, as both are entirely swing-oriented and involve essentially the same types of skills. However, *the Uneven Bars is clearly more the complex and challenging event, because it requires the gymnast to interface about two rails of differing heights.* In addition, the larger-diameter rails make these intricate release/regrasp moves somewhat more difficult, particularly in light of the hand-size difference between the typical male and female gymnast. Because the performer must blend elite-level swing skills back and forth about these rails, many consider the Uneven Bars the most exciting event in all of artistic gymnastics!

To gain a more comprehensive insight into the following concepts, *a thorough review of chapter 4, "The Mechanics of Swing," is highly recommended.*

FUNDAMENTAL UNEVEN BARS CONCEPTS

1. Swinging—A Closed-Loop System of Kinesthetic Awareness

Swinging is similar in some respects to airborne somersaulting, but has at least two distinct differences, both related to kinesthetic awareness. Swing skills involve the total body unit circling by the hands about a fixed axis of rotation, whereas somersaulting involves the entire body rotating about its center of mass as it travels

freely through space. *Because the performer on the bars has continuous hand contact with a fixed axis, "swinging" can be defined as motion in a "closed-loop" system.* In other words, being "tied" to a stable frame of reference gives the performer additional cues to enhance kinesthetic awareness and spatial orientation—cues not available in the "open-loop" system of somersaulting. Of course, this advantage is predicated on knowing how, where, and when to employ these frames of reference.^{1,2}

Despite each swing skill's unique characteristics, it is fair to say all skills on the bars have four visual frames of reference in common: the bar, ground, walls, and ceiling. While the ground is invariably the ultimate frame of reference, the apparatus can be considered part of—or better said, an outgrowth of—the ground. This is because the performer's hands remain affixed to the ground-stabilized apparatus throughout the swing. For this reason, the performer should *focus on the bar as the primary "gun sight" through which to interpret the other frames of reference for enhanced kinesthetic and spatial awareness.* In so doing, she enjoys a better opportunity for a more precise "fix" on her body orientation relative to the ground.

*Like the airplane pilot performing complex aerial maneuvers,
the gymnast should focus intermittently
on fixed frames of reference.*

2. Dancing with the Bars

Because the rails of the uneven bars are "elastic" in nature, they not only bend (deflect) according to the amount and direction of the forces applied but also return quickly (restitute) to their original shape once these forces terminate. This bending or "loading action" in the bar serves to momentarily store energy that can—and should—be employed for the very next phase of the movement. And as discussed, *it is the body's internal-swing movements that largely determine the direction and degree of deflection/restitution in the bar rail.* This elastic property is not only critical to optimum execution of all giant swing skills but can also facilitate on-bar "cast-oriented" skills.

For example, the Cast to Handstand in figure 12.1 illustrates precisely "how" the bar responds when a proper "cast-action" is applied. The performer starts in a loaded or piked front-support position with the body's upper and lower halves tightly wrapped about the bar (illustration A). Notice that *the shoulder girdle is fully elevated and remains so through the entire skill.* A forceful, vigorous hip-joint extension not only drives the legs and feet in a back-upward direction but also simultaneously presses the pelvic girdle against—and therefore loads—the bar in a fore-downward direction (B). The depressed bar (*deflection*) indicates energy has been momentarily stored for immediate use in the upcoming rise to the handstand.

¹ Refer to *The Sixth Sense* in chapter 3.

² Refer to *Kinesthetic Awareness—Eye of the Storm* in chapter 9.

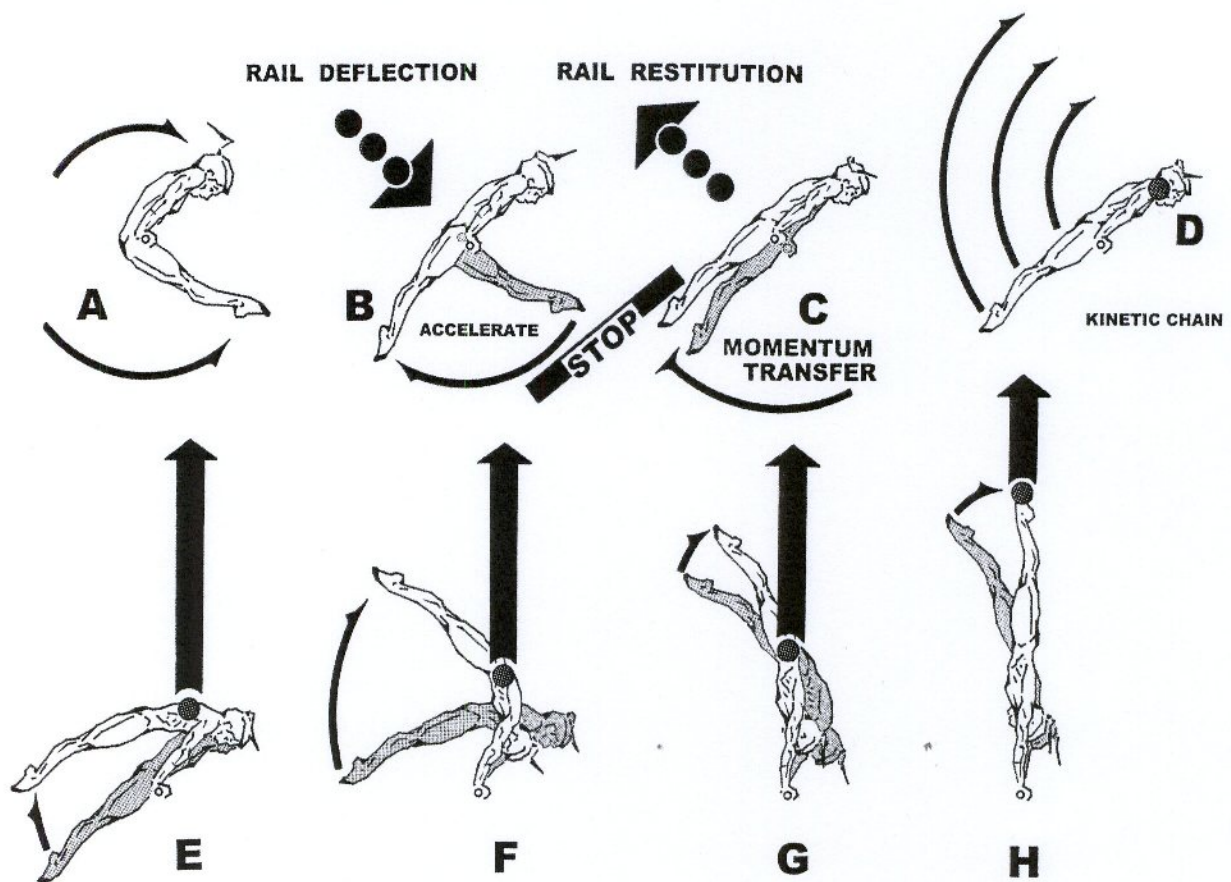


Figure 12.1. The bar rail's response to an effective cast-action in executing a Cast to Handstand on the uneven bars.

Just prior to attaining a straight-line body shape, the forceful leg drive is "instantaneously stopped," causing its momentum to be transferred into the total body (C). As this leg momentum is being transferred, *the momentarily loaded bar quickly "fires back" to its original position (restitution), adding a further lifting impetus to an already-rising body (C, D).*

It is important to reiterate the sequence of events: 1) the forceful leg drive causes the pelvic girdle to push against, and thereby load, the bar in a fore-downward direction; 2) the instantaneous stopping action of the leg-drive causes the legs' momentum to transfer into the total body unit in a back-upward direction; 3) the "loaded" bar rail returns to its original position just as the momentum transfer of the legs into the total body unit is being completed; and 4) the "unloading" of the bar provides an additional lifting impetus to the cast-action.

From a timing standpoint, it is critical that the performer be able to "feel" the subtle performance characteristics in the elastic bar. For example, *the actual push-action of the hands against the bar should occur just as the deflected bar "unloads" its stored energy.* Once this push-action begins, notice how the performer literally "unfolds" in a progressive sequential fashion, up into the handstand position (E, F, G, H).

*Precise "timing" is perhaps the most critical component
in the
"dance" of gymnastics.*

3. The Elastic-Ruler Concept

Much like skills in tumbling, *proper execution of long-hang swing skills requires maintaining a mild but active contraction of the muscles on both the front and back of the body.* Establishing a balance of "dynamic tension" in these muscles creates a quasi-elastic property in the total body unit. As a result, the performer is better able to feel the natural flow pattern inherent in swing from a "holistic" body perspective. This not only enhances kinesthetic feedback throughout the total body but also improves the performer's ability to alter body shape instantaneously, within the dictates of the given skill.³

*Stay tight, yet responsive
to the natural flow pattern of the swing,
and its secrets will be revealed.*

The actual flow pattern inherent in all long-hang swing skills can be demonstrated by comparing the progressive changes in shape that occur naturally in a swinging elastic ruler to that of a gymnast when rotating about a fixed axis. In figure 12.2 for example, it is interesting to observe the striking similarity in the swing patterns of the ruler and the gymnast. Just as the ruler bends under tension, storing energy in the "descent" only to give it up in the "ascent," so too does the performer's body tend to mimic the very same swing pattern. Not only is this bending in response to the natural forces of the swing, but also it provides a consistent flow pattern to build upon for executing virtually every swing-oriented gymnastics skill.

³ Refer to *Dynamic Tension* in chapter 9.

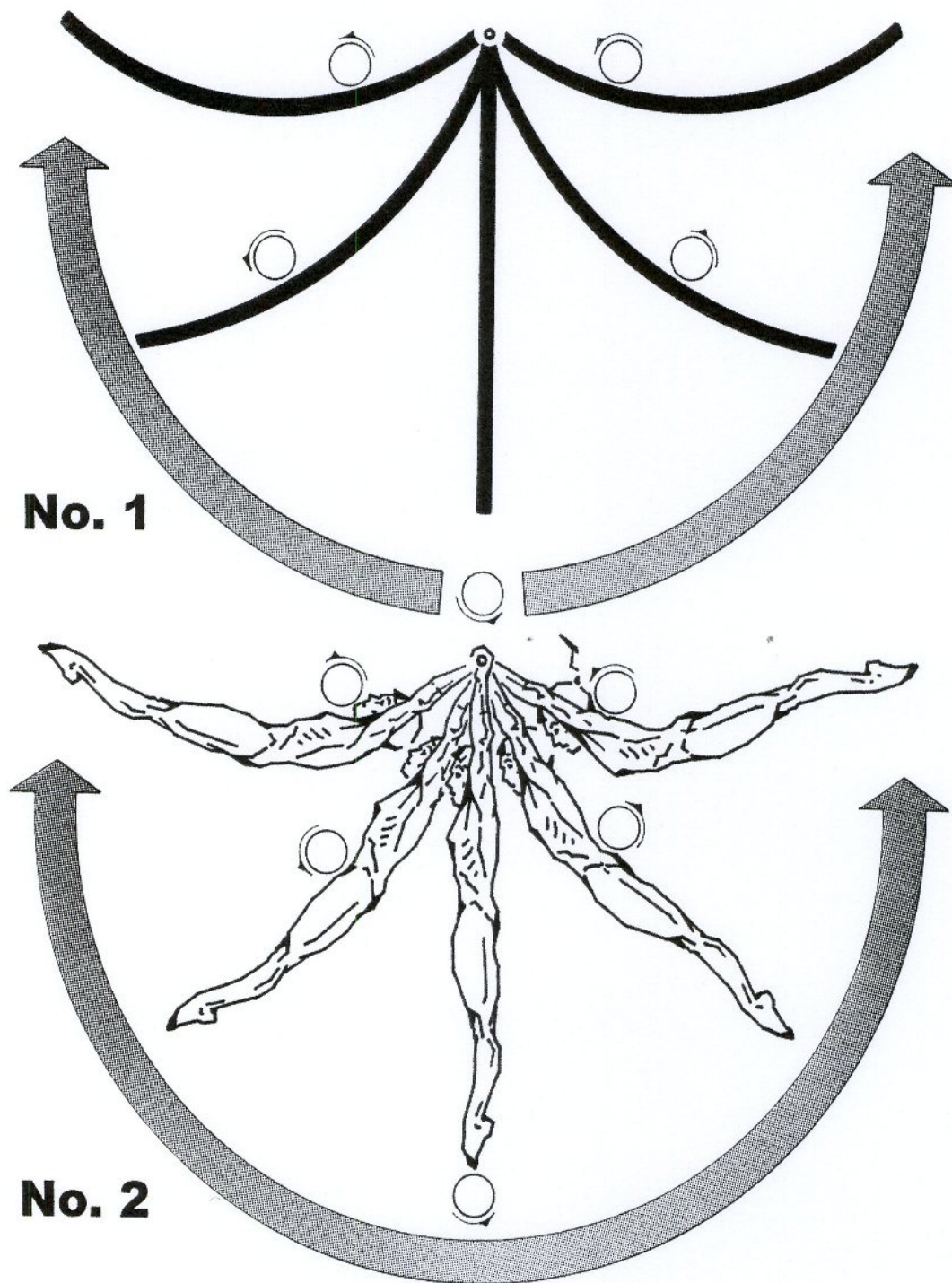


Figure 12.2. The natural flow pattern of swing: (1) plastic ruler; and (2) gymnast.

*Once a child senses the natural flow pattern of swinging,
she no longer needs a push!*

4. Keeping the Giant in the Swing

*To achieve the maximum tolerance limits in execution, all swing skills on the bars should be as large (grand) as possible. Throughout every external-swinging movement, this basic premise centers on staying as far from the bar as mechanically possible without actually letting go.⁴ The performer should make every effort to keep her effective body weight (center of mass) far from the bar (axis of rotation) to maximize her swing profile's external amplitude. In particular, *this involves keeping the upper half of the body away from the bar by maintaining locked arms, an open arm-trunk angle, and a fully elevated shoulder girdle at all times.**

*This maximum radius concept applies not only to traditional long-hang swing skills and their innumerable variations but also to "in-bar" skills such as hip circles and sole circles. For you see, *it's the "grand total" of amplitude prescribed in both the descent and ascent phases that sets the stage for optimum execution of every swing skill!**

*To develop the concept, figure 12.3 compares two techniques for maximizing descent-swing amplitude in a Straddle-On/Straddle-Off to Handstand. Although both achieve a straddle-on, notice that performer 2 employs a more open arm-trunk angle, a fully elevated shoulder girdle, and a *very narrow* straddle-on position relative to the hands. As a result, her center of mass is positioned as far as possible from the bar. *By maximizing her radius of rotation throughout the descent, the performer can draw on a significantly greater quantity of swing amplitude for the upcoming ascent.**

⁴ Refer to *Body Shape and Radius of Swing Rotation* in chapter 4.

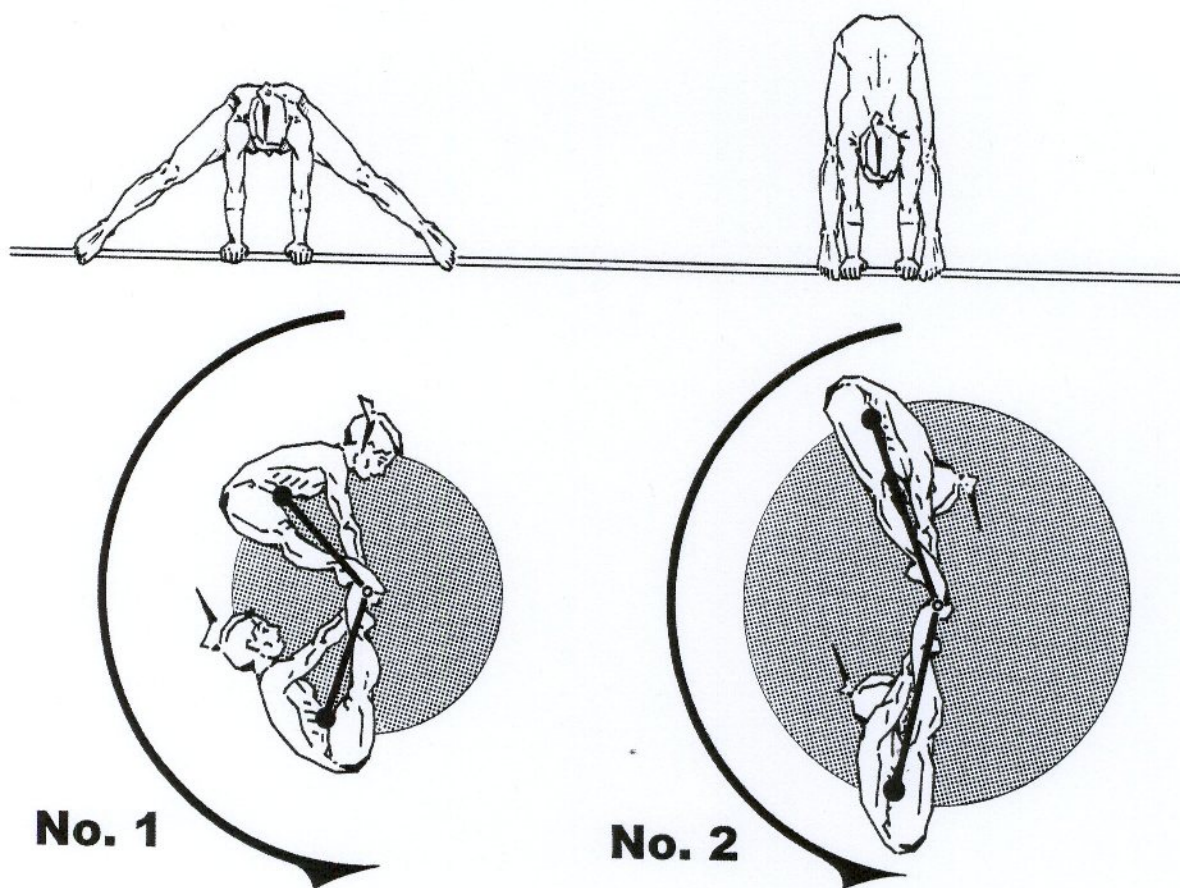


Figure 12.3. Comparative effects of straddle techniques on descent-swing amplitude in executing a Straddle-On/Straddle-Off to Handstand on the uneven bars: (1) wide straddle-on = less amplitude; and (2) narrow straddle-on = more amplitude.

5. The Circumduction Technique

As discussed, a fundamental prerequisite for maximizing swing amplitude centers on keeping one's mass center far from the bar throughout the descent phase of every skill, and straddle-oriented skills are no exception. Consequently, *the wise performer employs as narrow a straddle action as mechanically possible during every descent phase, regardless of straddle type, i.e., a straddle-on for all sole-circle skills as well as a straddle-in for all Stalder-oriented skills.*

However, *the actual path to be taken by the performer's legs when straddling-off during the ascent phase depends on the nature and objective of the intended skill.* For example, if the primary objective of the ascent phase is to generate maximum lift and rotation—as required for dismounts and release-grip skills—then the path of the legs in the straddle-off phase should reflect the path taken by the legs for the straddle-on, i.e., bringing the legs back together as quickly as possible while extending out. By executing a narrow straddle-off, the performer's legs come together sooner, thereby

ensuring a better opportunity to extend (kick) through the A-P plane, resulting in a more effective transfer of momentum. *The net effect of a narrow straddle-off is a greater potential to maximize both lift and rotation for the upcoming release-grip skills and dismounts.*

By comparison, *if the skill's objective centers on creating a smooth, fluid ascent to an ultimate handstand position, then circumduction of the legs at the hip joints is the preferred straddle-off technique.*⁵

To demonstrate the *Circumduction Technique*, figure 12.4 isolates the proper leg action for a Straddle-On/Straddle-Off to Handstand. Because the performer executes a very narrow straddle-on (close to the outside border of the hands), the lion's share of the leg movement involves hip joint flexion (straddling frontally) rather than hip joint abduction (straddling laterally). In other words, *the path prescribed by the legs during the descent phase is more in the A-P plane* than in the lateral plane (illustrations A, B, C). *In the ascent phase, however, the legs prescribe a primarily lateral path*, thereby ensuring as wide a straddle-off as possible. Such a leg path not only minimizes unwarranted rotational tendencies throughout the ascent phase but also it ensures maximum level of elegance and control in reaching the ultimate handstand (D, E, F, G, H).

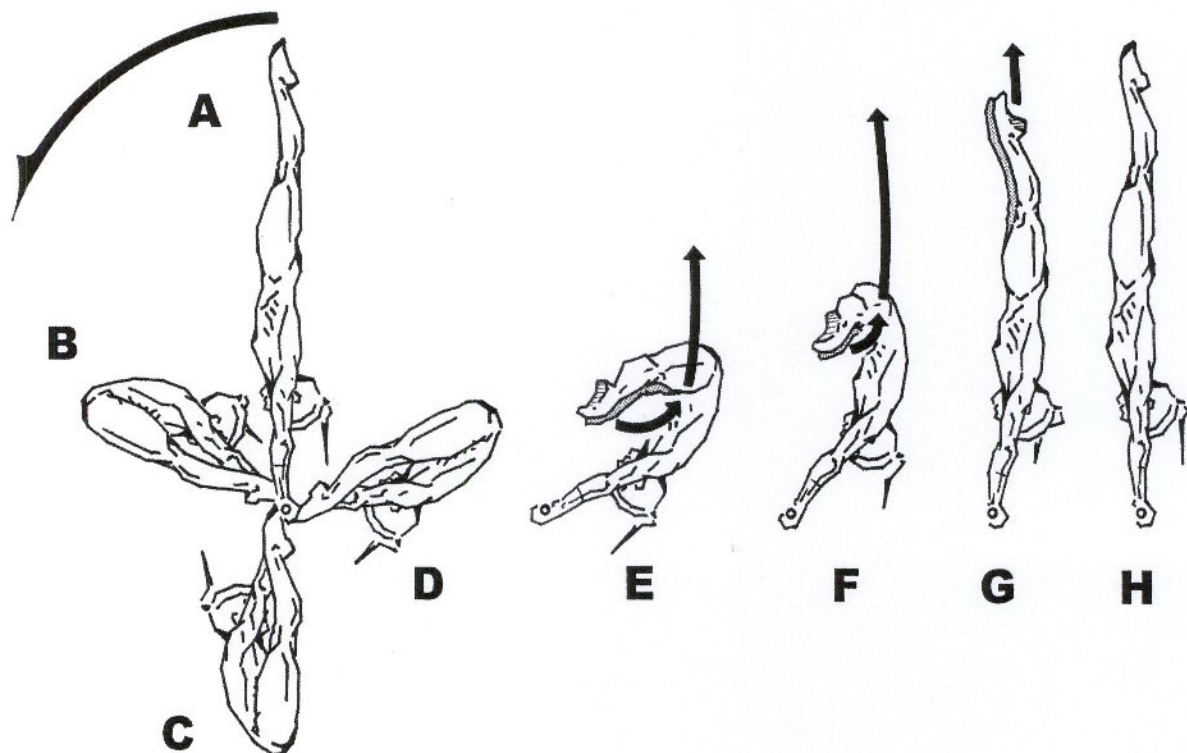
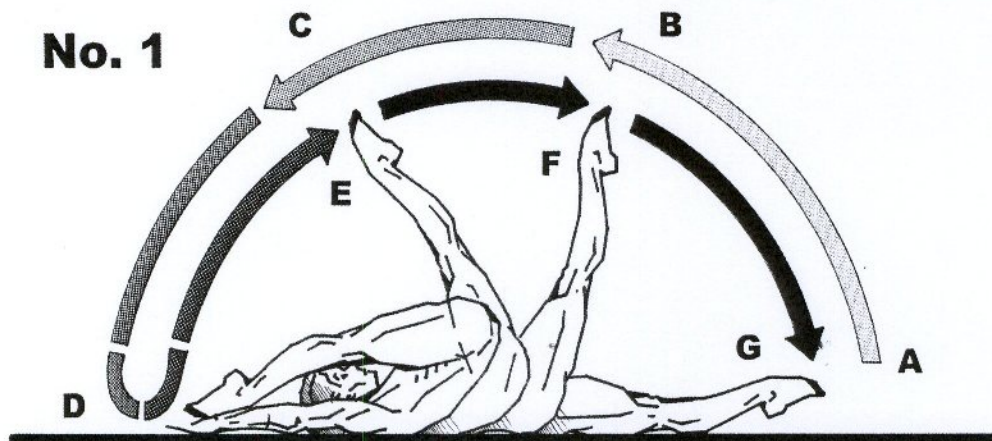


Figure 12.4. Proper leg-action technique in executing a Straddle-On/Straddle-Off to Handstand on the uneven bars.

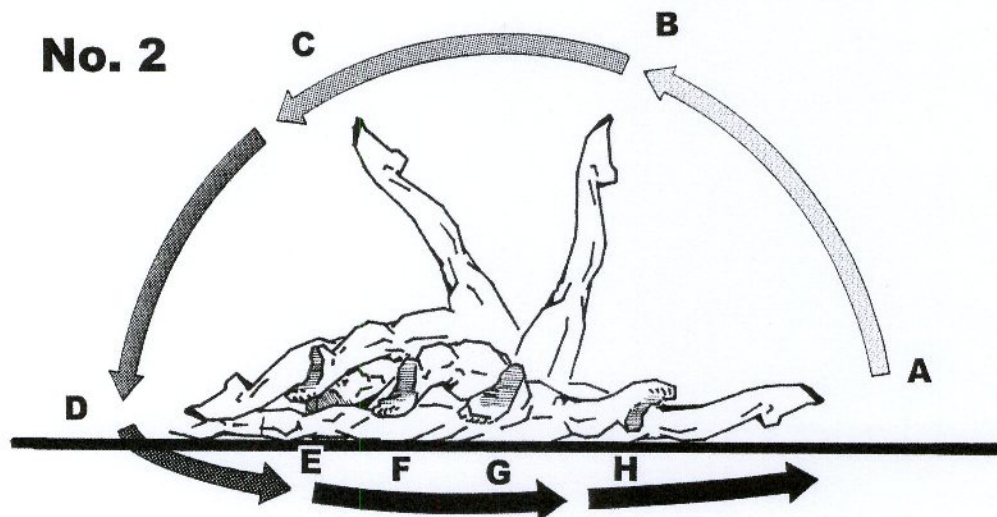
⁵ "Circumduction" is a kinesiology term describing motion of a limb or body part that prescribes a "cone."

Looking at this concept of hip-joint *circumduction* from another perspective, figure 12.5 compares two distinct leg-action techniques that could be employed for executing a Stalder. For the straddle-in phase, notice the legs of both performers follow the recommended narrow path (illustrations A, B, C), primarily in the A-P plane—and this, of course, is how it should be. However, notice *performer 1 employs the very same path for both the straddle-in and straddle-out phases*. While this may be particularly advantageous as a set-up motion for executing release-grip skills and dismounts, it is not the preferred straddle-out technique for executing Stalders.

ANTERIOR-POSTERIOR PLANE



ANTERIOR-POSTERIOR PLANE



LATERAL PLANE

Figure 12.5. Comparative leg-action techniques in executing a Stalder to Handstand on the uneven bars: (1) narrow straddle-out = poor technique; and (2) wide straddle-out = good technique.

By comparison, rather than merely reversing direction in the straddle-out, *performer 2 continues driving her legs laterally so they prescribe a conical path in returning to the start position* (D, E, F, G, H, A). This straddle-out technique is best suited for rising gracefully to a handstand position, i.e. a traditional Stalder or any of its related skill variations.

Simply put, *proper leg action for executing straddle-oriented swing skills to the handstand* is not a matter of straddling in-and-out, as in a back-and-forth path of the legs. Rather, it is *a matter of straddling in-and-around, wherein the straddle action continues circling in the same direction by prescribing an elongated path of circumduction!* Consequently, for those Stalders and other straddle-oriented skills intended to arrive *in the handstand*, it is wise to remember:

*Come in narrow,
go out wide.*

6. The Handstand Arrival—A Litmus Test for Excellence

Always keep in mind that successful execution of a gymnastics skill is not simply a matter of “what” is done, but more importantly the “way” in which it is done. And this principle is never more apparent than in swing skills passing through a vertical handstand on the uneven bars. For example, *all forms of pirouetting* originating out of giant swings, free hip circles, straddle on-and-offs, and Stalders *are evaluated in terms of their relationship to handstand arrival*. Therefore, for pirouette-oriented skills, achieving a handstand is not the “alpha” but rather the “omega” in timing. In other words, *excellence in pirouetting is not determined by virtue of attaining a handstand position, but rather by “when” and “how” that position is attained*.

Remember, too, *proper timing of any given pirouette requires the turn to be initiated during the upswing phase of the circular swing*, as opposed to arriving in (or worse, beyond) the vertical handstand before initiating the pirouette. Rather than arriving first in a handstand and then pirouetting, *the performer should pirouette as she is rising into the handstand, i.e., the Peaking Principle*.⁶ Consequently the actual “timing” of handstand arrival serves as a fundamental barometer for evaluating quality of execution in all pirouettes—just ask any gymnastics judge!

It is also important to emphasize that *having an extremely powerful ascent swing from which to proceed is the only way one can pirouette into a handstand*. Or to put it another way, maximum external-swing amplitude must first be achieved to execute an early pirouette successfully. And the only way to ensure an extremely powerful ascent swing is to secure maximum amplitude in its preceding descent swing.⁷

⁶ Refer to *Peaking Principle* in chapter 2.

⁷ Refer to *External Swing* in chapter 4.

What goes around, comes around...

To demonstrate, figure 12.6 illustrates a Blind Change from an Overgrip Giant Swing. Because maximum amplitude is generated in the giant swing (illustrations A, B, C, D, E, F), the performer is able to *initiate, execute, and complete* the entire $\frac{1}{2}$ -turn immediately prior to achieving the vertical handstand position (G, H, I, J, K). In addition to peaking the Blind Change, the performer is now ideally positioned to execute any sequentially related skill originating from a Forward Giant Swing.

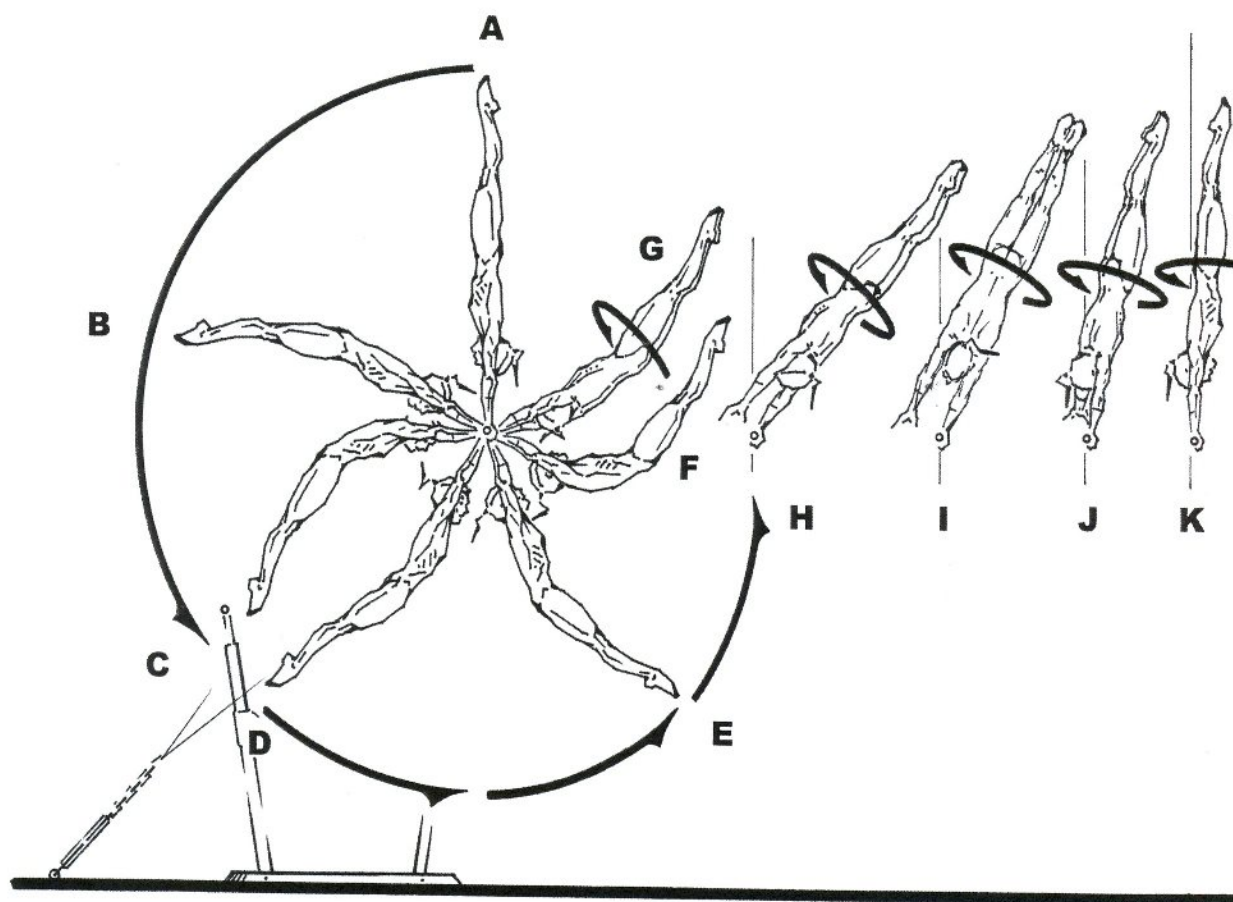


Figure 12.6. An Overgrip Giant Swing into a Blind Change. Notice how the performer "peaks" the skill by initiating, executing and completing the entire pirouette just prior to the handstand.

*The greater the ascent-swing amplitude,
the greater the potential to initiate, execute, and complete the entire pirouette
prior to the vertical.*

The Cast-Reverse Pirouette to Handstand in figure 12.7 is another depiction of initiating, executing, and then completing the $\frac{1}{2}$ -turn prior to arriving in the handstand. In this example, as in the Blind Change, notice the performer opens up

and pushes through her total body unit to initiate the pirouette (illustration C). This is sometimes referred to as "corkscrew twisting." Extending into the turn not only minimizes the tendency to move out of alignment but also progressively reduces the radius of turn rotation, and is therefore more efficient.

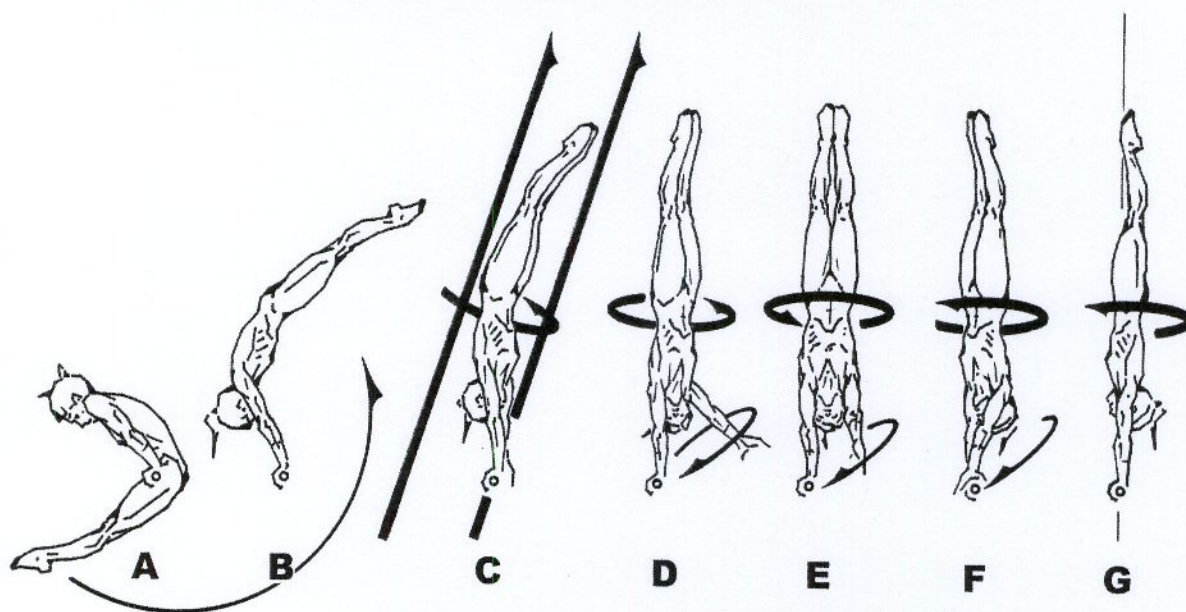


Figure 12.7. A Cast-Reverse Pirouette to Handstand on the uneven bars.

7. Timing the Release

Most release-grip skills and virtually all dismounts from the uneven bars have specific, characteristic rotation requirements. In every case, it is important to note that the *"timing of the release"* affects not only the flight direction (trajectory) but also the potential rotary motion (angular momentum) available for executing the intended skill. This is particularly critical in dismounts with more than one somersault. It is therefore wise to consider the following relationships, particularly as related to multiple-somersault dismounts:

- If the dismount involves swinging and somersaulting in the same direction, e.g., swinging backward while somersaulting backward (as in a Double Backward Flyaway Dismount), then:
 - 1) The later the release, the greater the rotary potential and height above the bar; whereas
 - 2) The earlier the release, the more rotary potential and height above the bar are compromised.

- *If the dismount involves swinging and somersaulting in opposite directions, e.g., swinging backward while somersaulting forward (as in a Toe-On Toe-Off Forward 1½ Somersault Dismount), then:*
 - 1) The later the release, the greater the height above the bar, but the rotary potential is compromised; whereas
 - 2) The earlier the release, the greater the rotary potential, but the height above the bar is compromised.

Keep in mind that these relationships are effective only within a very small timing window. *Dismounting much too early or much too late does not serve either "master" (lift or rotation), but rather leads to catastrophic failure.* Always proceed cautiously, making very minor adjustments in timing the release.⁸

8. Tapping the Release

Properly "timing" of release-grip swing skills or dismounts involves more than determining precisely "when" to let go of the bar. *Of equal importance are the subtle body movements employed by the performer just before the actual release.* These internal-swing movements, sometimes referred to as "tapping the release," have a pronounced effect on the outcome of any airborne skill. And in order to employ the *Tapping Technique* correctly, the performer must have a clear understanding of the specific "lift, travel, and rotational" requirements for the intended release-grip skill or dismount.

For example, figure 12.8 compares the internal-swing actions just prior to release for a Layout Flyaway Dismount versus a Layout Double Flyaway Dismount. Both dismounts require a most powerful ascent swing (illustrations A, B, C, D), but they differ in the amount of rotation needed for successful completion. *Since the primary objective of the Layout Flyaway Dismount is maximum lift, performer 1 trades-off a portion of potential rotation by executing a vigorous total-body extension immediately prior to releasing the bar (D, E).* Forcefully pushing her hands against the bar in a back-downward direction, her body quickly extends and rises fore-upward (see arrows). This timely "tapping action" just before the release provides an increased measure of "lift" that would otherwise have been employed for "rotation."

⁸ Refer to *The Tangent-Release Principle* in chapter 4.

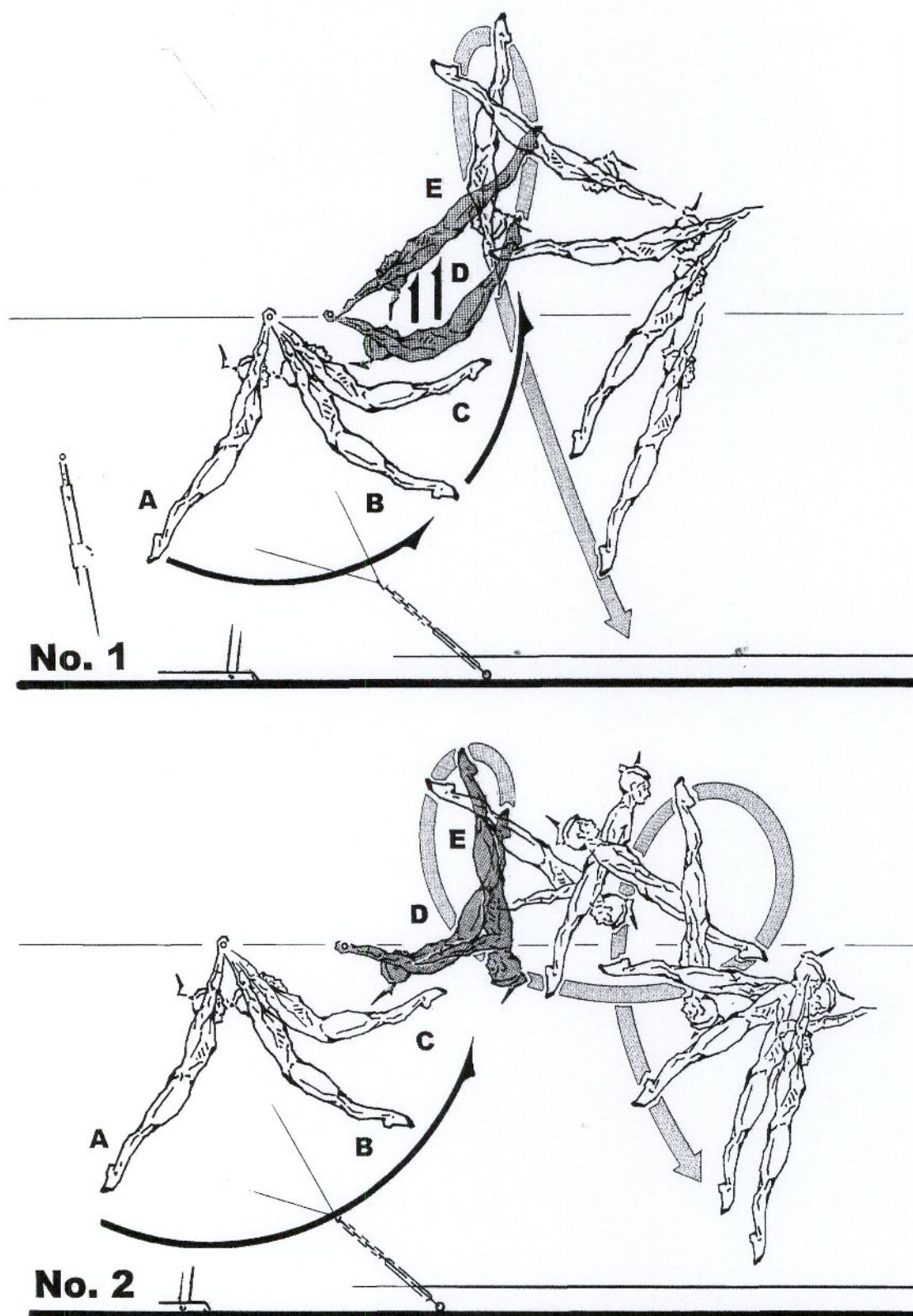


Figure 12.8. Comparative examples of "tapping the release" from the uneven bars: (1) Layout Flyaway Dismount; and (2) Layout Double Flyaway Dismount.

Although "lift" remains an essential component in all release-grip swing skills, achieving a maximum quantity of somersault rotation is a primary objective in a *Layout Double Flyaway Dismount*. To accomplish this, notice performer 2 further inverts her body by driving her legs more deeply into the upswing phase (illustrations A, B, C, D). Immediately prior to the release, she abruptly "stops" the leg-drive action, causing its momentum to be transferred into the total body unit upon release (D, E). This "tapping action" results in increased "rotation" at the expense of some additional "lift."

For the *Layout Double Flyaway Dismount*, notice that the actual opening up of the body shape does not occur until after the performer has released the bar and is airborne. Immediately after release, also notice the performer vigorously lowers her arms to her hips. This timely decrease in the body's "radius" of rotation serves to correspondingly increase her "rate" of somersault rotation, an essential ingredient for optimum execution of the dismount.

9. The Bottoming Effect

The *Bottoming Effect* is an interaction between the performer and the rail of the uneven bars as the body proceeds through the descent phase and into the ascent phase of the external swing. Because the bar has considerable elastic properties, it bends (*deflects*) according to the amount and direction of the force applied by the performer—due to the internal-swing mechanics she employs—during the course of the skill. As the applied force terminates, the bar quickly returns to its original shape (*restitutes*), giving the performer an additional impetus upon which to capitalize.

While *this elastic property of the bar* is similar in effect to that of a spring floor in tumbling, it has an additional performance characteristic, i.e., it can bend and therefore respond to forces in whatever direction they are applied about the circle. As depicted in figure 12.9, *this bending of the bar is similar to the cocking of an archer's bow and can be most advantageous. It provides the performer an opportunity not only to store energy momentarily in the bar, for use in the very next phase of the movement, but also to employ this energy in a precise "direction" according to the dictates of the intended skill.*

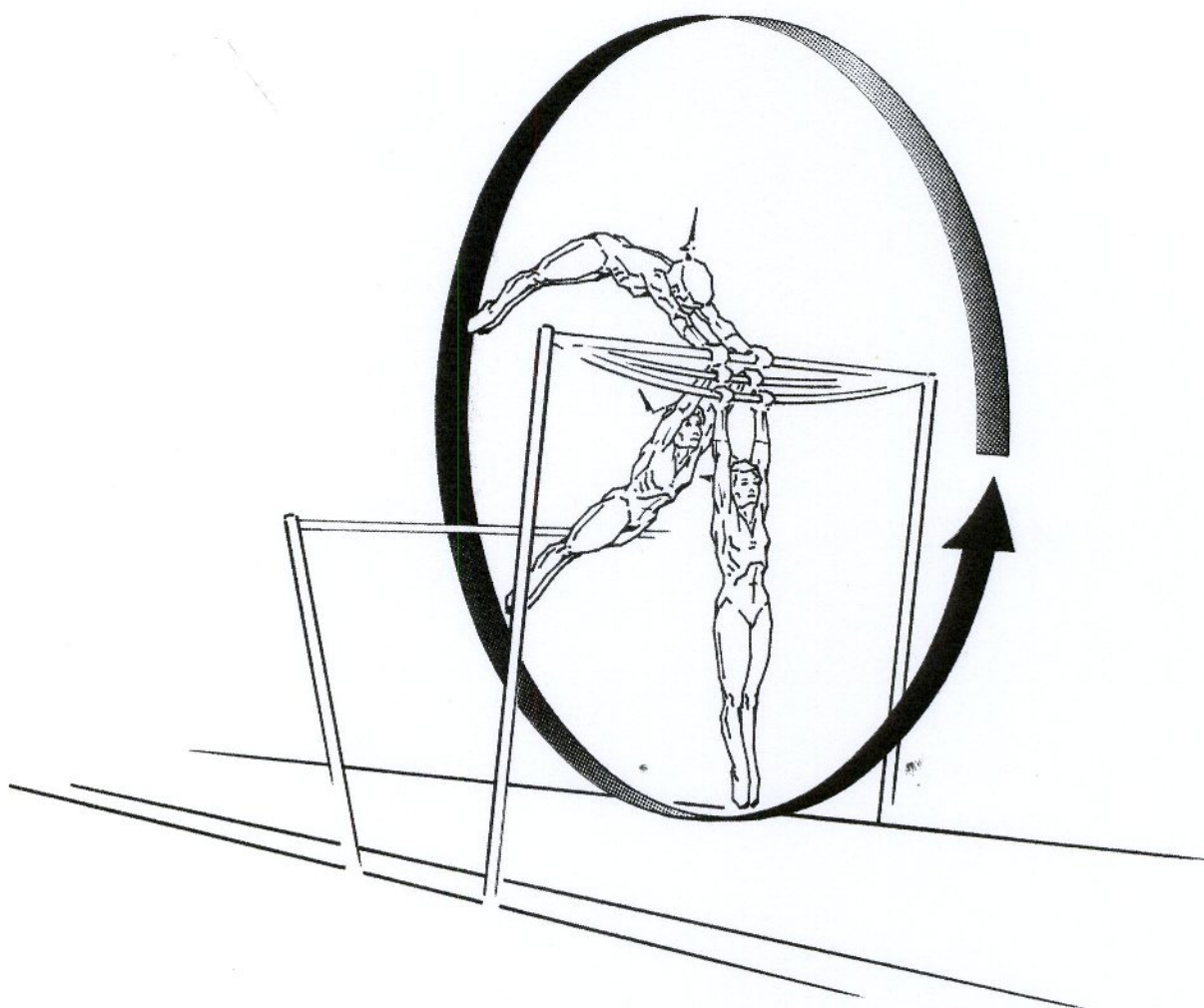


Figure 12.9. The Bottoming Effect of the bar.

*The archer bends the mighty bow and takes aim
that her arrow might fly
swift and far...*

10. The Slingshot Technique

The "slingshot" (a slang term in gymnastics parlance) is a rather advanced technique for taking maximum advantage of the Bottoming Effect. It is used primarily to gain additional measures of lift and rotation for advanced dismounts and release-grip skills. Because it significantly amplifies the forces generated on the performer's hands, it increases the performer's potential to inadvertently "rip off" the bar. Consequently, *the Slingshot Technique should be employed only under carefully controlled conditions by adequately trained gymnasts.*

Figure 12.10 illustrates how the *Slingshot Technique* can be used to maximize both lift and rotation for a Tucked Double Flyaway Dismount from the uneven bars. Notice the performer has purposely "overshot" the vertical handstand position from the giant swing by continuing a forceful foot-lead drive (illustration A). This acceleration of the body over the top of the bar serves to "advance the timing" as well as to "skew the circular pattern" for the approaching descent phase. With the legs and feet steadfastly driven in a decidedly downward direction, the descent becomes more "vertical" than "circular" (B, C, D). In addition, *this foot-lead action results in a deeply hollowed (cocked) total body shape*, which is perhaps best described as a "loading of the gun."

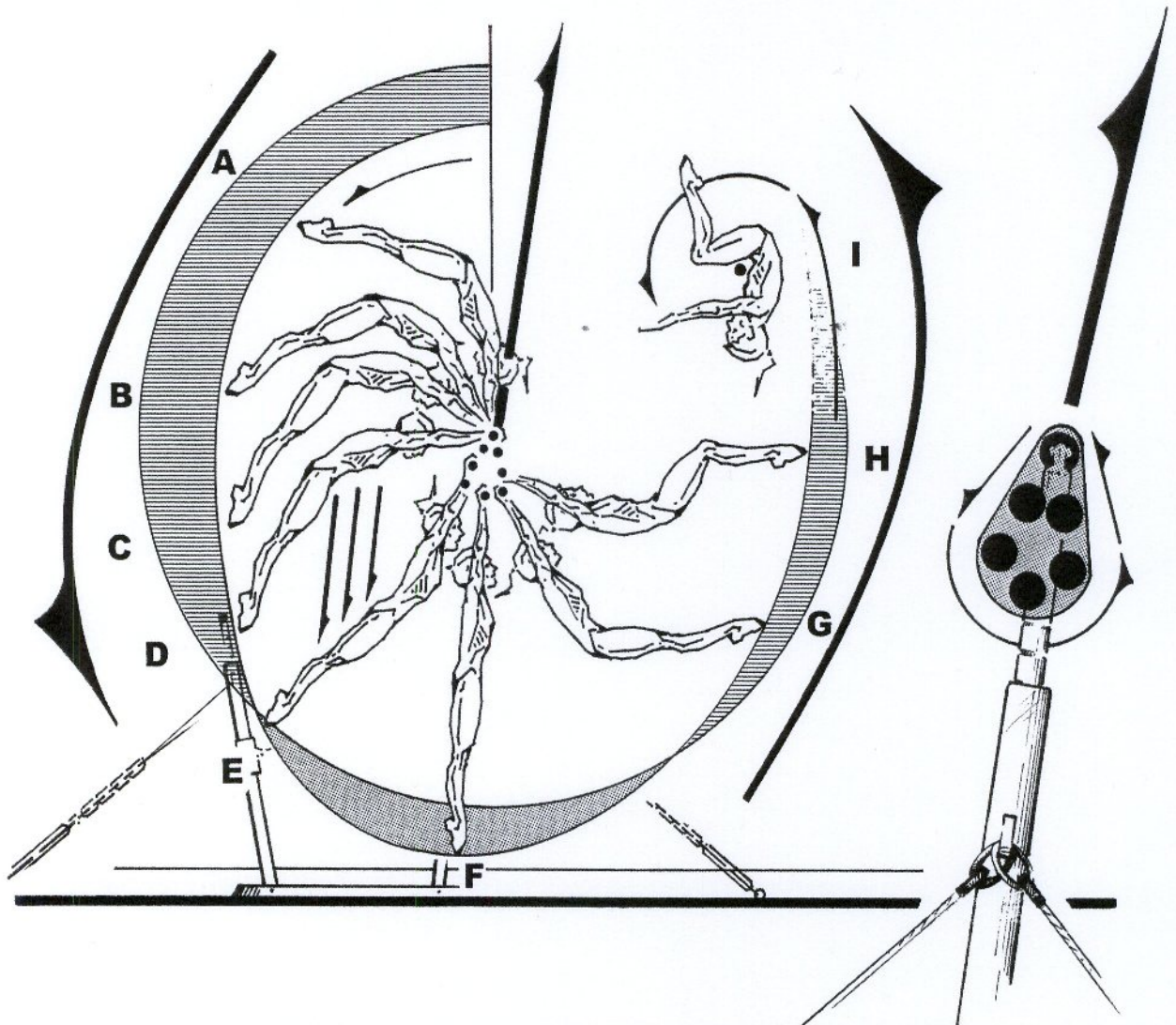


Figure 12.10. The Slingshot Technique for directing and maximizing the Bottoming Effect of the bar in executing a Tucked Double Flyaway Dismount.

Immediately prior to arriving at the exact bottom of the swing, notice how the performer "fires the gun" by releasing, or "dumping," her hollowed shape into a fully extended shape (E). *This forceful unloading action of the body causes the bar to be depressed more deeply and for a longer duration of time (E, F).* To put it another way, the unloading action of the body causes a momentarily deeper loading action of the elastic rail in a direction that is slightly off top-dead-center (see exploded view).

As the performer passes through the bottom of the swing, the energy momentarily stored in the deeply depressed bar is "released," providing an additional measure of "lift" to the already-rising body (G, H). At the same time, *the performer builds upon this Slingshot Effect of the bar by forcefully driving her feet, then knees and hips in the desired upward direction.* Properly executed, the resulting effect is increased lift and rotation in the airborne phase of the dismount (I). But remember:

*You ain't got a thing,
if you ain't got that swing...*

REFERENCES AND SUGGESTED READING

- Adrian, M. J., and J. M. Cooper (1994) *Biomechanics of Human Movement* (2nd ed.). Dubuque, IA: William C. Brown.
- Alter, M. J. (1996) *Science of Flexibility*. Champaign, IL: Human Kinetics.
- Basmajian, J. V., and C. J. De Luca (1985) *Muscles Alive: Their Functions Revealed by Electromyography* (5th ed.). Baltimore: Williams & Wilkins.
- Bunn, J. (1955) *Scientific Principles of Coaching*. Englewood Cliffs, NJ: Prentice Hall.
- Carr, G. A. (1997) *Mechanics of Sport: A Practitioner's Guide*. Champaign, IL: Human Kinetics.
- Dyson, G. H. (1970) *The Mechanics of Athletics* (5th ed.). London: University of London Press.
- George, G. S. (1980) *Biomechanics of Women's Gymnastics*. Englewood Cliffs, NJ: Prentice Hall.
- Hall, S. J. (2003) *Basic Biomechanics* (4th ed.). New York: McGraw-Hill.
- Hamill, J., and K. M. Knutzen (1995) *Biomechanical Basis of Human Movement*. Baltimore: Williams & Wilkins.
- Hamilton, N., and K. Luttgens (2002) *Kinesiology: Scientific Basis of Human Motion* (10th ed.). New York: McGraw-Hill.
- Hay, J. G. (1993) *The Biomechanics of Sports Techniques* (4th ed.). Englewood Cliffs, NJ: Prentice Hall.
- Hennessey, J. T. (1969) *The Trampoline As I See It* (2nd ed.). Lafayette, LA: International Publications.
- Hennessey, J. T. (2007) *A Successful Guidebook of Twisting Single and Multiple Somersaults*. <http://www.trampoline-usa.com>.
- Knudson, D. V., and C. S. Morrison (1997) *Qualitative Analysis of Human Movement*. Champaign, IL: Human Kinetics.
- Kreighbaum, E., and K. M. Barthels (1996) *Biomechanics: A Qualitative Approach for Studying Human Movement* (4th ed.). Needham Heights / Boston: Allyn & Bacon.
- McGinnis, P. M. (1999) *Biomechanics of Sport and Exercise*. Champaign, IL: Human Kinetics.
- Miller, D. I. (2000) *Biomechanics of Competitive Diving*. Indianapolis, IN: U. S. Diving Publications.
- Plagenhoef, S. (1971) *Patterns of Human Motion: A Cinematographic Analysis*. Englewood Cliffs, NJ: Prentice Hall.
- Salmela, J. H., ed. (1976) *The Advanced Study of Gymnastics*. Springfield, IL: Charles C. Thomas.

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Perfect Justice

*The truth is that the whole of your life's experience
is but the outer expression of inner thought. . .*

*We always do choose how we think;
and therefore our lives are just the result
of the kind of thoughts we have chosen to hold;
and therefore they are of our own ordering;
and therefore there is perfect justice in the universe. . .*

Chic Johnson