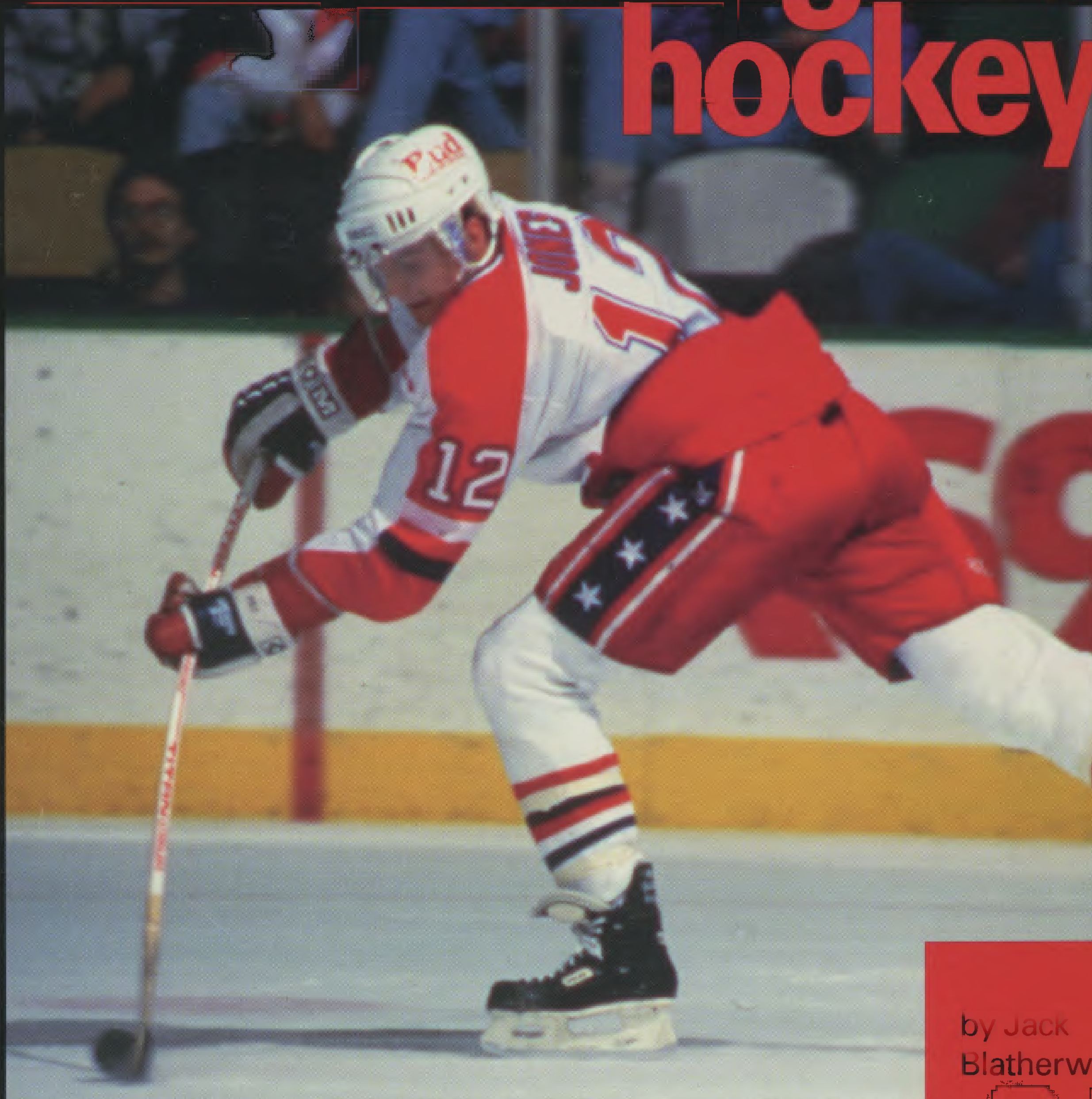
OVER-SPEED

Skill Training for hockey



Interval training on-ice and the off-ice building blocks

by Jack Blatherwick

OVER-SPEED

Skill Training for Hockey

USA HOCKEY

Interval training on-ice and the off-ice building blocks

By Jack Blatherwick Ph.D.

OVER-SPEED Skill Training for hockey

To coaches and players:
For quick reading, to search for a topic, or to review:
Because this book contains some scientific detail, you may find it helpful to read the highlighted blue portions of the book first:

- Most chapters have an overview, which summarize the upcoming chapter. The chapter contains more detail.
- Paragraph headings are in bold letters for each new topic.
- Pictures and graphs are worth a thousand words!
- A suggested calendar can be found in the chapter on periodization.
  The twelve month year is divided into shorter phases within two macrophases:
  In-season and ***Off***-season.
- Sample workouts are suggested for each phase of the off-season.
  Plan your own program based on personal goals, weaknesses and assets.
- On-ice overspeed drills are included as examples of the timed intervals.
  Each coach will want to design more creative drills from these simple examples.

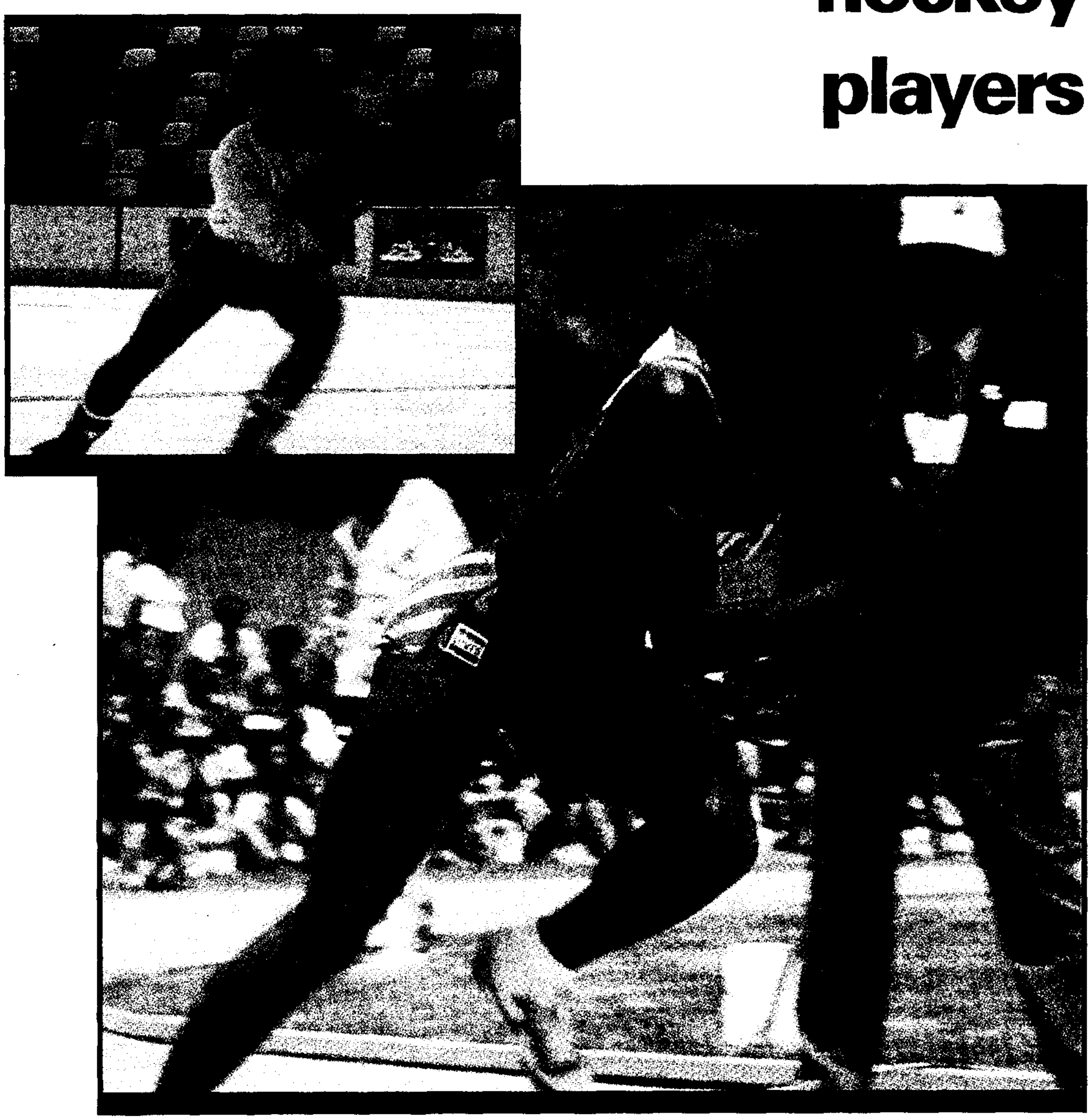
For more detail:
Some scientific studies related to ice hockey are summarized along with the implications for a coach or player. If you want to look even further into certain topics, a bibliography is included toward the end of the book.

Contents:

Note: since there is technical detail at times, most chapters have a one page overview at the beginning which covers important topics.

CHAPTER ONE

Athleticism, synergism developmental training and informed hockey players



Athleticism, synergism, developmental training, and informed hockey players

Having never written a book, I'd like to start by violating a rule from tenth grade English class: never turn your readers off in the introduction. I recall after violating rules in tenth grade, I'd either fail an essay or end up sitting in the principal's office all afternoon. This time around, I'll just lose an audience.

This book is ***not*** written for the aging hockey player, whose skills have matured and whose goals are to maintain the present level of conditioning, maintain the present job for a few more years, maintain the present salary, and maintain the present quality of play. Save your time — don't read on.

We're not talking about maintaining the present level of anything. We're not talking about a general conditioning program that would be healthy advice for the masses. **We're talking about improvement.**

Furthermore, I confess to being functionally illiterate about the other end of the age scale, how mites, pee wees, and squirts learn hockey skills — magic I'd guess — fun, I hope. So, after losing 75% of the market, those who are either too young or too old, or those who are interested in the status quo, I'd like to state clearly...
...this book is written to help young players and their coaches plan for improvement.

To be most effective, training must be specific to your individual goals, and it must be well planned (including very different phases) for at least a year. In a later chapter, we'll discuss the importance of a year-long plan, allowing for psychological and physiological stresses of a competitive season. Individual development is often given a lower priority during the season, when goals such as winning and team systems require practice time. Therefore, a player's year-long development calendar must emphasize individual growth in the off-season. This automatically defines two distinct *macro-phases: **In**-*season and ***Off***-season.

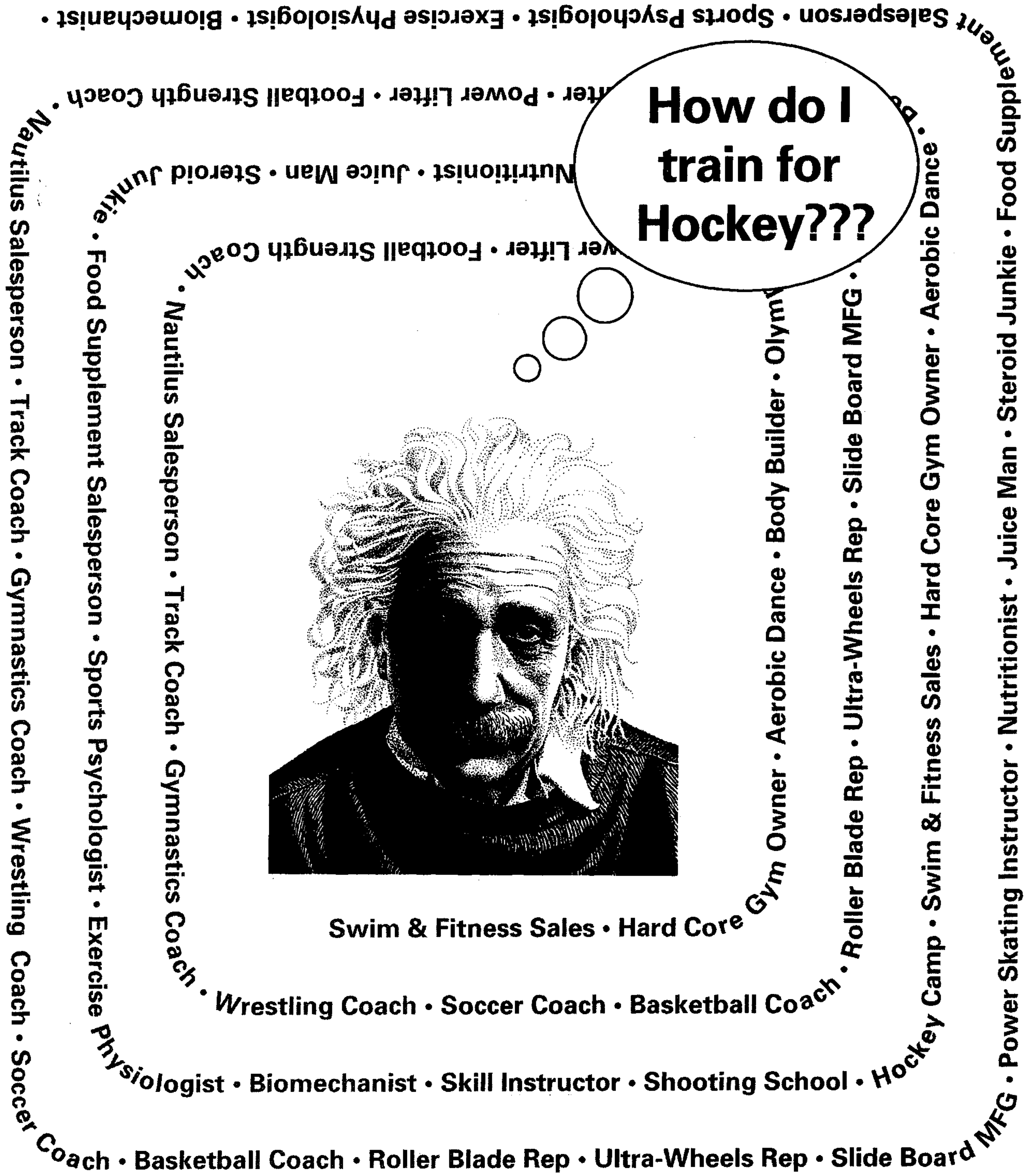
Before starting in on a training schedule, you should understand that random choices about training will lead nowhere. Hard work will only be productive if it is focused to move in one direction ... and that direction should be determined by the athlete.

Hockey lags behind much of the rest of the athletic world in developmental training. Track coaches know how to train athletes to become faster sprinters, better jumpers, stronger throwers, or better endurance runners. We can learn much from them. Body builders know how to build muscle mass. We can learn from them, also. Swim coaches use advanced technology to improve their athletes. Physiologists, nutritionists, biomechanists, and psychologists can certainly add helpful advice. But, these people should not be considered sources to answer the individual's question: "what is the most important training for my development?" They do not know as much as the athlete and his coach about the long-range direction in which the athlete wants to improve. We've gotten advice from so many directions we don't know if the most important training is aerobic dance or stretching, skating or lifting weights, jogging or rollerskating, sprinting or shooting pucks.

We are constantly bombarded by the biases of 'experts' in their own specific area of training or nutrition. Television propaganda, individual testimonials, scientific lingo, and awesome looking bodies can too easily effect our decisions about training.

With so much conflicting advice, and everyone selling his product...

...do you need to be a rocket scientist to know who to trust???



What direction should your training go? You hold the keys to answer this for yourself.

For the all-important decision: *in which direction do you want your game to move ... trust yourself.* In deciding whether you want to emphasize speed, agility, strength, shooting, stickhandling, checking, or even fighting — or if you want to prepare for over-speed skill development in the upcoming years... trust yourself.

Don't trust me. I'm biased toward a skillful game like that played in the Olympics. I'd like to see hockey move in that direction rather than toward more hooking and interference — the game college and pro coaches are calling, "... good, sound defense." This book is an extension of my bias. I think every player should work on over-speed skills, no matter what his specialty might eventually be.

What direction should your training go? You hold the keys to answer this for yourself.

If you can see that your niche in the future hockey world would be as a big, strong, aggressive, intimidating player, you can sleep happily knowing that every scout in hockey is looking for you ... and, I'll be glad to help you prepare for your future. You should train somewhat differently than a smaller player who can't make it by the same route. Like every player, you'll want to emphasize skills, quickness, goal-scoring, and playmaking as well as defense. But, you should also accentuate your assets.

If you are big — train to get bigger and stronger. If you're not big, consider this a natural advantage in a game that is dominated by agility — quick changes in direction. A short player has the same advantage a sports car has over a jeep in a race with many turns. Unfortunately, scouts have yet to understand this physics.

A body builder will be biased toward making you bigger. The power lifter thinks you should be a power lifter on the way toward your goal of being a hockey player. The avid cross-country runner and many physiologists think you should be a distance runner first, and a hockey player second. The vitamin salesman thinks his product is 'the answer'. The person selling memberships to the local fitness center will tell you their equipment and program will make you into an Olympian. The potential benefits of in-line skates and slide boards can become exaggerated. We all get passionate selling our own particular bias — at times, the more money involved, the more passionate we become.

My bias is toward raising your present 'comfort zone,' increasing the speed at which you perform all skills. Whether you are a genius playmaker, an intimidating forechecker, a goal scorer, or a defensive specialist — in order to make the next step up in your hockey career, you must perform your own unique set of skills at a faster pace. Evidence will be presented to verify this. We'll talk about how to build a base off-ice and on-ice to complement the overspeed skill training that is the focus of this book. All players can benefit from this training.

When you consider the specific building blocks — the athletic attributes that will help you move toward your goal — at that point you may call on the expert in that area. For a particular phase of your training, if you want to build muscle mass, you might talk to a body builder. He knows this phase better than anyone. Your track coach might know how to make you a faster skater. If you're trying to lose body fat, talk to a nutritionist.

But, you are the one to trust when deciding what kind of hockey player you want to be — what direction your training should take. Make this decision first; then, establishing the building blocks will be dircted by your long-range goal — by your own informed decision.

The Decision-Making Pyramid

Focus your training efforts in ONE direction

Trust yourself!!!

First: Set a long-range goal on the direction you want for your hockey career.

- **Endurance**
- **Body fat and muscle mass**
- **Upper body strength**
- **Leg strength and power**
- **Midline muscles**
- **Coordination**
- **Skating Skill**
  - **Quickness**
  - **Speed**
  - **Agility**
- **Running speed, quickness**

For evaluation and help in a specific target area, you might see an expert.

Any training plan begins with a decision about the major objective, so that all your energies are directed toward a goal. In the words of a leading West German swim instructor, Janos Satori: "Training can take place with an insufficient knowledge, but that would mean a high probability of failure."

Don't just train hard — train smart !!!

In this book we will focus on the question: how do I train to be a better hockey player?

This does not mean that a player should specialize, and focus all his training in one direction. In fact, the more diverse the training at a young age, the better the athlete. The better the athlete, the better the hockey player.

Athleticism, synergism and putting the training pieces together.

Athleticism is the word used by Herb Brooks and Soviet coaches to describe the physiological attributes necessary to become a great hockey player. Athleticism could be characterized by: speed, quickness, agility, rhythm, balance, coordination, strength, power, flexibility, and endurance, put together in a skillful package. All these attributes can be improved during the teen-age years with intelligent training, but potential for improvement in some areas diminishes rapidly with age. Strength and endurance can be improved at any age — there are many years left for jogging and building massive biceps. But if a young athlete wants to work toward lofty career goals, he should learn everything he can about training for those athletic attributes which are best developed right now.

Note: **During adolescence there is potential for improvement in athleticism that will never again be matched.** Neuromuscular patterns of power, speed, coordination, and skill can be developed more effectively at these ages than ever again. Hormonal changes and the growth rate of muscle and bone are factors that underline the importance of finding the right approach at a young age.

Synergism: Is it possible that 2 + 2 = 5 ???

Synergism literally means that when physiological systems work together efficiently, one system makes another more effective, so that taken together,
... ***the whole is greater than the sum of its parts.***

For example, in very small organisms, oxygen can diffuse quickly from the external world to the interior, where it is used to help produce energy for the cell to carry on its function. Through millions of years of evolution, as organisms got bigger, simple diffusion over large distances was way too slow, and oxygen was eventually carried close enough to working cells through small invaginations of sea water inside the organism. Of course, with bigger animals, there arose a need for a heart to pump the sea water through vessels, and red blood cells increased the ability of the sea water (blood plasma) to hold greater quantities of oxygen. Those animals that developed lungs could live out of the sea, because blood vessels were thereby exposed to a large surface area of the surrounding air (the total surface area of all the tiny alveoli in our lungs is about 700 square feet!).

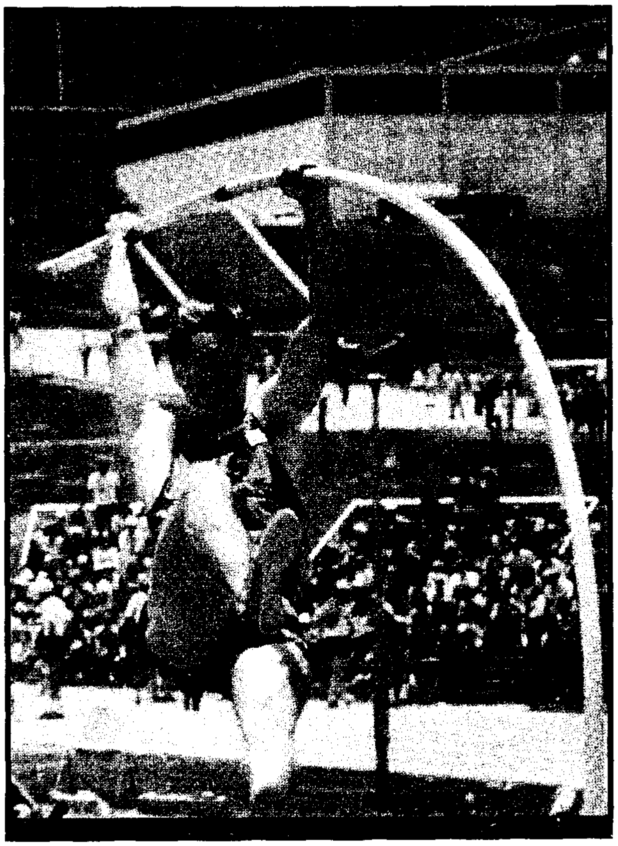
During adolescence, train for quickness, skill, agility and coordination.

So, in the evolutionary strategy, any one piece in the cardio-respiratory chain could not have contributed enough to support life in an organism that grew too big. Red blood cells can bind a lot of oxygen and release it in just the right areas of the body. But, by themselves, without the heart, lungs, blood vessels, and plasma, the red blood cells wouldn't make much of a contribution to life. Together, the pieces of this cardio-respiratory system contribute infinitely more than the sum of what each piece would contribute by itself.

In this case: 2 + 2 + 2 + 2 + 2 = 5,000,000,000,000,000,000,000,000,000,000 !!!

Intelligent training is *synergistic,* there is no single piece of the overall training puzzle which is by itself — the answer.

No single form of training is self-sufficient. Weight lifting is often over-rated by strength coaches, but it is certainly one of the important building blocks of athleticism. Skating treadmills, roller blades, and skating machines look impressive at first, but are at best, poor substitutes for the real thing. If used in conjunction with other forms of training, however, these workouts can help increase strength-endurance in a skating range of motion.



Athleticism in Action

As strange as it sounds, skating alone is not the best way to improve skating. On-ice skating practice must be supplemented by improvements in athleticism, accomplished in different phases of the year.

Developmental training is synergistic:

➤ when your training is directed toward a long range goal;

➤ when the calendar allows for a different emphasis at different phases of the year;

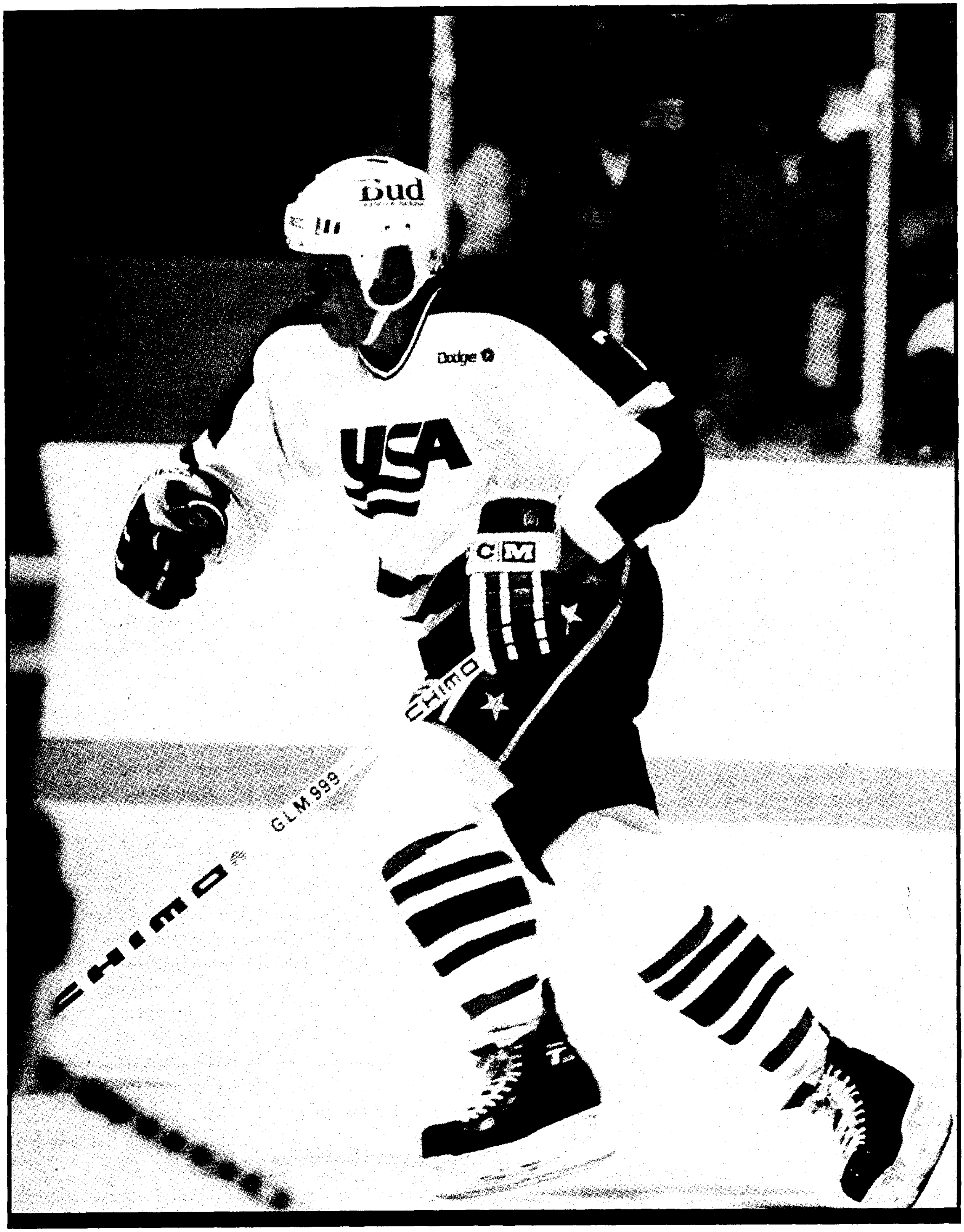
➤ when sprinting and skating-specific plyometrics promote greater are added to strength gains and transferred to skating speed;

➤ when slide board or roller skating intervals promote greater knee bend and increase muscular endurance;

➤ when stronger legs and loss of body fat allow you to corner with a lower center of gravity;

➤ when midline muscles and leg strength are combined with upper body strength to make a strong weight lifter into a strong player;

➤ **when the various pieces of training are put together; the contribution of each one becomes greater than if the other pieces were missing. This is synergistic training, and it is accomplished by periodizing the yearly calendar to emphasize different aspects of athleticism in different phases of the year.**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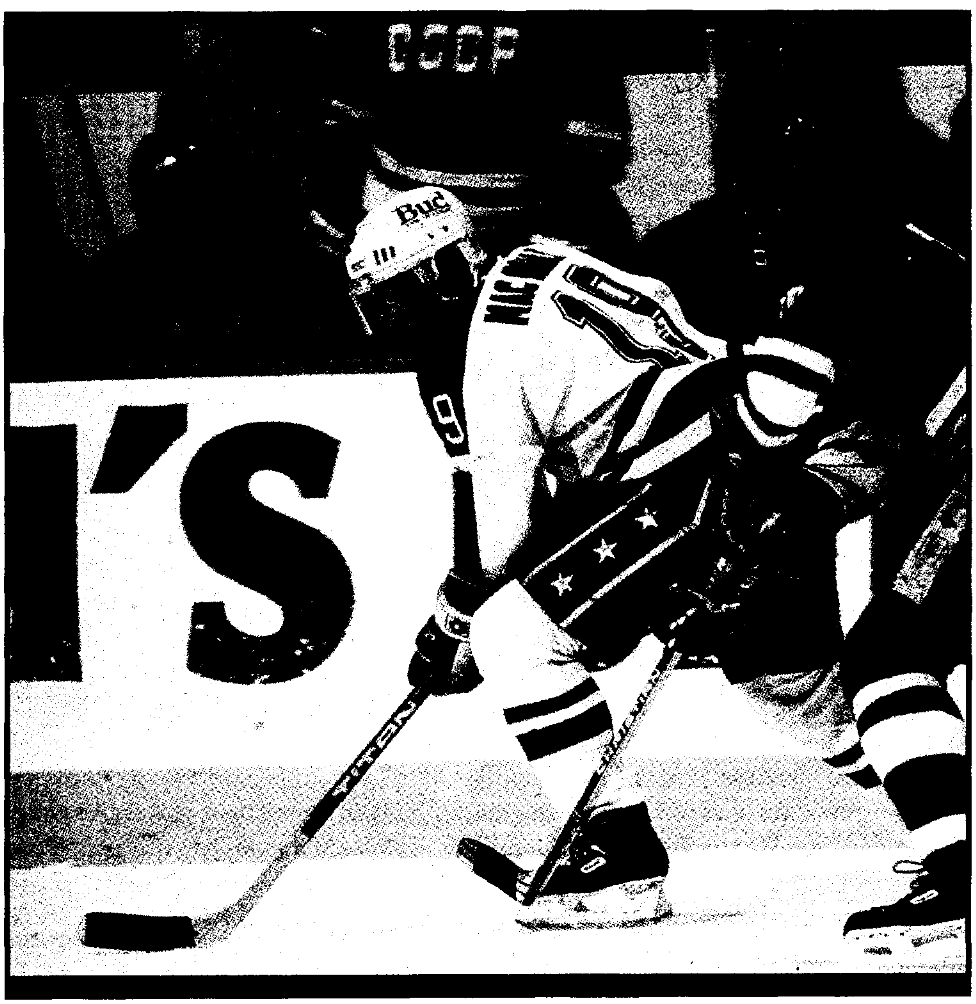
CHAPTER TWO

Overspeed skill practice:

the Soviet comfort zone



Note: Since the time of the first printing, the USSR has been politically and geographically divided. However, the word "Soviet" will be used throughout this text, because it was their training of young players that serves as a model for the rest of us in hockey.

Overspeed skill practice: the Soviet comfort zone

How should a young hockey player prepare for the next level up? How should a team train to make the next step? How does the U.S. Olympic team prepare for competition with the Soviets?

The following analogy demonstrates the similarity in all three questions.

Consider two teams:

a) the Soviets;
b) the rest of us.

The Soviets practice all skills at uncomfortably fast tempo and maintain this pace for hours. In 1981, S.Y. Deryabin, of the Central Lenin Institute of Physical Culture, submitted to coaches that Soviet youth should emphasize, "...speed, acceleration, and high speed turns, puck skills, and special (hockey-specific) endurance. In Soviet hockey everything is constructed on sudden spurts and turns of speed."

The rest of us practice at comfortable speed. To work on our shot, we dump a bucket of pucks at the top of the circles and take slap shots with a slow, comfortable wind-up. Meanwhile, the Soviets work on shooting while their feet are moving at full speed, never letting the goaltender know when the shot is coming. The rest of us set our feet and coast, because even in practice, we want to crank off impressive shots in front of our peers.

As a Soviet forward approaches the defense, his feet are flying, his stick never stops moving in and out, his head and shoulders move side to side, and all of a sudden he's past the defense, sprinting toward the goal. Passes are made and received while skating full speed around corners. The rest of us follow the North American tradition, practicing and playing at one speed and "kicking it up a notch" for the playoffs.

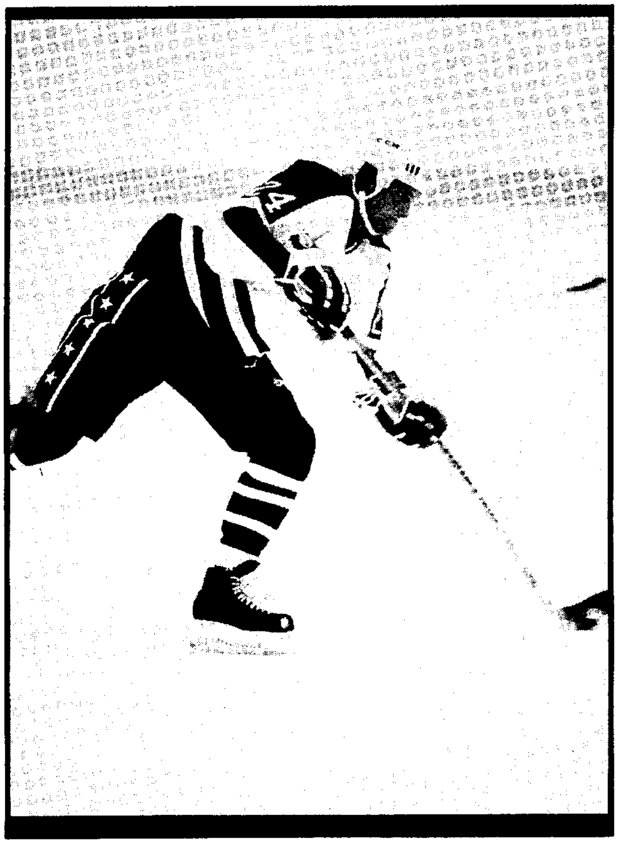
Actually, the Soviets are happy the rest of us get emotionally high for the Olympic Games, and try to compete faster than ever before. They know the opponent will not operate effectively in the "Soviet Comfort Zone." Added tension is created because of the unfamiliar pace of skills, and this leads to fatigue. The Soviets have practiced and played in this zone — hour after hour, year after year. The rest of us have not.

... we must begin practicing skills at an uncomfortably fast pace for many hours and many months in order to raise our own comfort zone.

Over-speed skill practice — raising our own comfort zone

If we consider the problem facing any youngster competing for the first time at a higher level, it is the same problem the rest of us face in competition with the Soviets: attempting to play at a faster pace than the one established by hundreds of comfortable repetitions. In other words, we must begin practicing skills at an uncomfortably fast pace for many hours and many months in order to raise our own comfort zone.

Consider how often we move at comfortable speeds in practices, games, and in our everyday lives. It's easy to see how permanently ingrained these slow speeds are in our makeup. Besides being a psychological phenomenon, the comfort zone is truly physiological as well. By definition, walking, jogging, and all aerobic training is done at a comfortable pace. If a jogger speeds up just a little he experiences discomfort from lactic acid build-up in muscles and blood. As a result of the acidity, the jogger feels pain,



loses strength, endurance, and coordination, and hyperventilates, because the pace is just slightly above the comfort zone set from many training sessions.

Increasing the speed at which we perform all skills in competition requires five phases of on-ice training. The order is important.

1) Learn basic skills at a comfortable pace (not discussed in this book, but a good topic for another day and a more qualified author).

2) Overspeed skating without pucks: increase skating speed and acceleration beyond present limits, especially short bursts around corners. Avoid tightening up from your effort to reach new speeds. Relax, and attempt overspeeds in a comfortable, smooth, efficient way.

3) Gradually add skills like carrying the puck, shooting, and passing into your overspeed skating.

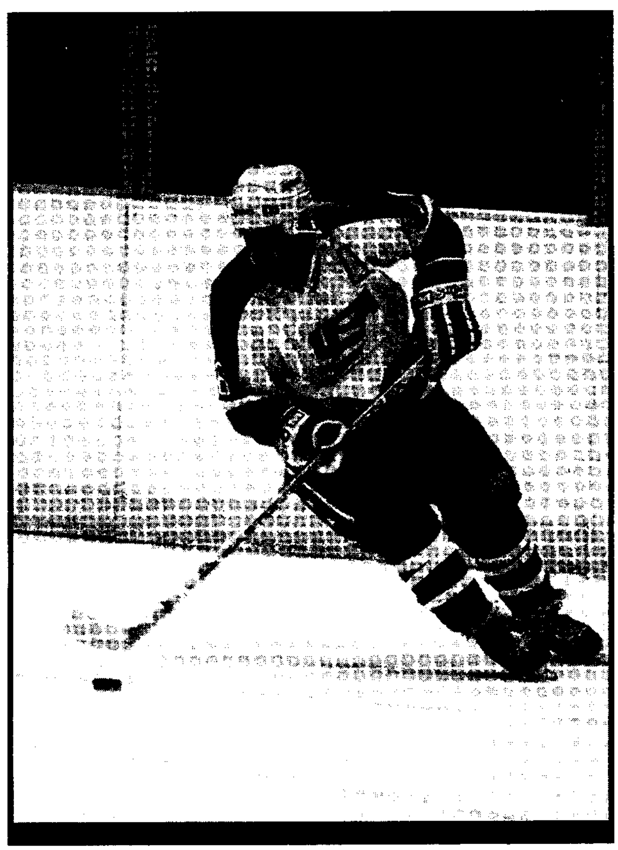
4) Incorporate spontaneity or creative decisions into the overspeed drills.

5) Overspeed competition: this may require new types of scrimmage activities where the environment is controlled by the coach. Try 3-on-3; 4-on-4; and 5-on-5 with no contact, very short shifts, and even with lighter equipment.

If at any time the pace of the skill practice slows down, return to the simplest, fastest skating drills without pucks. Sometimes, simple straight-ahead races are a vivid reminder of the pace at which we want to attempt all skills.

Off-ice preparation for over-speed skill practice: the essential building blocks

The critical ingredient for on-ice, over-speed workouts is ***quality repetition.***
Without first forming a solid base of ***endurance, leg speed,*** and ***leg strength,*** the skating skill will be compromised at some point and repetitions will be done incorrectly, teaching slowness rather than quickness.

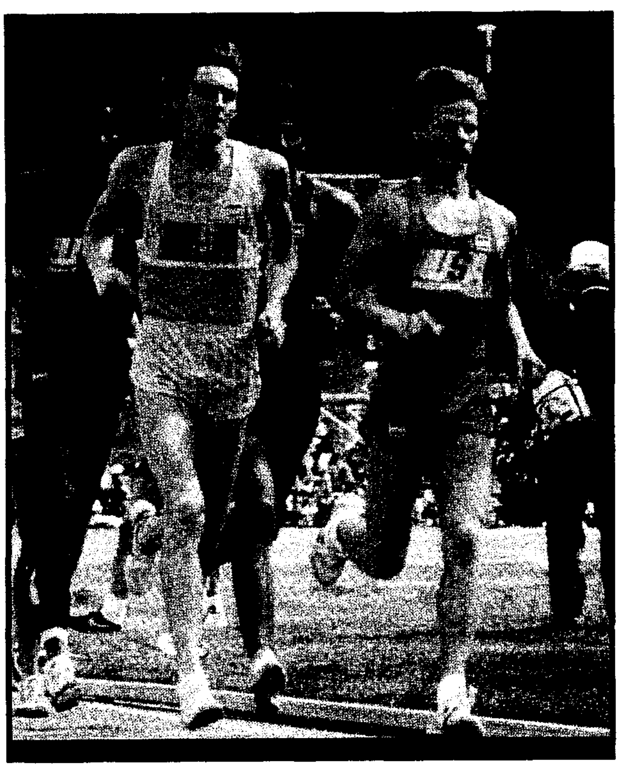


Physiological "Comfort Zone," not just a psychological barrier

Imagine sitting in on dinner with a distance runner the night before the Boston Marathon. His personal best time is 2 hours : 20 minutes, a pace of 5 minutes : 20 seconds per mile. Someone asks the question, "Why don't you just go out tomorrow and run each mile ten seconds faster? That doesn't seem like a big difference in average speed and would give you a 2:15 marathon — close to the winner."

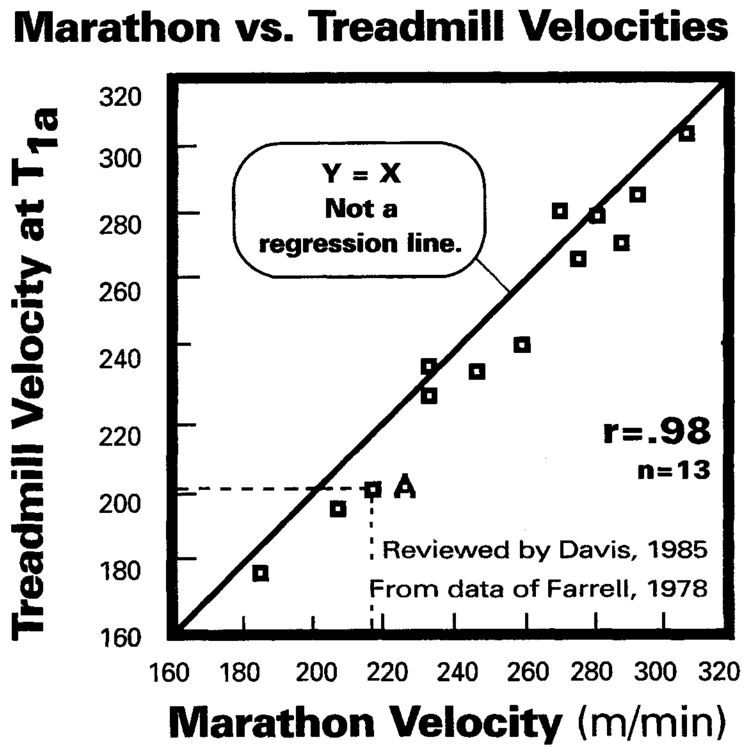
Good question. In fact, we might think the difference is in the runner's mind. Much of the problem with barriers like this one originates in our mind. Much of it doesn't. There are physiological consequences for a marathoner performing just slightly faster than his normal practice and competition pace — the comfort zone he's been establishing with all those grueling miles over the years.

In his doctoral thesis at the University of Arizona, P.A. Farrell (1979) studied 13 marathoners during a progressive treadmill test, in which the speed of the treadmill was gradually increased until the runner could not continue. For each treadmill test, there was a distinct velocity (below maximum) where lactic acid began to accumulate rapidly. This point, Tla is called the lactate or anaerobic threshold. At any speed below this point, lactate would not accumulate much if he ran for hours. At higher speeds, there is substantial buildup and complications of lactic acid.
Much research has been done on the concept of 'anaerobic threshold' but it is generally agreed that when an athlete works at speeds above his threshold, Tla, he hyperventilates, and feels general discomfort, in addition to the usual pain in the legs associated with increased acidity (Wasserman, 1986). The following graph indicates that marathoners should incorporate more quality interval work, in which they run slightly faster than previous 'race pace' — "*over-speed training*".



To interpret Farrell's data, each runner's average performance speed during the marathon is compared to the velocity on the treadmill at which he reaches threshold. The interesting physiological fact is that each runner stays so close to his threshold velocity during competition. They run within their well-established comfort zone.

The interesting physiological fact is that each runner stays so close to his threshold velocity during competition. They run within their well-established comfort zone.



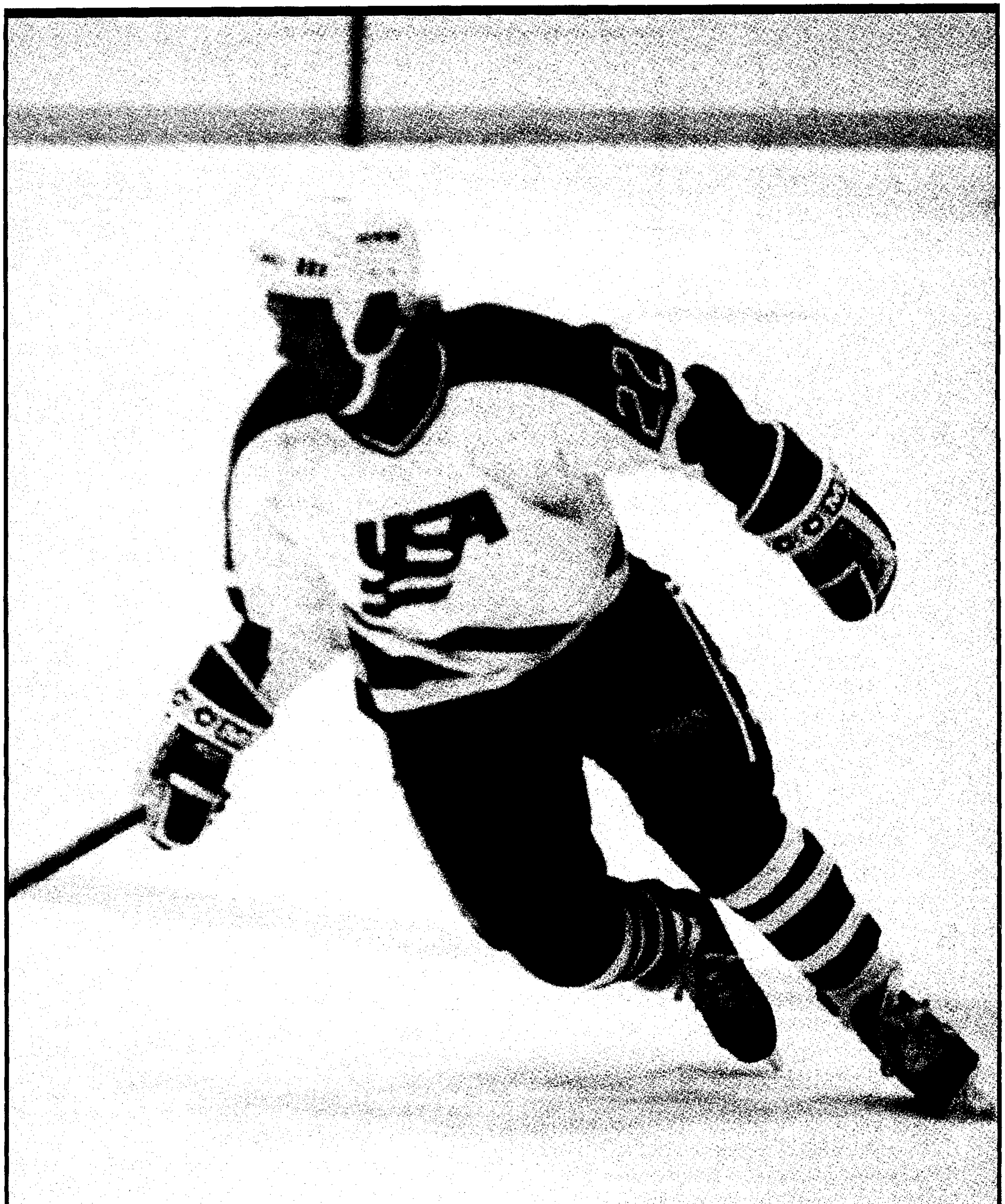
Note on reading the graph: most of the runners compete at a speed slightly faster than their threshold velocity (to the right of the diagonal line). Notice runner A competes at about 218 m/min but reaches anaerobic threshold at 201 m/min. This might mean they are over-achieving slightly in spite of physical stress. More likely, it indicates that running on a treadmill, wearing an uncomfortable mask to collect expired gases through a hose, and having a catheter in a vein for collecting blood samples, the runner reached threshold at a slightly lower velocity than while competing outdoors

Why can't we compete slightly faster than we train?

There will be lactic acid buildup, hyperventilation, and substantial muscular dysfunction and pain. Hockey players have a comfort zone that is just as ingrained, but perhaps more difficult to graph, because we don't play at a constant velocity.

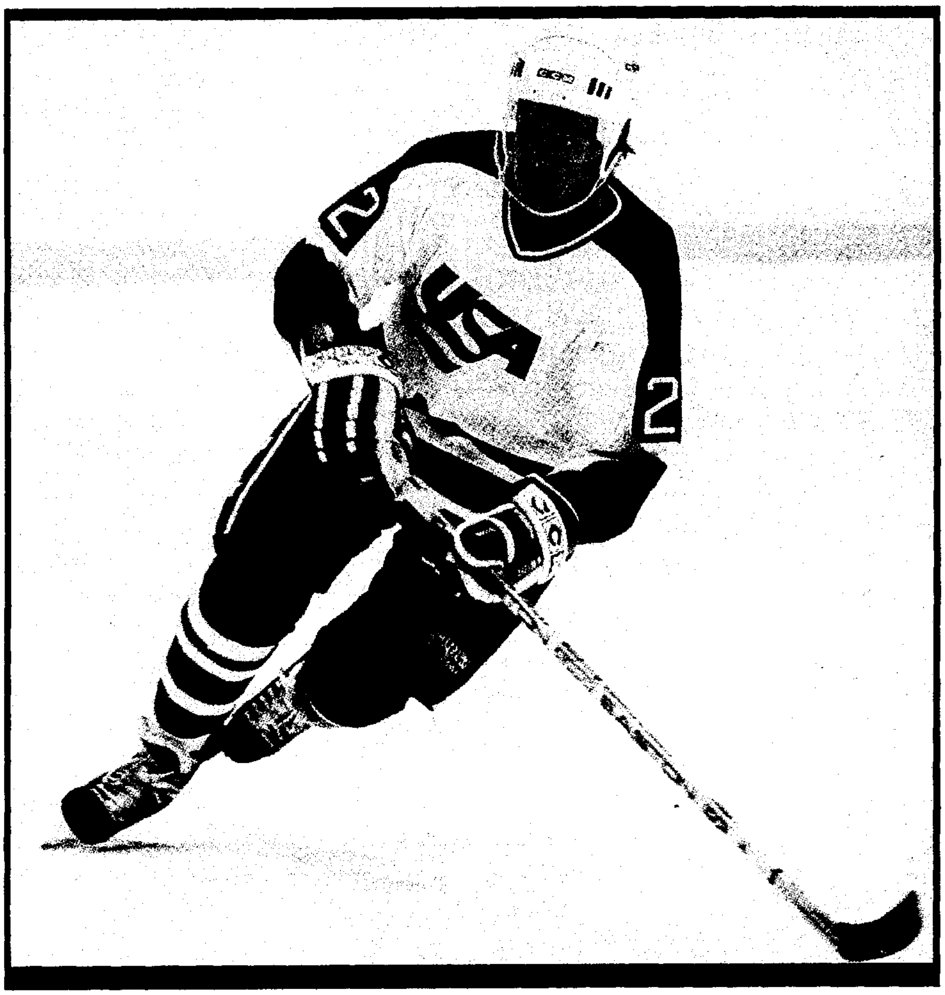
For a hockey player, attempting competition out of his comfort zone — picking up the pace just a little in the biggest games — his efforts would be met with just as significant physiological consequences. If we add the complications within the nervous system caused by using nerves and muscles in a way they've never trained, one can only imagine the stress.

This is why we must train at a pace we'd like to use later in the most important competition of the year. That way when we get there, and are really psyched up to play at 110%, we are operating in an intentionally elevated comfort zone, built from hours and years of overspeed practice.



Skating quickness:

speed, acceleration, agility



Chapter Overview:

1 Players and coaches of U.S. teams have seen that Europeans are extremely fast skaters, especially adept at cornering and performing skills at high speed.

It is no wonder Soviet scientists communicate to their coaches the importance of testing and training for speed (on and off-ice) in comparison to all other physiological tests:
"Factor analysis, including tests of physical development showed the greatest factor loads go to tests describing speed capabilities ... especially speed, acceleration, and high speed turns. This is particularly important since that component of fitness is most successfully open to development at a young age" (Deryabin, USSR 1981).

2 Our research with over 2000 hockey players and 60 teams of various age and skill levels shows that teams at a higher designated level of play are faster at top speed and accelerate more quickly.

3 Attempting corners at over-speed requires greater knee bend, a fact which does not apply to over-speed skating in a straight line. Simple physics of cornering forces shows us that strength training must supplement on-ice learning in order to develop this skill correctly:

Cornering skill might be learned and performed perfectly at a slow speed, but while the technique does not change at higher speeds, it becomes increasingly difficult to corner as we attempt faster speeds. The player must lower his center of gravity more using greater knee bend, and this must be done against extremely high centrifugal forces. Without strong legs, players will revert to some form of compensation which develops poor technique if repeated often.

These facts imply that we must start training at a very young age for a low center of gravity by bending our knees in off-ice drills as well as when we skate.

Picture a sports car competing against a jeep in a race around corners.

Skating quickness: speed, acceleration, and agility

Hockey: a game of short sprints and explosive turns

Biomechanists at the Olympic Training Center used high speed film and computers to analyze movement patterns during a training game for the U.S. Olympic Team (Dillman, Stockholm, and Greer, 1984). They found that a typical shift was characterized by short, 2.0 second accelerations followed by coasting and deceleration of about 2.1 seconds. Other scientists have found similar results with Canadian junior players (Green, 1976), and the Czechoslavakian National Team (Seliger, 1972).

A test of 'top speed'

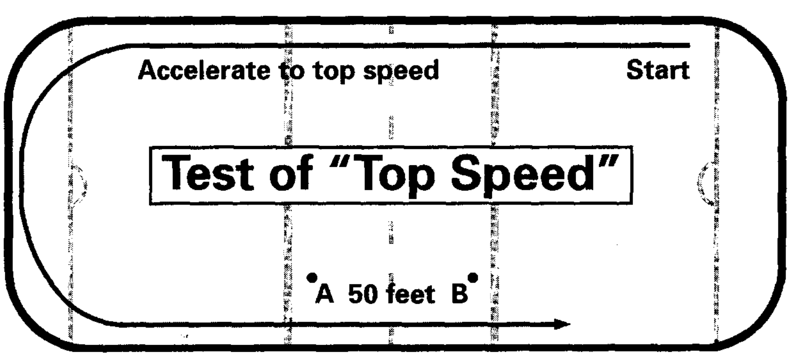
A test of 'top speed' was developed, in which players skate through photocells for a distance of 50 feet after a considerable run-up. In preliminary studies, skaters took more time than they would have guessed to accelerate to full speed and decelerate to a stop. It was necessary to include a run-up along one length of the rink, around one end, and up to the neutral zone, where they were timed for 50 feet.

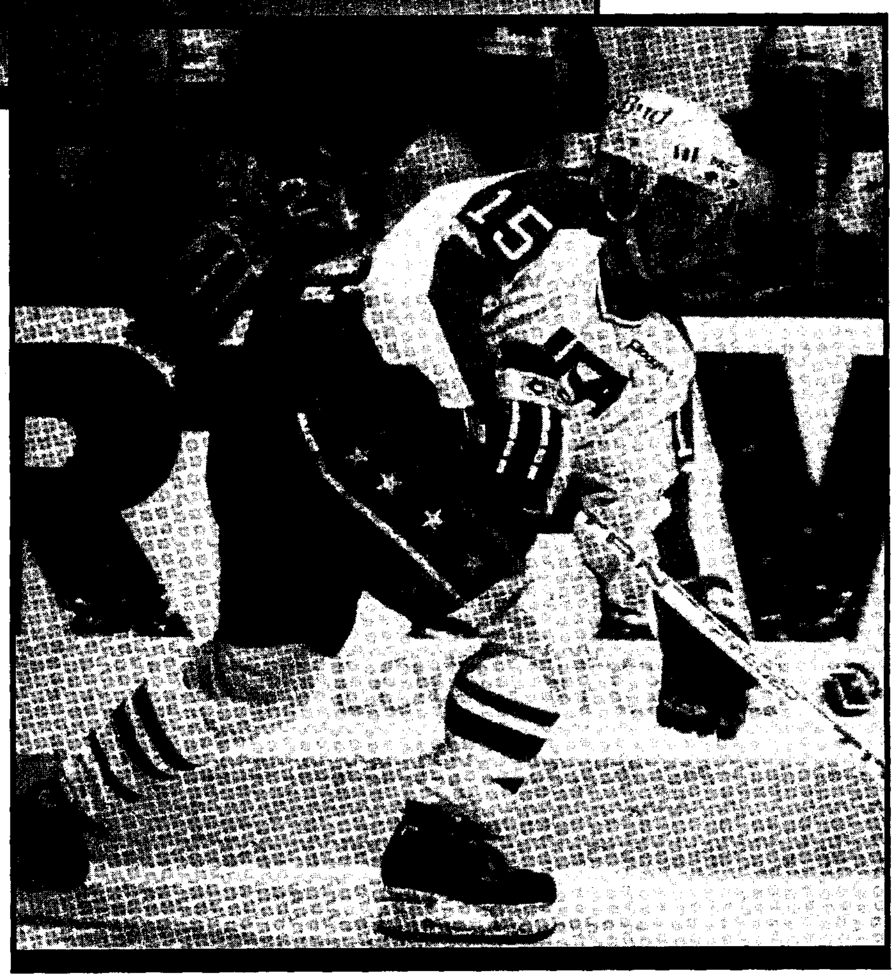
The results of the top speed test were highly reliable (repeatable) and showed clearly that players at higher designated levels of play were faster.

Skating tests showed clearly that players at higher designated levels of play were faster.

The top 80 amateur players in the country tried out for the 1980 Olympic Team, and the ones who eventually won the Gold Medal at Lake Placid were significantly faster than the players who tried out but didn't make the team. In testing 60 teams since that time, we have found similar results . Teams at higher levels of play are faster. Obviously, there are exceptions in which fast players can't compete at higher levels because they either lack other qualities or aren't given the chance, as in the case where scouts ignore small players regardless of their abilities.

Skating speed is also highly related to age: notice in the following graph that older teams are faster. The curve peaks at 25 years, however, because older professional players have stopped training for speed and have spent too much practice time hooking and interfering. It is obvious that age is not the reason for the drop-off in speed, because we all witnessed some aging track athletes who ran the best times of their lives in the last Olympics after what they called their best training years: Florence Griffith Joyner, age 28; Edwin Moses, age 32.





Team average maximum skating velocities

Test of "top speed"

Teams of same age and different level of competition.

OVER AGE 20		
U.S. OLYMPIC TEAM	>	UNSUCCESSFUL CANDIDATES
NCAA DIV.I UNIVERSITY CHAMPION	>	NCAA DIV.II COLLEGE CHAMPION
NCAA DIV.II COLLEGE CHAMPION	>	DIV.II COLLEGE TEAM (SAME LEAGUE)
18-19 YEAR OLDS		
U.S. NATIONAL JUNIORS	>	USHL JUNIOR A TEAM
JUNIOR A TEAM	>	JUNIOR B TEAM
15-18 YEAR OLDS		
U.S. NATIONAL MIDGETS	>	HIGH SCHOOL VARSITY
HIGH SCHOOL VARSITY	>	UNSUCCESSFUL CANDIDATES
HIGH SCHOOL VARSITY	>	HIGH SCHOOL JUNIOR VARSITY
13-14 YEAR OLDS		
A BANTAM TEAM	>	B BANTAM TEAM

STATISTICAL T-TEST RESULTS

> means faster; significant at the .01 level

Representative of 57 teams (n = 2013 players)

Test-retest ***reliability*** for "top speed" varies between r=.997 and r=.920 depending on age and homogeneity of team.

Table 1 has some interesting comparisons. It shows that when teams are grouped by age, the teams that play at a higher designated level are faster at 'top speed.'

Acceleration capabilitlies

Quick short bursts of acceleration are a top priority of the training by U.S. Olympic teams, because we've seen the superior quickness of European teams on the larger Olympic sized rinks.

In 1979, we began testing the acceleration capabilities of 41 hockey teams (n=1886) over a 90 foot test in which the players were given a 10 foot "running start" and timed from 10 to 90 feet using photo-electric cells. The test was found to be reliable (r=.92 to r=.98) during test-retest measurements and correlated with the high speed film/computer analysis of acceleration in the first 20 feet (Greer, 1984).

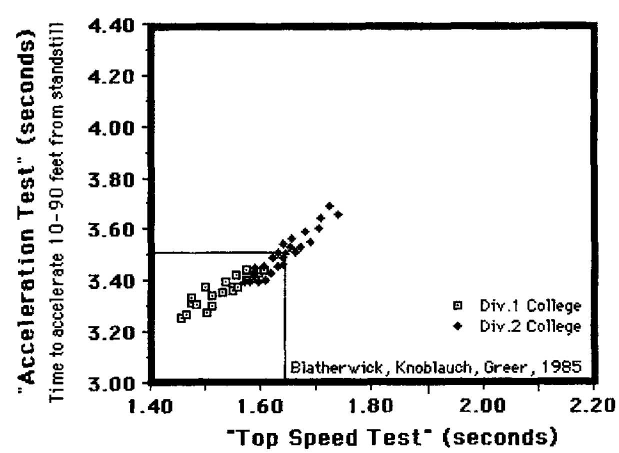
Even the slowest players on a pro or college team are very fast.

Acceleration, like 'top speed,' was an important predictor of achievement level. For example, a Division I university hockey team was three standard deviations quicker ($p<.0005$) on the skating acceleration test than a Division II college team with players of similar age, height, weight, and body composition. These two teams are compared in the next graph showing times for both the "top speed" and "acceleration" tests.

Note: the following graphs show the times to perform both the top speed and acceleration tests, not velocities and accelerations. Therefore, the lower a player's point is on the graph, the quicker is his acceleleration, and the farther to the left, the faster is his top speed.

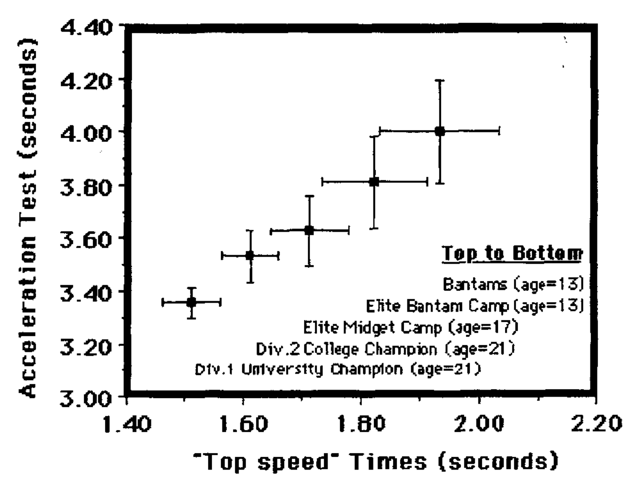
Of the 1886 players tested for both "top speed" and "acceleration" times there were 8 professional, National, or Division I University teams tested. Not one player from these "elite" teams had results which fell outside the rectangle in the lower left corner of the graph. Even the slowest players on a pro or college team are very fast.

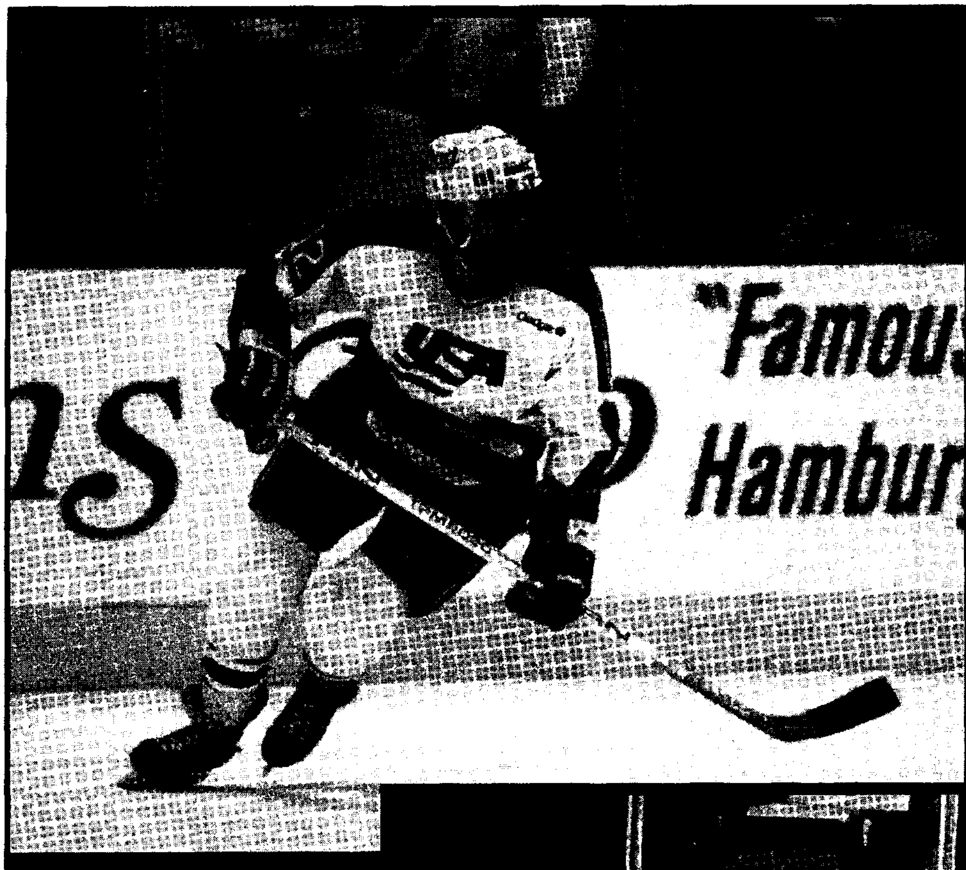
Skating "Top speed" vs. Acceleration Times



Above: times for each player from two teams the same age.

Below: means ±1 s.d. of five teams timed on both tests. Notice that teams the same age, but different classifications have very different speed and acceleration capabilities.





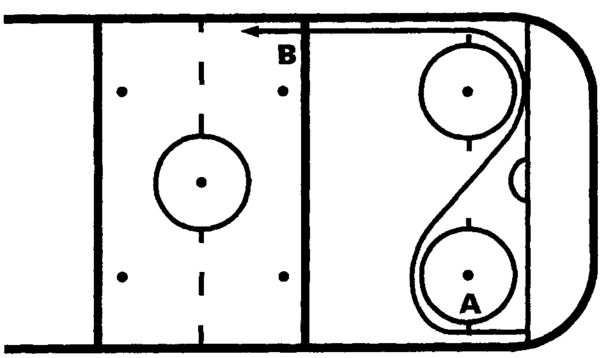
Agility and cornering ability is more difficult to test

Agility would probably be best defined as the ability to change directions quickly, and is perhaps the most important of all skating attributes. It is difficult to quantify, because the test protocol would require (almost random) quick changes in direction, and if players were able to follow the same course exactly, the ice would be cut up at each corner. Our attention shifted to a simple 'S-test' with two turns, where it was necessary to spray water to avoid cutting deep ruts in the ice.

The ability to skate corners is highly trainable on and off the ice

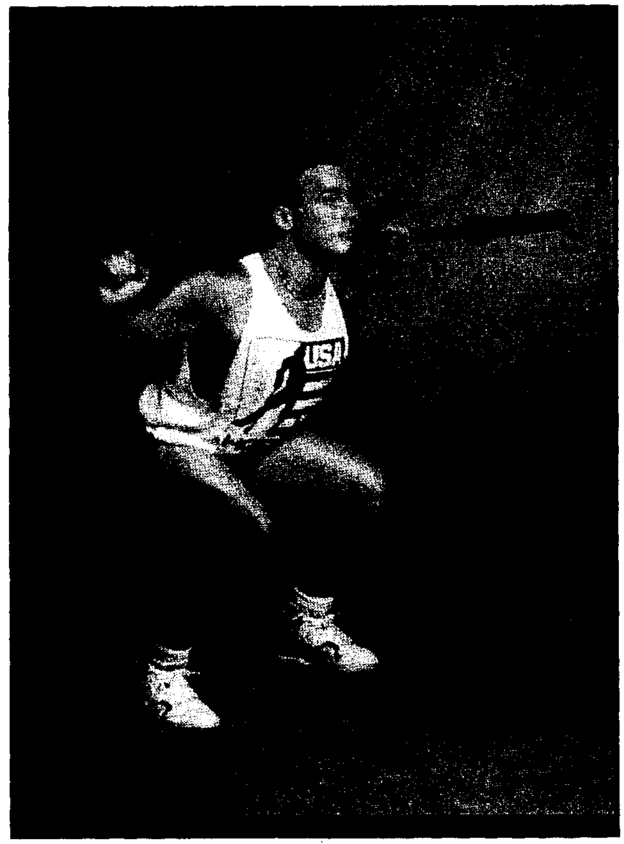
Two groups of 15 year old hockey players served as subjects for a summer training study with on and off-ice tests before and after the 7 weeks. One group played in a summer league and trained as they normally would (control group, n=12). Another group trained three times per week for up to 2 hours on-ice followed by an hour of lower body weight training (training group, n=16).

The on-ice workouts consisted of short sprint intervals with and without pucks for an hour at the beginning of the summer and 2 hours at the end. The last 15-20 minutes of each skating session consisted of skating corners wearing weight vests representing about 15% of body weight.

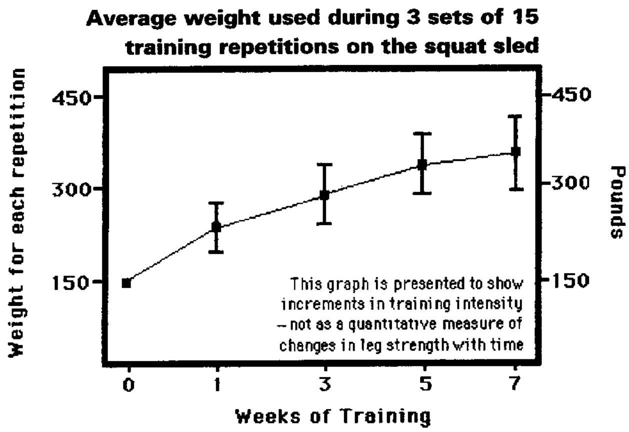


S-Test using photocells and high speed film

Lower body strength training started with squats using an unloaded bar for the first three weeks, but gradually small amounts of weight were added.



The heavier resistance training was done more safely on a plyometric squat sled (Owatonna Engineering; Medford, MN) designed to simulate the position of bar-bell squats. Players worked out with at least 3 sets of 15 repetitions, and over the seven weeks, the average training weight increased from 150 pounds to 360 pounds.



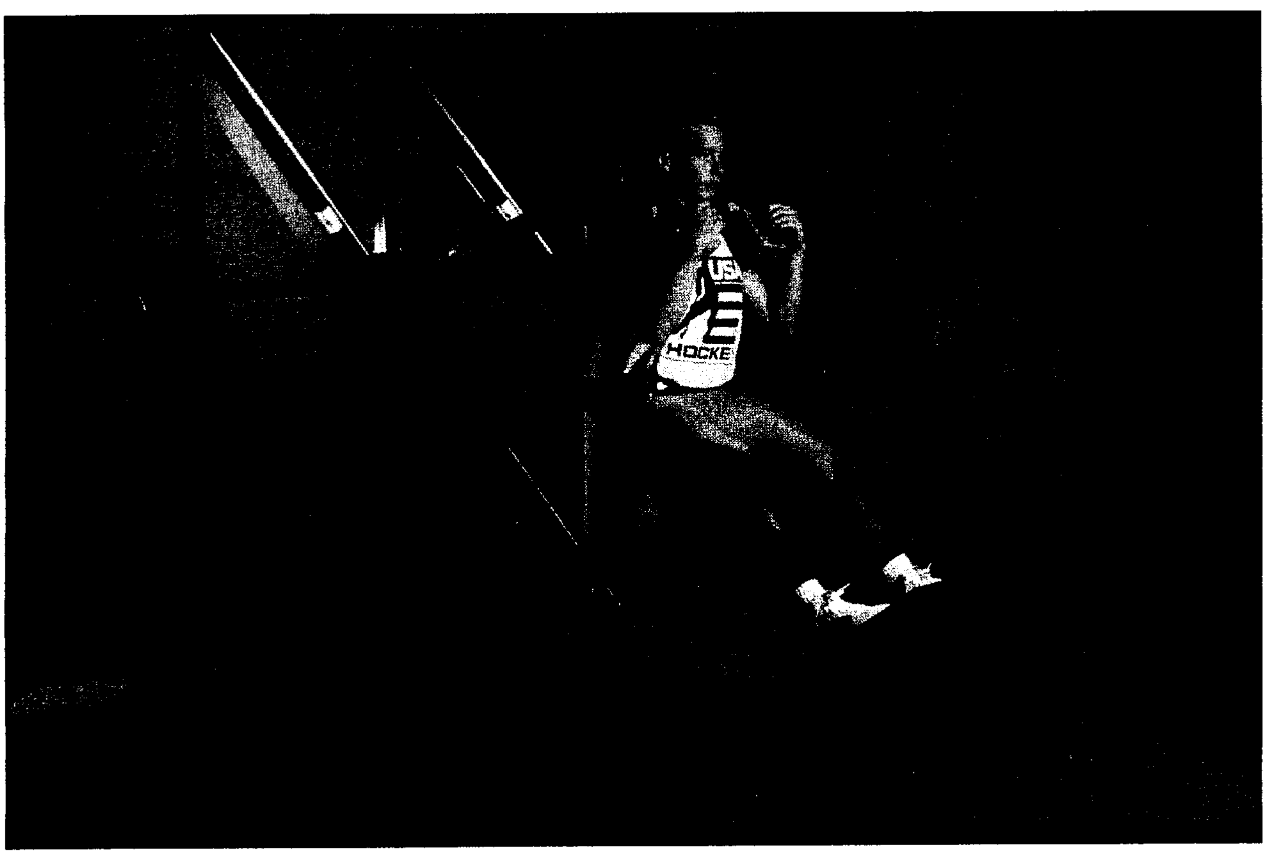
The results of seven weeks of training compared to seven weeks of games are shown graphically on the next pages.

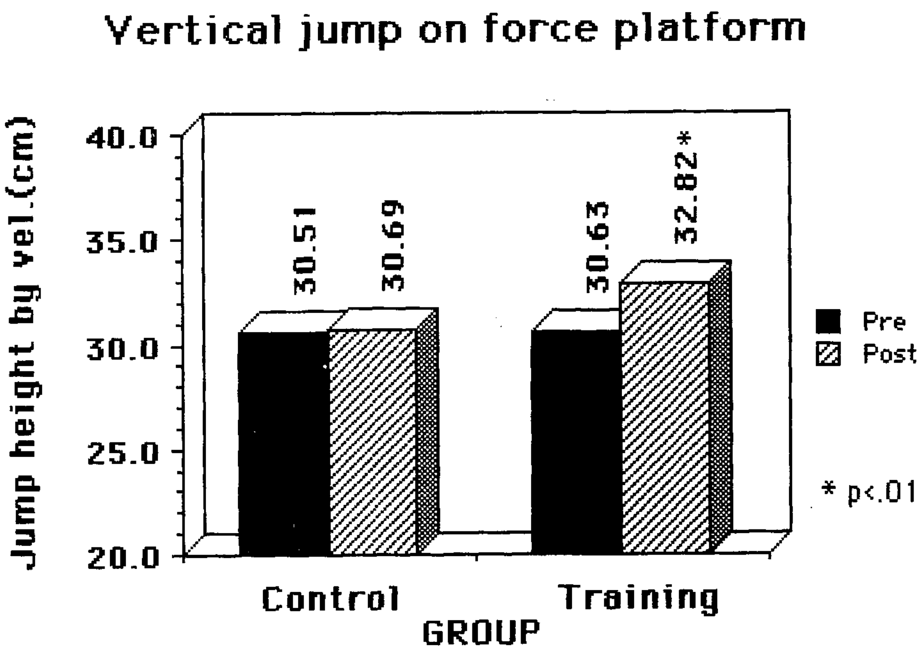
1) Both groups reduced body fat and increased lean body weight significantly ($p<.01$).

2) The training group (but not the controls) improved performance times on all skating tests, especially the cornering test (5.2%) and the top speed test (4.5%), which includes a high speed corner before starting the electronic timer.

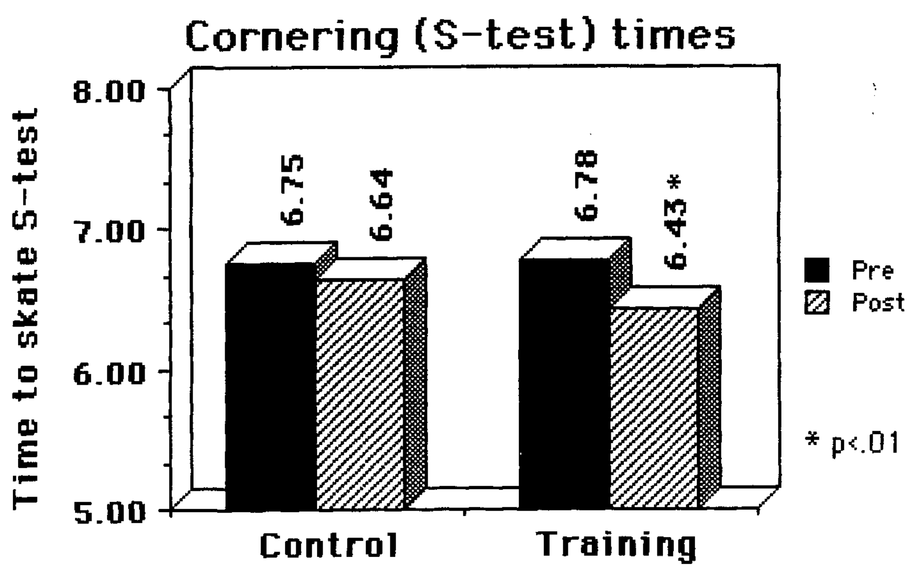
3) The training group (but not the controls) increased the ratio of thigh girth to fat, a measure used to monitor relative muscle mass in the thigh.

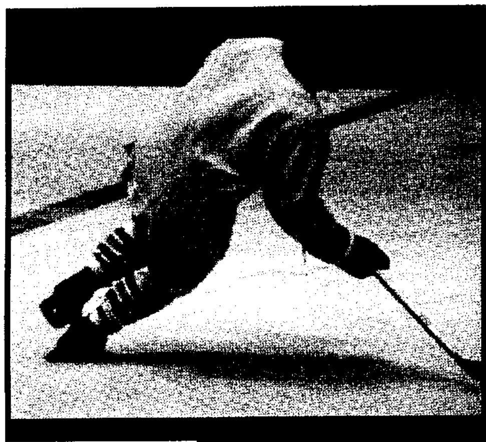
4) The training group (but not the controls) increased vertical jump measured on the force platform.

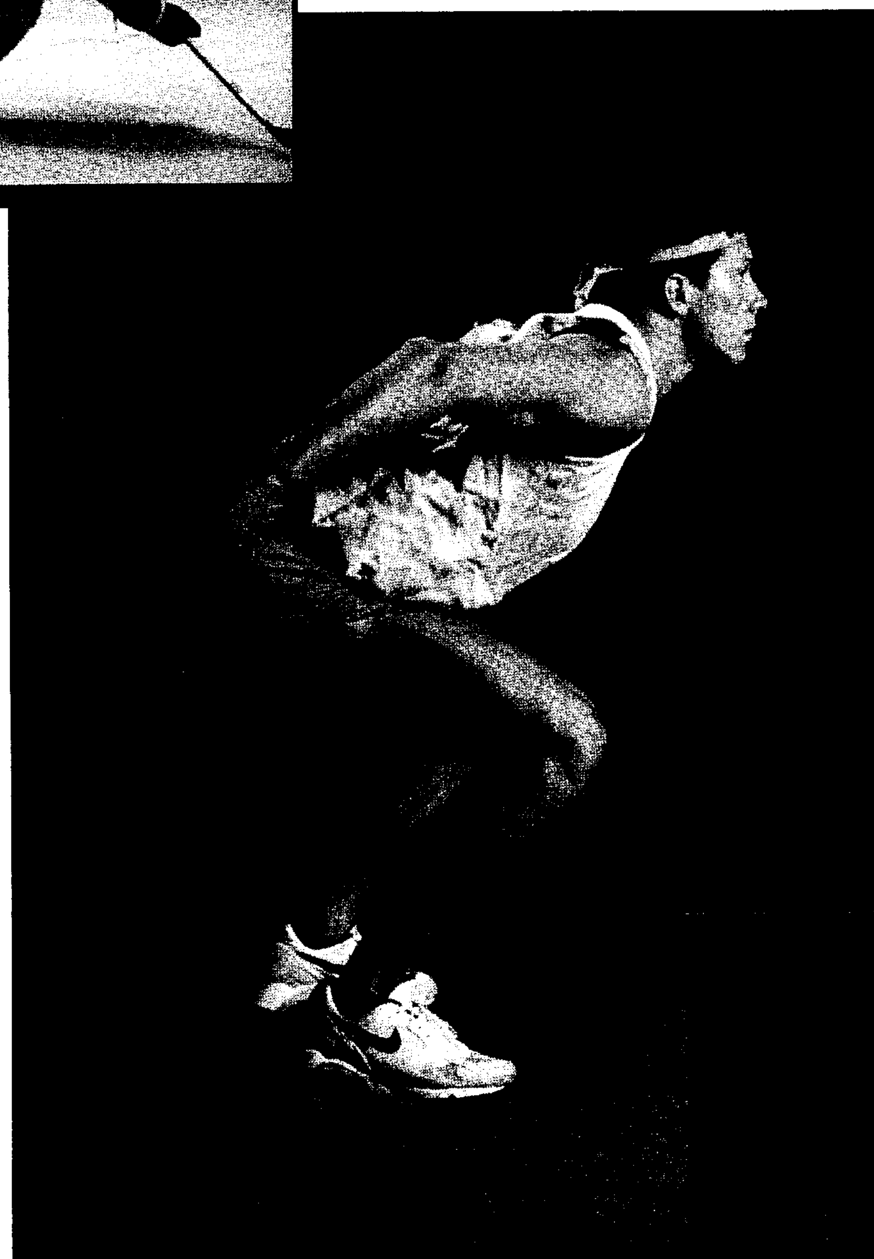


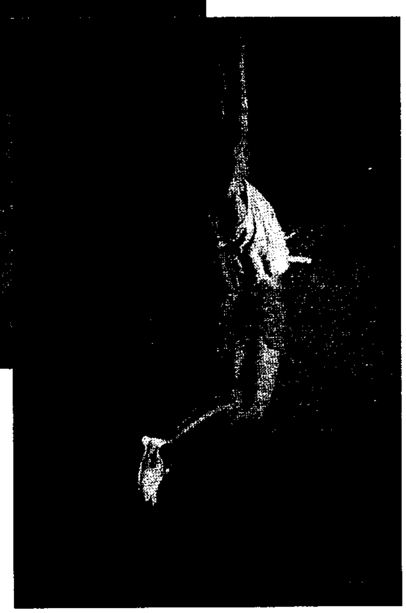


In skating corners and jumping ability, the training group improved more than those who had skated in a summer league for the same weeks.





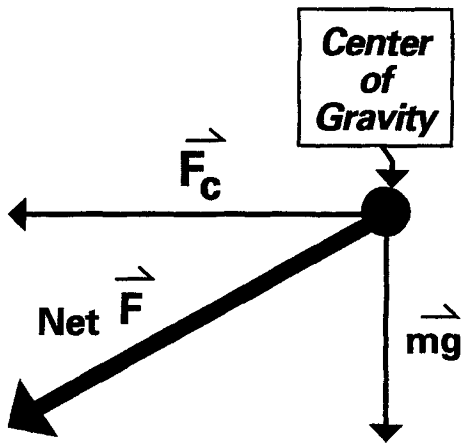




Velocity and cornering forces

One of the consequences of the high velocities attainable by hockey players is increased centrifugal force on corners. Using one of the 1984 U.S. Olympic players as an example, maximum skating velocity was 10.7 meters/second (35.0 feet/s or 23.8 miles per hour) and weight with equipment was 100 kg (220 pounds). If this player were to skate a corner as wide as half the rink (r = 50 feet) at full speed, the resultant force (centrifugal force and body weight) would be 450 pounds as shown below. This is not only possible but one of the sprint interval drills in the daily training program of U.S. Olympic Teams.

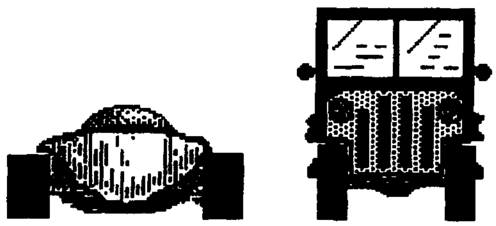
Centrifugal force, $Fc = mv^2/r$



Note: Net force, F, is the vector sum of weight (vertical force, mg) and centrifugal force (Fc, horizontal), and must be 'summed' using the Pythagorean theorem.

.... a net force greater than 400 pounds on one leg as he corners at top speed !!!

The double-edged sword: "To compound the problem of a large force on the legs as we corner faster, the player must bend his knees more to lower his center of gravity. Picture a sports car in a race with a jeep on a track with many high speed corners."



As a result of the physics and not because the technique of cornering is difficult, players are reluctant to attempt uncomfortably fast speeds around corners. This is not true skating straight lines. Coaches must be aware of this reluctance, and encourage young players to risk falling during overspeed intervals in order to improve cornering ability.

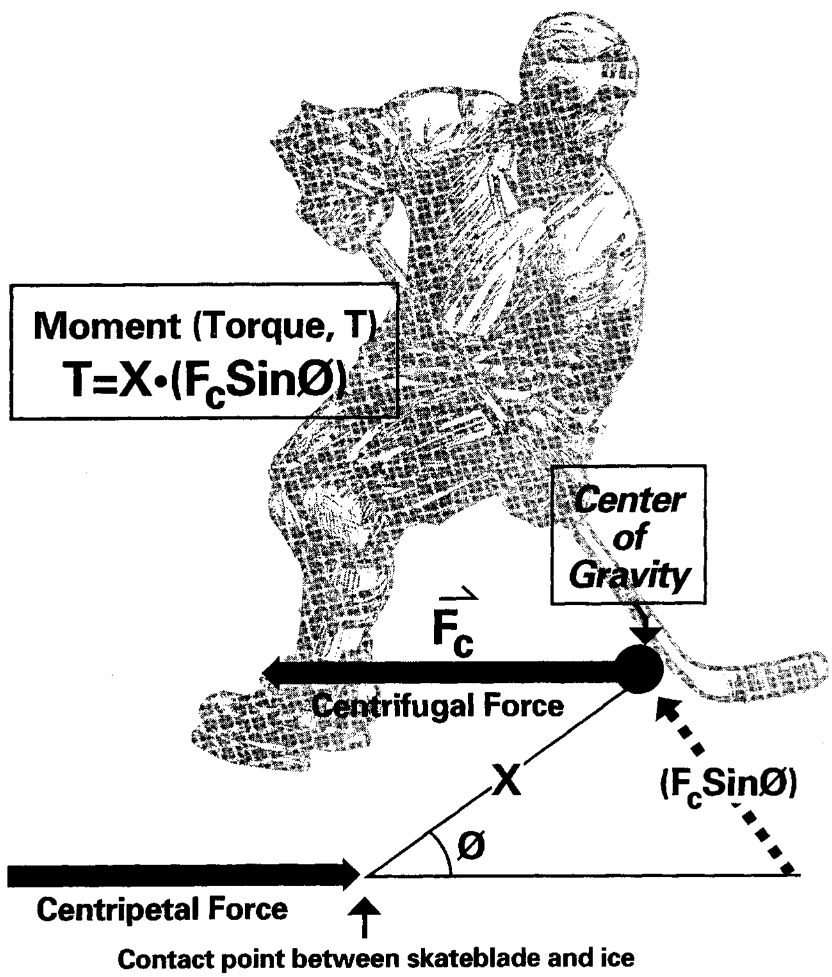
Conclusion from the physics:

Leg strengthening is an essential part of the process of learning to skate corners faster. We must train for a low center of gravity at a young age.

Study the following diagram and you'll see that, with a given speed and centrifugal force, Fc, to reduce the outward torque, either X has to be reduced by bending your knees, or you have to lean more, reducing angle Ø.

The efficient way to accommodate the increasing torque due to greater velocities, is to bend the knees, thereby reducing the lever arm, X.

However, for every player there is a velocity at which the net force becomes too great to be met with enough knee bend. At this point the player must lean into the center of the circle more (reducing angle Ø). This is sensed as the velocity at which the edges of the skates will no longer hold, and the normal reaction is to slow down.



To skate faster...

train like a sprinter!

Chapter Overview:

1 Our research with more than 2000 hockey players has shown that the ability to skate fast is highly related to off-ice sprinting and jumping.

2 This tells us that hockey players should train like track sprinters, hurdlers, or high jumpers. ***Whatever makes us faster sprinters or higher jumpers is likely to improve skating quickness and cornering ability.***

3 Off-ice sprint training — quality sprints with plenty of rest — can help us become quicker skaters. This should include some uphill sprints for overload, and some sprints down a slight hill (~5%) for overspeed.
Sprint training is one of the best ways to improve skating speed at any age.

We should not under-estimate the value of quality sprints. Just because there isn't a lot of pain in the muscles (like after lifting weights) doesn't mean there hasn't been a lot of development. We are training the nervous system. Sprinting uses every attribute of athleticism and teaches the intricate neuromuscular patterns required to move our legs quickly, summing up forces in a very coordinated, consecutive manner from our trunk, down through hip extensors, to knee extensors, to the final pushoff from the ankle and foot extensors.

To sprint fast, you must learn to increase power output while remaining relaxed. This is a valuable lesson for a hockey player trying to skate faster. Both movements utilize quickness and power, but are most efficiently done in a relaxed, coordinated, rhythmical, smooth manner.

The recovery phase of running and skating is equally as important. An added benefit of doing sprints (especially uphill sprints) is to help avoid strains to the hip flexors that are so common when we first skate all-out in the fall. Relatively slow strength training, even in the correct range of motion may not prepare us as well as sprints for the explosive movements in skating that cause injuries.

Young hockey players should consider sprinting on the track team. Track coaches know how to make you faster. We can learn a lot from their training methods.

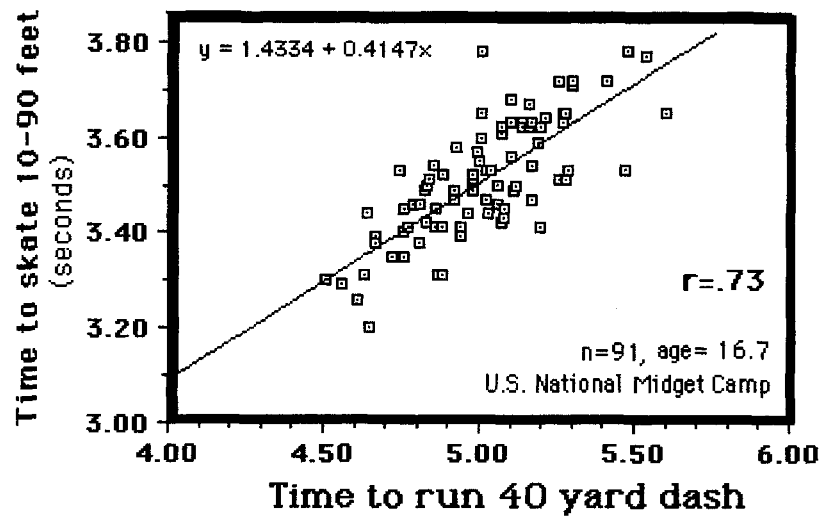
4 Lower body strength training is essential for a powerful skating stride. We have previously discussed the need for strength training to corner properly against high centrifugal forces. This is almost an isometric or static strength. For skating quickness we need to develop power: the ability to combine strength with speed.

5 Plyometrics for skating should emphasize jumps from a deep squat to develop power in a skating range of motion. Runners have a different priority, and many of their plyos are not recommended for hockey players.

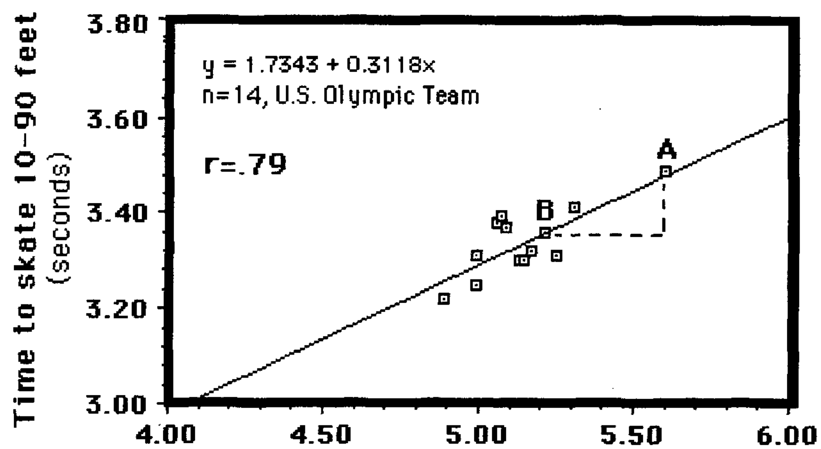
6 Overload plyometrics, such as one-legged or two-legged jumps with or without a weight vest can help us form correct habits of skating with greater knee bend. These should be modified to approximate the skating range of motion.

The fastest skaters are likely to be the fastest sprinters!

With every one of the 50 teams tested, there was a consistently high correlation between times on the skating acceleration test and a running forty yard dash (r values between 0.7 and 0.9). Even on professional and Olympic teams, where skating times are so homogeneous, this relationship is still very strong (r≈0.8).



These graphs show the relationship between running and skating sprint times. The fastest skaters and sprinters are found in the lower left region of the graph.



The importance of these graphs is they show that if a player were to improve off-ice sprinting ability, his point on the graph would be likely to move downward and to the left (such as from point A to point B).

This represents an improvement in skating just by becoming a faster sprinter!

Whatever

training

makes you

a faster

sprinter, ...

will

make you

a faster

skater.

Whatever you do to become a faster sprinter will help you become a faster skater

- Short, quick sprints on a flat track.
- Explosive sprints up a steep hill.
- Plyometrics modified for skating.
- Leg strength using free weights, machines, or weight vest.

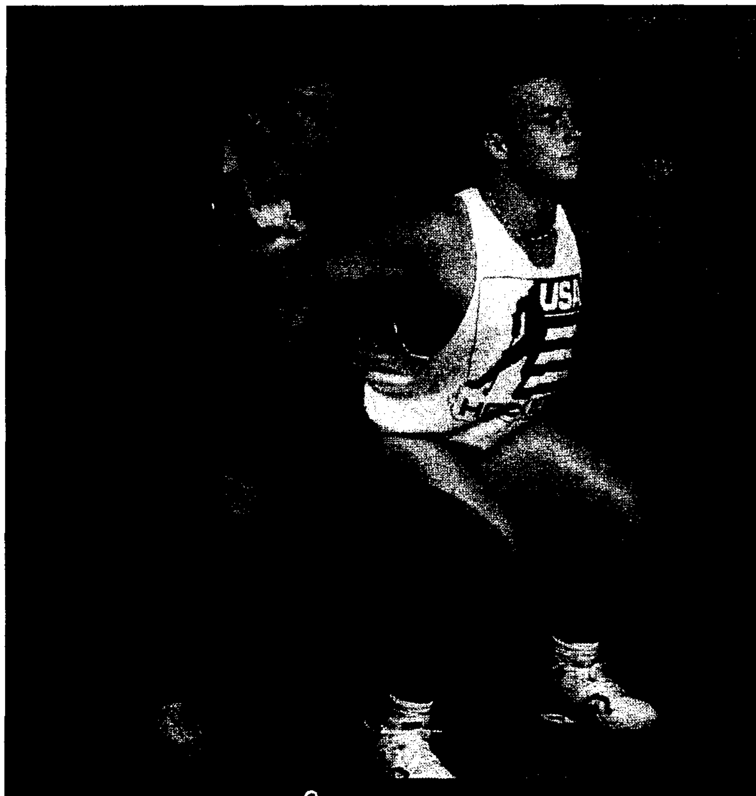
Track coaches, scientists, and strength coaches have worked together for more than two decades to help sprinters become faster. They've found innovative training techniques to incorporate speed with strength, coordination, agility, and flexibility. If we want to become faster skaters, we should adapt some of their training to skating — both on and off-ice. The best choice is to go out for track and work with the sprinters.

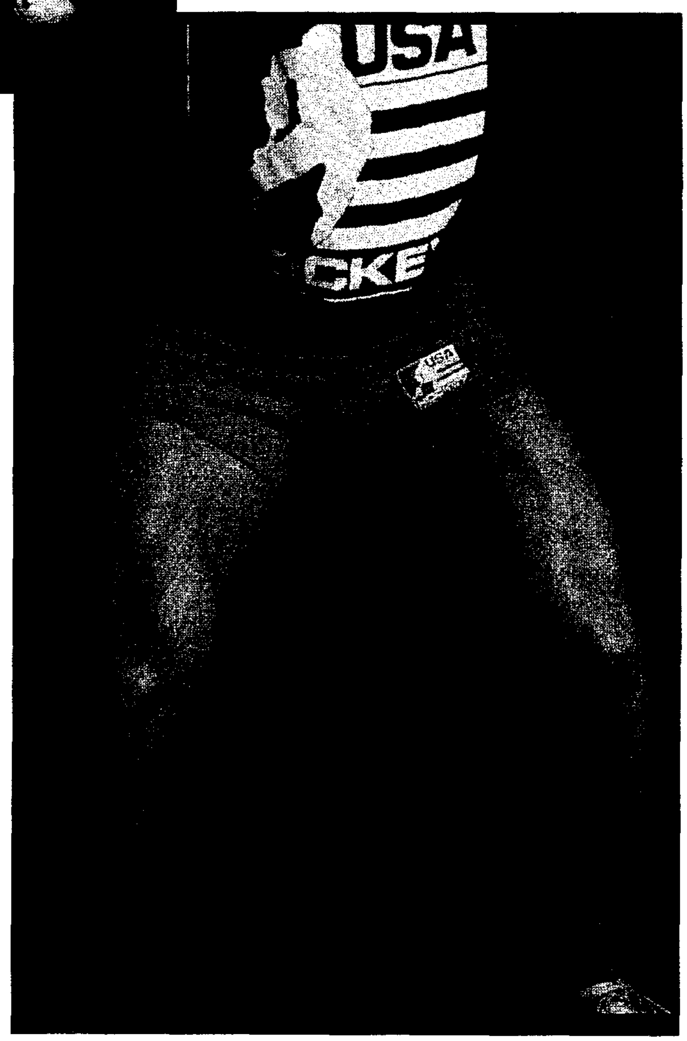
The importance of leg strength

Sprinters have been competing for thousands of years, yet winning times continue to drop at every level. One of the biggest changes in track over the last forty years is the evolution of strength training. In the fifties, few great sprinters (or football players, for that matter) trained with weights. One common concern was the worry that bulky muscles would be slower.

Soviet scientists and coaches have seen the value in sprinting.

Football players and sprinters have demonstrated that strengthening the legs with weight training helps make them quicker — even when they've gotten extremely bulky, in the case of football players. The graph below demonstrates the relationship between sprinting 20 yards, and relative muscle mass in the thighs. High school track sprinters (n=356) were tested while attending a clinic on speed development. Thigh girth was divided by the sum of three ultrasound readings of fat in the legs, yielding a number which is used to determine which athletes had the biggest legs with the least fat. The farther to the right on the horizontal axis, the more thigh muscle an athlete had compared to thigh fat.





Leg strength

is a

critical

factor

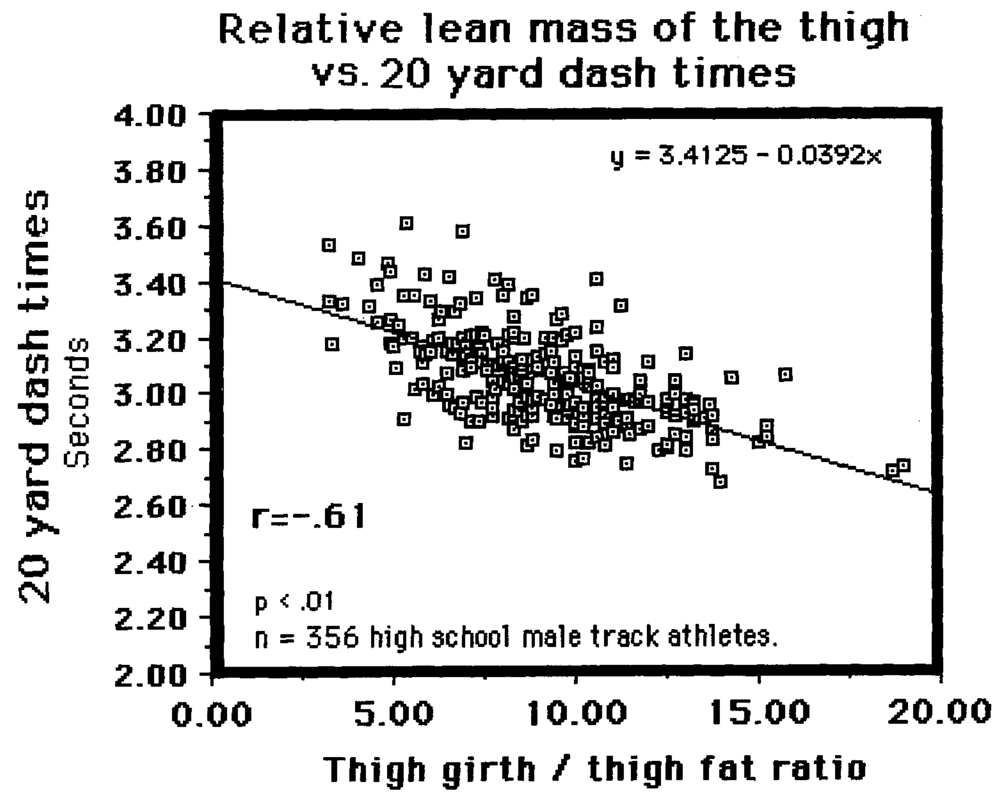
to

develop

quickness

in skating.

Football players and sprinters have demonstrated that strengthening the legs with weight training helps make them quicker — even when they've gotten extremely bulky, in the case of football players. The graph below demonstrates the relationship **Athletes with the biggest thigh muscles (compared to fat) were likely to be the quickest sprinters in the 20 yard dash. A similar result was found for skating.**

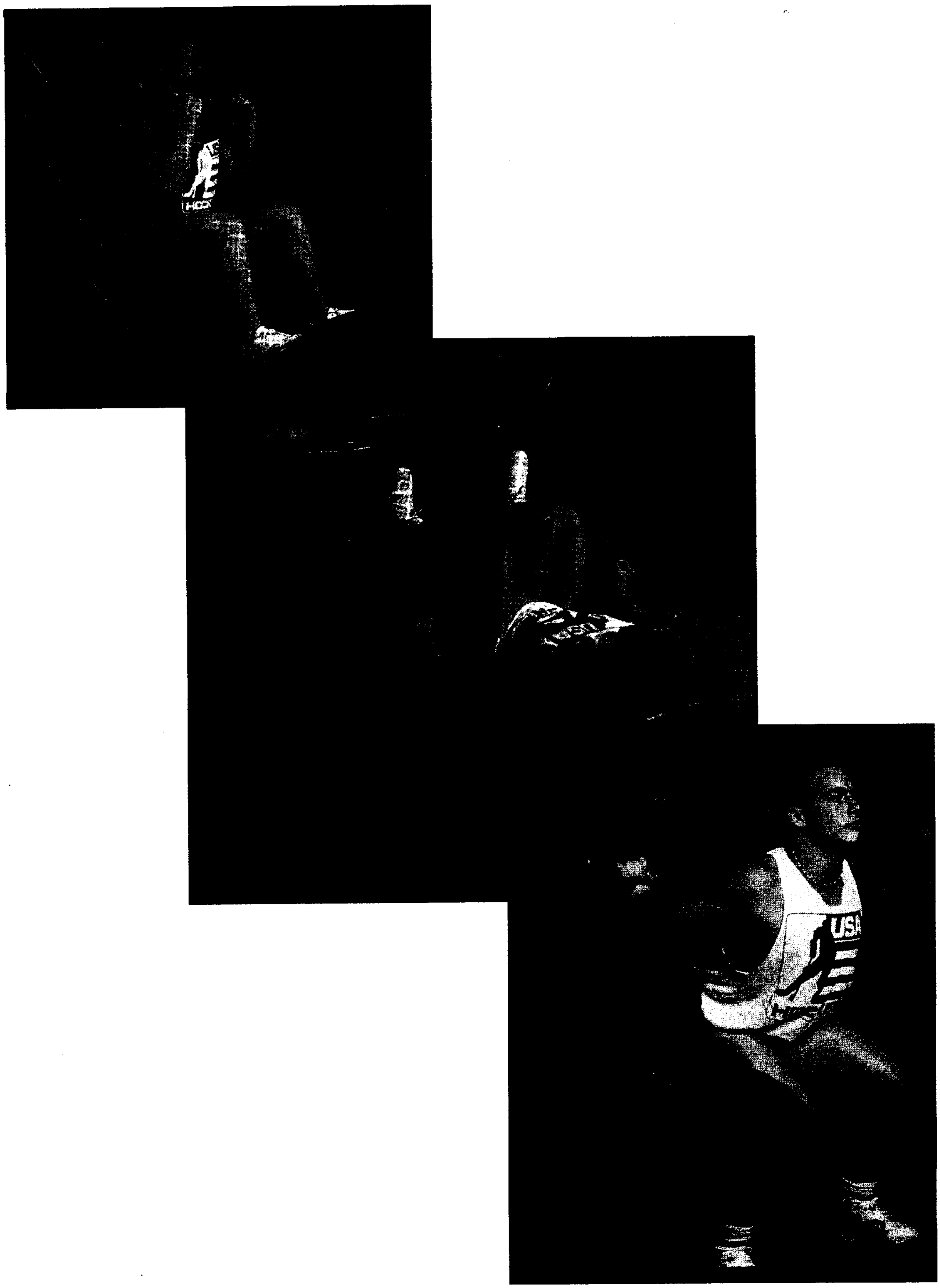


Thigh girth in cm, measured at mid thigh.
Thigh fat in mm is the sum of 3 sites by ultrasound.

between sprinting 20 yards, and relative muscle mass in the thighs. High school track sprinters (n=356) were tested while attending a clinic on speed development. Thigh girth was divided by the sum of three ultrasound readings of fat in the legs, yielding a number which is used to determine which athletes had the biggest legs with the least fat. The farther to the right on the horizontal axis, the more thigh muscle an athlete had compared to thigh fat.

Can we learn from Flo Jo and Ben Johnson?

In the 1988 Summer Olympics, both the male and female winners of the sprint events attributed their recent dramatic improvement to intense weight training (Bock, 1988). At 28 years old, Florence Griffith Joyner shattered existing world records, and ran 100 meter times comparable to elite male sprinters of a few years ago — better than O.J. Simpson!!!


USA

In previous years, Joyner's weakness had been her starts, so she studied the techniques and training of the fastest men. "It's leg strength that makes the difference," said Joyner, and she supplemented her sprint training with weight training, including sets of squats with 320 pounds. The model for her training program was Ben Johnson, who also attributes his world record performances to squat workouts with 600 pounds and more. The fact that his accomplishments have been clouded by steroid use doesn't mean we can't steal some ideas from his workouts. Strength training helped him become the most explosive runner ever, out of the blocks, where sprinting and skating are very similar.

Force • Speed = Power: Using strength explosively.

The goal in track and hockey is to transfer increased strength to quickness.

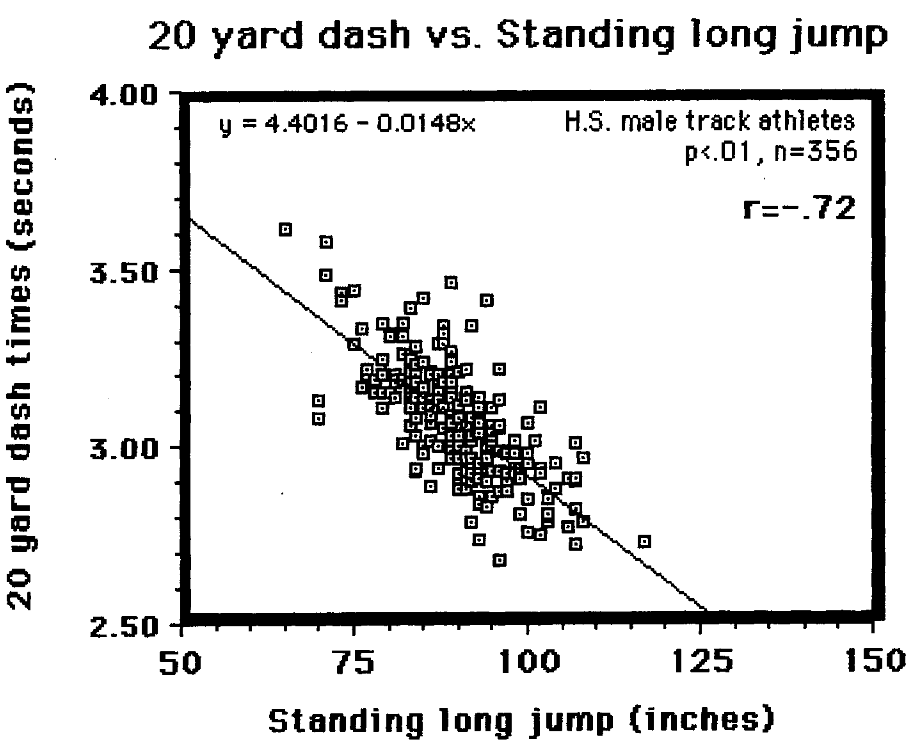
Sprinters have used plyometrics effectively, training the neuromuscular system to apply great forces in an explosive, fast movement. Jumping, hopping, or bounding exercises that resemble the triple jump are done for maximum speed, height, and distance. With high school track athletes we found a strong relationship between speed and jumping ability (long jump: r=-.72, shown below; and vertical jump: r=-.64, not shown).

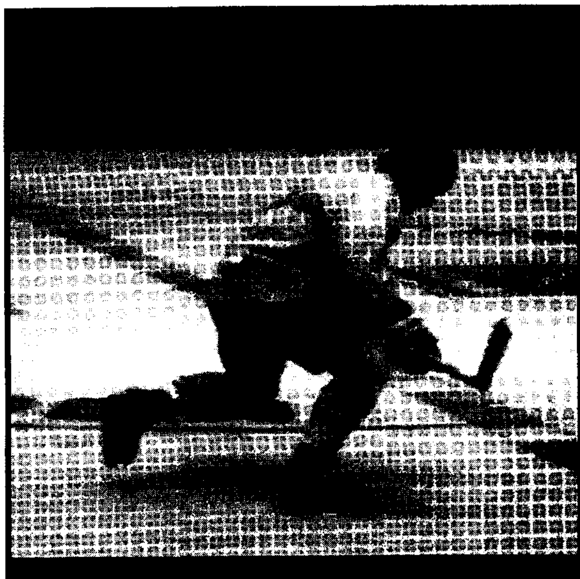
The same relationship exists between jumping ability and skating quickness.

For every one of 50 teams we tested in this manner, the fastest skaters were likely to jump the highest or longest (r values between .6 and .8). We can look at the following graph in the same way as the relationship between on- and off-ice sprint speed...

..whatever training helps you jump higher should make you a quicker skater!

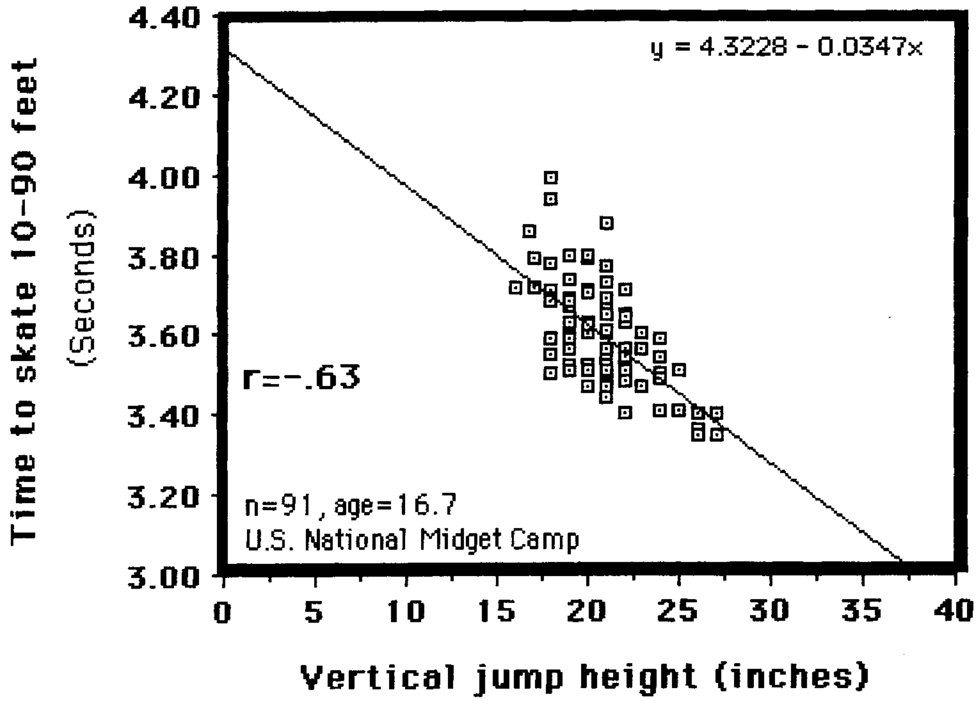
The goal in track and hockey is to transfer increased strength to quickness.





Plyometrics should be modified to approximate the skating stride.

Vertical jump height vs. On-ice acceleration times



Plyometrics should be modified specifically for hockey

Side-to side jumps and one-legged squat jumps should emphasize knee bend and explosive power. As seen in these pictures, the jumper and skater are using the same muscle groups in a similar range of motion. These jumps incorporate balance and coordination, and can be used to improve in these areas.

One of the main goals of sprinters' plyometrics is to shorten the contact time with the running or jumping surface. Many of these plyos look like the bounding or hopping of a triple jump or depth jumps off boxes. Because their purpose is different than skating, and because they cause a great deal of stress on joints, tendons, and ligaments, it is best to stick to skaters' plyometrics.

Dr. George Kingston, of the Canadian Olympic program, thinks we should rename the skating plyos, "Heiden jumps" so they are not confused with the highly ballistic and stressful bounding plyometrics.

Forming a habit of bent knees:

There are two important factors in developing a habit of good knee bend during skating or off-ice workouts:

1) The intricate neuromuscular patterns must be repeated perfectly in order to make the movement become reflex — eventually requiring no conscious thought.

2) Muscular endurance must be developed in this range of motion, so that a player doesn't return to previous habits as soon as there is a little fatigue.

Plyometrics, or jumping activities, can improve skating in several ways:

1) We are training for strength and speed of movement; this amounts to training for power.

2) Each jump follows immediately after a rapid recoil. This stretch reflex is common to running, skating, body-checking, and practically any athletic movement.

3) If jumps are done with exaggerated knee bend, muscular endurance in this range of motion should help form habits of good knee bend while skating.

Dry-land skating improvement

Vary the workouts by emphasizing ***two*** of the ***four*** areas each day — three days a week.

RUNNING SPRINTS — **EXPLOSIVENESS AND QUICK FEET**

Warm up with gradual acceleration sprints — stretching and situps during rest intervals.
Choose from the sprints below, depending upon your objective.
Use less rest if the workout is shorter than 15 minutes.

Quick Starts (quick feet)	2-4 sets x 20-40 yards	Start every 1-2 minutes
Down a slight hill (quick feet)	2-4 sets x 20-40 yards	Start every 1-2 minutes
Sprint and cut (agility)	2-4 sets x 20-40 yards	Start every 1-2 minutes
Through tires or ropes	2-4 sets x 20-40 yards	Start every 1-2 minutes
Backwards (quick feet, agility)	2 sets x 20-40 yards	Start every 1-2 minutes
Sprints up hill (power)	3-6 sets x 20-40 yards	Start every 2-3 minutes
Stride work (lengthen stride)	2-4 sets x 60-80 yards	Start every 2-3 minutes
Anaerobic (sprint) endurance	3-6 sets x 150-200 yards	Start every 2-3 minutes

SLIDE BOARD OR ROLLER BLADE INTERVALS — **BENT KNEES**

Slide board or roller blades	6-15 sets x 40 seconds	Start every 2 minutes

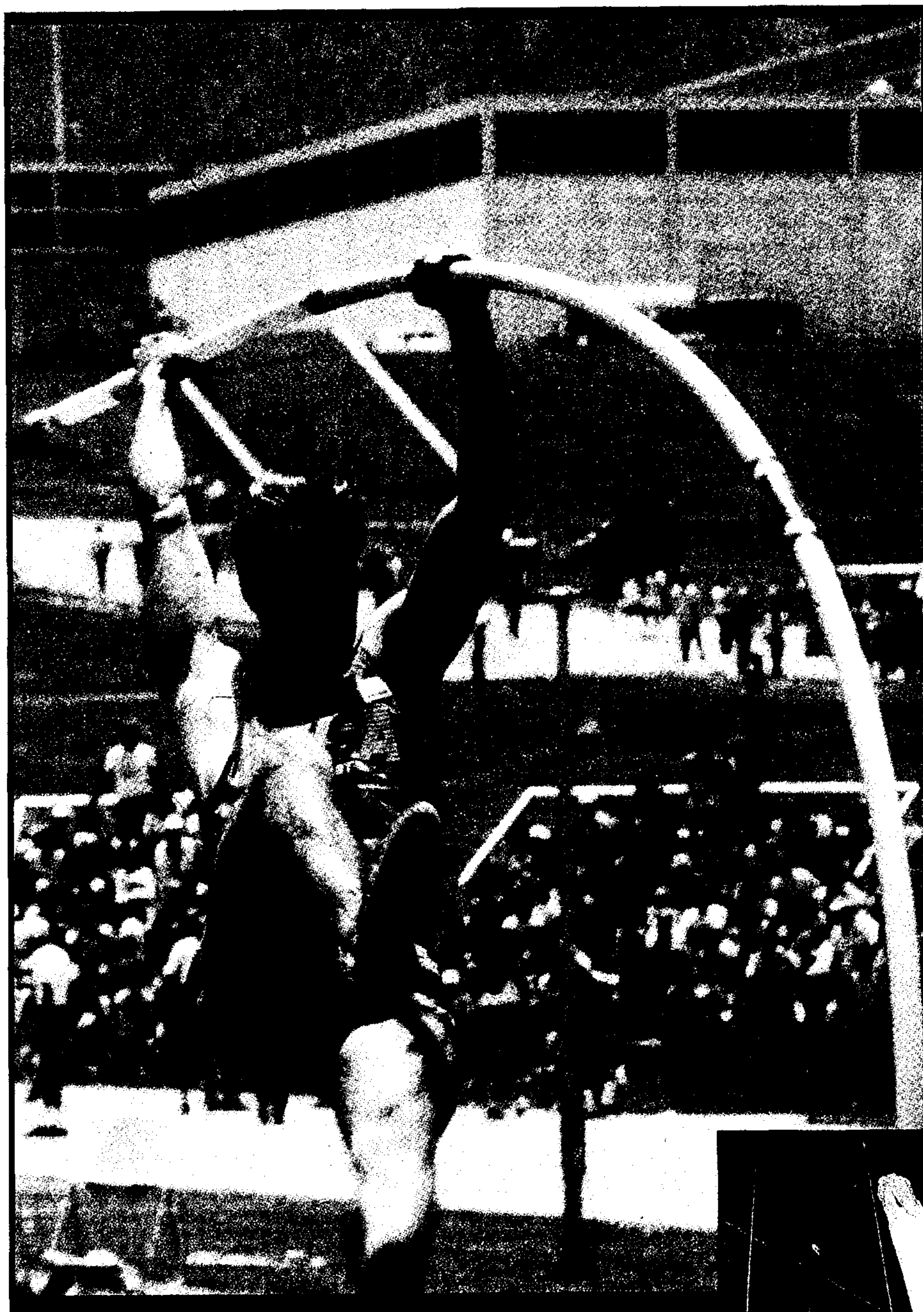
The objective of roller blade or slide board intervals is to form a habit of bent knees:
1) nerve/muscle patterns must be learned, and 2) muscular endurance developed.
Roller blading or ice skating should ***never*** be done as a distance workout.

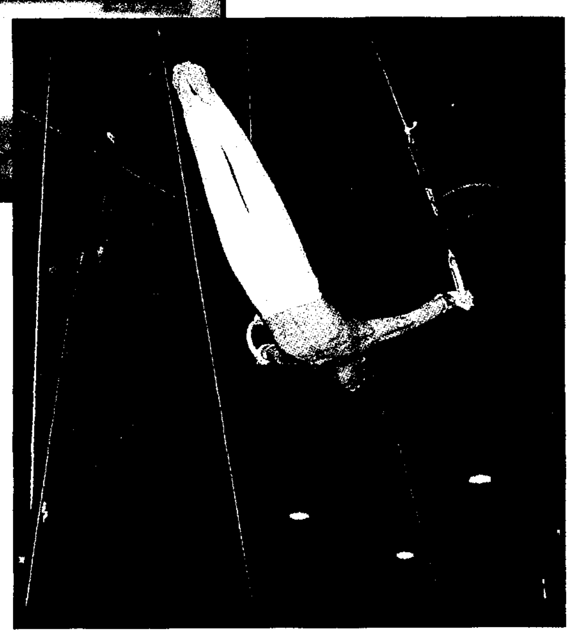
LOWER BODY WEIGHT TRAINING — **LEG STRENGTH**

Change workouts each month. See suggested schedules in later chapters.

PLYOMETRICS — **WITH OR WITHOUT VEST: POWER AND ENDURANCE**

Side to side jumps	1 set x 12 each leg	Start every 90 seconds
One-legged squat jumps	2 sets x 12 each leg	Start every 90 seconds
Two-legged squat jumps	2 sets x 12	Start every 90 seconds





Creating the environment for over-speed skill development ...the physiology

Repetition does not make perfect

— only permanent.

Chapter Overview:

1 The critical factor for on-ice, high speed skill workouts is quality repetition, and this is the responsibility of both the player and the coach.

a) The player must attempt every drill at uncomfortably fast speeds.
b) The coach must plan as systematically for rest and recovery as for workouts. Rest intervals are timed between overspeed drills. Recovery days are interspersed between intense workouts.

2 In order for a series of drills to improve quickness and skill:

a) All-out sprint intervals should last about 5-15 seconds;
b) Rest intervals should be at least 60-75 seconds.

If there are no stops-and-starts or if, by design, the effort is less than maximal, the work intervals can be longer.

3 ***NEVER*** is an individual skating drill done for endurance, because once lactic acid builds up and fatigue sets in, skating skill and speed are compromised.

4 Endurance is gained in several ways without reducing the rest interval and quality of each skating drill:

a) During a season there will be thousands of over-speed skating intervals, in which the work:rest ratio just barely allows recovery.
b) Gradually increase the length of a conditioning practice so that by mid-season it lasts as long as a game. All drills on that day (including team flow drills) are done with proper intervals, and all rests are planned and timed. On this day there are no lengthy explanations.
c) Gradually increase the length of some of the work intervals and shorten (only slightly) some rest intervals as the season progresses.
d) Include some longer skating intervals (like weight vest training) which are not done at high speed, but where the goal is to keep the knees bent, developing muscular endurance in this range of motion.
e) Maintain these workouts, at least twice a week throughout the season.
f) Incorporate dry-land training and weight training in and out of season.
g) Endurance is built gradually within a year-long training plan, including off-season conditioning; there are no quick fixes in the conditioning process!

5 Learning skating skill is no different than learning other athletic skills. Repetitions must all be done with quality, and endurance is not a priority in these drills. Never train for skill, quickness or agility when you are tired.

6 Supercompensation (improvement) from intense workouts requires rest and adequate nutrition. Hard work will only lead to progressive weakness if recovery days are not as well planned in advance as work days. Training camp is not a period of the year for two-a-day conditioning workouts.

Agility drills and two-a-day summer football practices

For several years I've watched the opening days of summer training camp for a professional football team. The coaches were pumped up with a repertoire of new drills, and the players were pumped up by prospects of new contracts.

I've seen some very creative 'agility' and 'speed' drills done with great effort, because in these early days of practice, the squad had not been cut yet. Running through ropes, sprinting and cutting, explosive starts, running backwards, sideways, skipping, hopping, and crab-walking are great drills for a football or hockey player to improve agility, quickness, and speed.

However, in late July, under the sun for two-a-day workouts, wearing heavy equipment, players did not improve either speed or agility. There was no attempt to time the rest intervals to allow for recovery. The few players waiting in line tried to stall a little, so they could sprint through the drill with some quality, but football coaches would have none of it. They seemed more preoccupied with 'discipline' than quality — discipline looking much like torture.

Skills, quickness and agility are improved by quality training (not quantity).

These are the same football coaches who sat up nights dreaming up great new drills. Their intentions and creativity were admirable, but because the drills were done under conditions of extreme fatigue and dehydration, there was certainly no speed or agility improvement in these workouts.

Parenthetically, let me add that the concept of two-a-day workouts to condition football or hockey players at the beginning of a season is idiotic — hot sun or not. The assumption is that players are not in shape, not quick enough yet, not agile, and not ready for games. Then, how can they be ready for the hardest workouts of the year? Games are a piece of cake compared to the hell that a football coach can dream up if he's given an entire summer to plan. How can athletes recover from one blowout practice and return for a second practice ready to improve?

How can speed, skill, or agility be improved when players are slopping through drills without rest?

Grinding athletes into the ground to improve quickness and skills

It seems that coaches of team sports have a monopoly on idiotic training concepts, defending the practice as traditional and character building. Developing mental toughness does not require blind adherence to a poorly conceived drill or practice. Like strength, speed, endurance, and agility it might be better to build character over a long period of intelligent, rigorous, self-disciplined training.

Coaches of individual sports like track know that sprinters get faster from running fast sprints. Football, basketball, and hockey coaches try to make players faster with traditional wind sprints, done slowly of course, because there is minimal rest. The apparent thinking is that the more sprints we do, the faster we get.

Gymnastics, pole-vaulting, or diving coaches would never have their athletes attempt a difficult, new routine when they're tired. Hockey coaches apparently have felt that skating skill is improved by grinding players into the ice, polluting quickness workouts with endurance.

A golfer wouldn't improve his swing by hundreds of repetitions made without rest. A world class 110 meter hurdler won't cut his time down by slopping over 500 meters of hurdles. But, for some reason, many coaches of team sports aren't satisfied with a drill unless the tongues of players' are hanging as low as their tails. We get nervous if we see players standing around. The original intent of the drill might have been to work on quickness, skill, and agility, but on the field the priority gets lost. "Just suck it up, work hard, and don't ask questions. If there's no pain, there's no gain."

Work intervals must be short ... Rest intervals must be long to allow quality repetitions.

Priorities must be established for every practice drill

If a drill is intended to improve endurance or strength, it may often be true that "...with no pain, there's no gain." However, drills designed for quickness, agility, skill, or speed must never be done past the point of fatigue or pain. Work intervals must be short and rest intervals long enough for quality repetitions.

Lactic acid: painful and debillitating

We've all experienced the pain in our legs after sprinting or skating full speed for more than 15-20 seconds. The pain comes from the buildup of lactic acid, which is an end product of fast paced effort (see "anaerobic work" in the glossary).

Laboratory experiments with a small piece of excised muscle in a dish of salt water show that electrical stimulation can make the muscle contract until acid is added. When a person exercises hard enough for lactic acid to build up there is a similar dysfunction of muscles. Strength, speed, and coordination are adversely effected.

Workers at the Wingate Institute in Israel devised an all-out sprint test on a stationary bicycle, in which the subject pedalled against a fixed resistance for 45 seconds (Bar-Or, 1987). The power output of the subject is the product of the pedalling speed and the fixed resistance, and is measured in Watts.

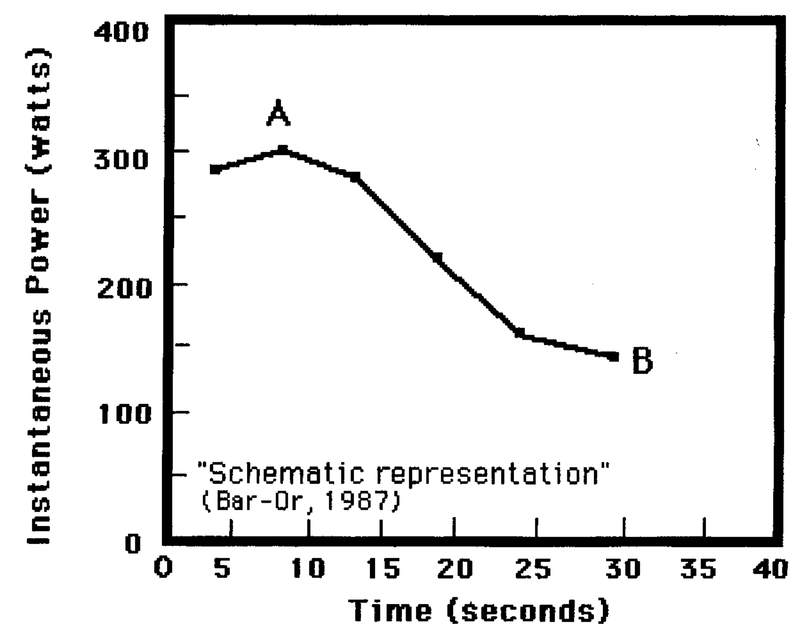
The bike test demonstrates how lactic acid and fatigue diminish power within 10 seconds. Ask any one who has done the test how his legs feel at 20 seconds.

From the following graph, we can see that a typical subject loses power quickly after an initial 5-7 second burst, and within 30 seconds is pedalling only half as fast.

Similar results have been observed in many studies since, even with highly trained college and Olympic hockey players tested on a bicycle (Blatherwick, 1983). We'll see that skating speed and skill are effected just as soon during stops-and-starts.

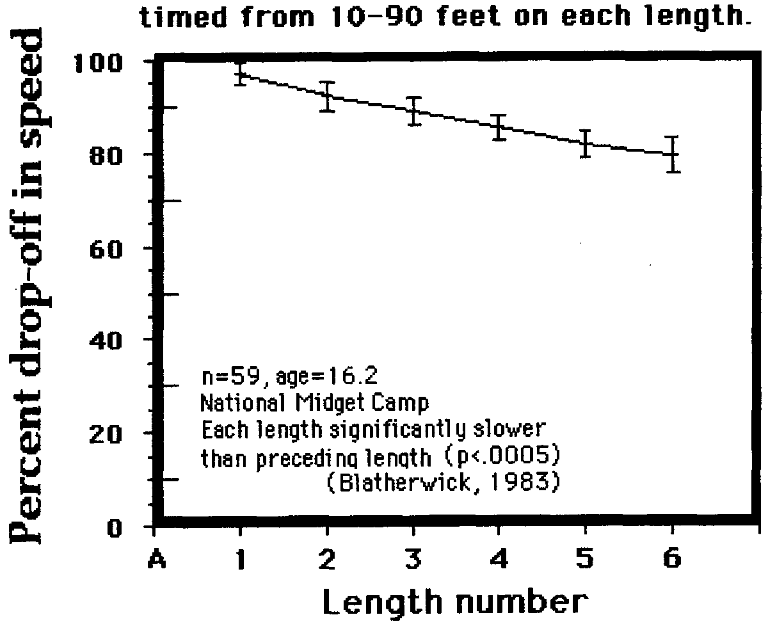
An all-out shuttle test of skating endurance shows a similar drop-off in speed.

Wingate anaerobic bicycle test



Skating endurance test; 6 lengths of 130 feet

Percent decrement in average velocity timed from 10-90 feet on each length.



A=average velocity 10-90 feet during separate acceleration test. (100% on this graph)

It is common in scientific literature to show average values plus or minus one standard deviation.

In this graph, each vertical bar includes about ⅔ of the players.

Greer, Dillman, and Blatherwick (1984) studied the effects of a 45 second all-out skating test on speed and biomechanical skill factors known to be associated with acceleration. Players sprinted from a standstill to a point 130 feet away, stopped and sprinted back to the starting point (constituting 2 lengths of a total of 6). Since skaters decelerated the last 40 feet or more of each length, their speed was monitored only from 10-90 feet. Prior to taking this endurance test, each player had performed an acceleration test of one length to establish his fastest average speed from 10-90 feet (Shown as length A or 100% on the following graph).

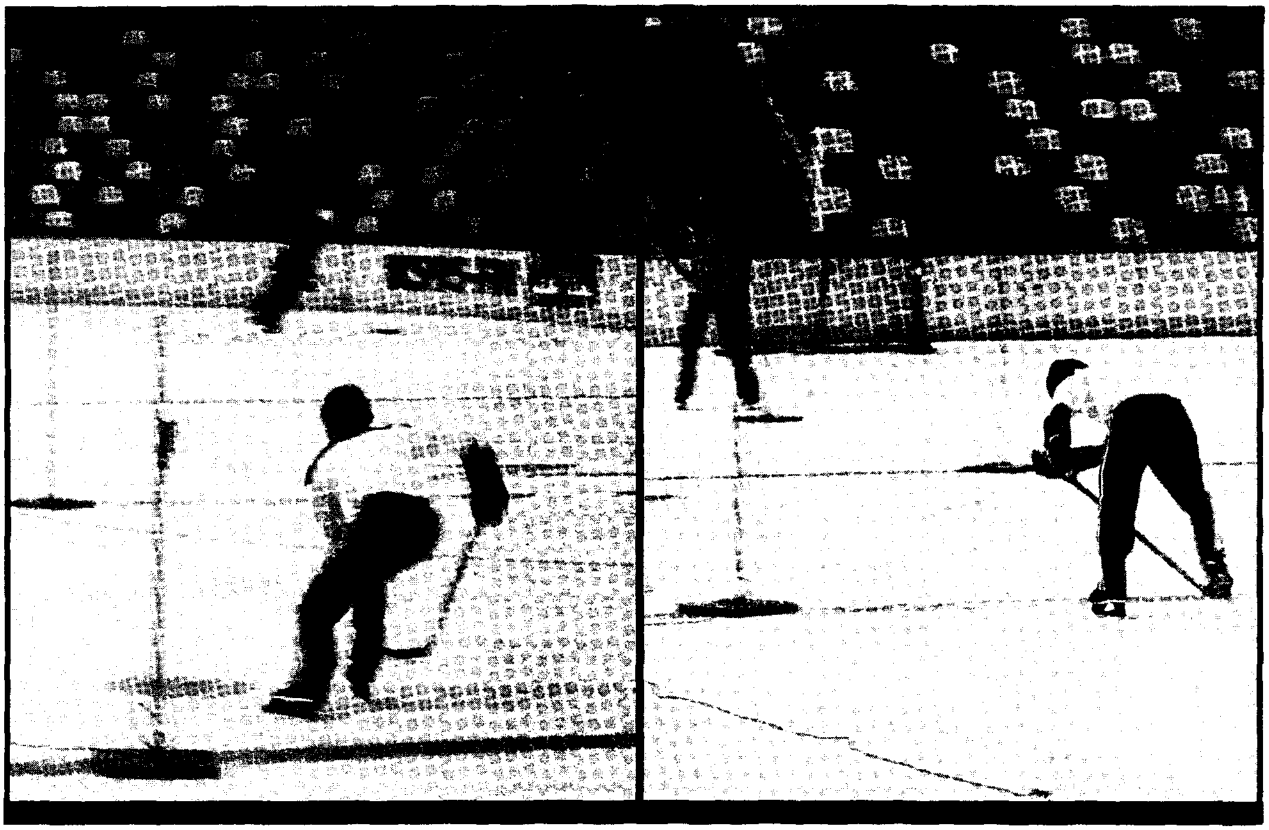
The results for a U.S. National Midget Camp are typical of 12 other teams we tested this way. They are shown graphically as the percent decrement in average velocity from 10-90 feet on each of the six 130 foot lengths compared to that same measure for a separate acceleration test, A.

After just two lengths of a stop/start skating drill, Lactic acid will ruin the stride!!!

For each length, the average velocity was significantly slower than the preceding length ($p<.01$). Combined with evidence of very high blood lactate in each of the subjects and significant changes in biomechanical parameters, this indicates a severe neuromuscular dysfunction with fatigue during all-out skating effort.

Loss of speed is only the symptom. The problem is that lactic acid ruins our skating mechanics within 15-20 seconds. Any repetition after that point teaches slowness.

Biomechanical factors such as stride rate and knee angles were previously identified as predictors of a high rate of acceleration (Greer, Dillman, Blatherwick, 1984a). From high speed, computerized film analysis it was seen that somewhere after the second length every skater was using slower strides, less knee bend and extension, and excessive forward bend at the waist.



The split-screen picture demonstrates why the work intervals must be kept short, if an all-out skating drill includes stops-and-starts. On the left the player is on his second length and on the right, the sixth and last length of the stop/start endurance test.

If a stop/start drill lasts 40 seconds (as traditional crushers do) the last 20-25 seconds are spent teaching neuromuscular patterns of slowness and poor skill. To gain endurance in this way is certainly not worth the trade-off in skating skill.

Other scientific evidence about using short work intervals and long recovery

Canadian and Swedish physiologists have done extensive research on hockey players using a technique called muscle biopsy to study the chemical reactions supplying energy within an exercising muscle. A very small piece of muscle is removed with a needle before and at different stages of the exercise test. This gives an accurate picture of which fuels are being used, what enzymes are present and which waste products are either accumulating or being removed.

The glossary explains briefly how muscles use high energy phosphates (ATP and CP) for energy in the initial few seconds of exercise. If the workload is slow enough, in the long run, much of the replacement of ATP will be from aerobic metabolism, which is the respiration (or burning) of glucose, fats, some protein, and lactate in combination with oxygen. This requires that the lungs, heart, and blood vessels supply enough oxygen to match the rate of work. It also requires that working muscles are capable of using oxygen at this rate, which implies they have an abundance of aerobic enzymes in the mitochondria.

If the pace of the work is too fast for fuels and oxygen to be supplied totally from the blood, the muscle will use its own stores of glycogen, and re-supply the ATP through anaerobic processes (without oxygen). The problem with this route is that glycogen stores are eventually depleted (in a matter of 30 minutes or more) and lactic acid accumulates in the muscle faster than it can be used as a fuel or shipped out in the blood to be converted elsewhere (this happens within seconds).

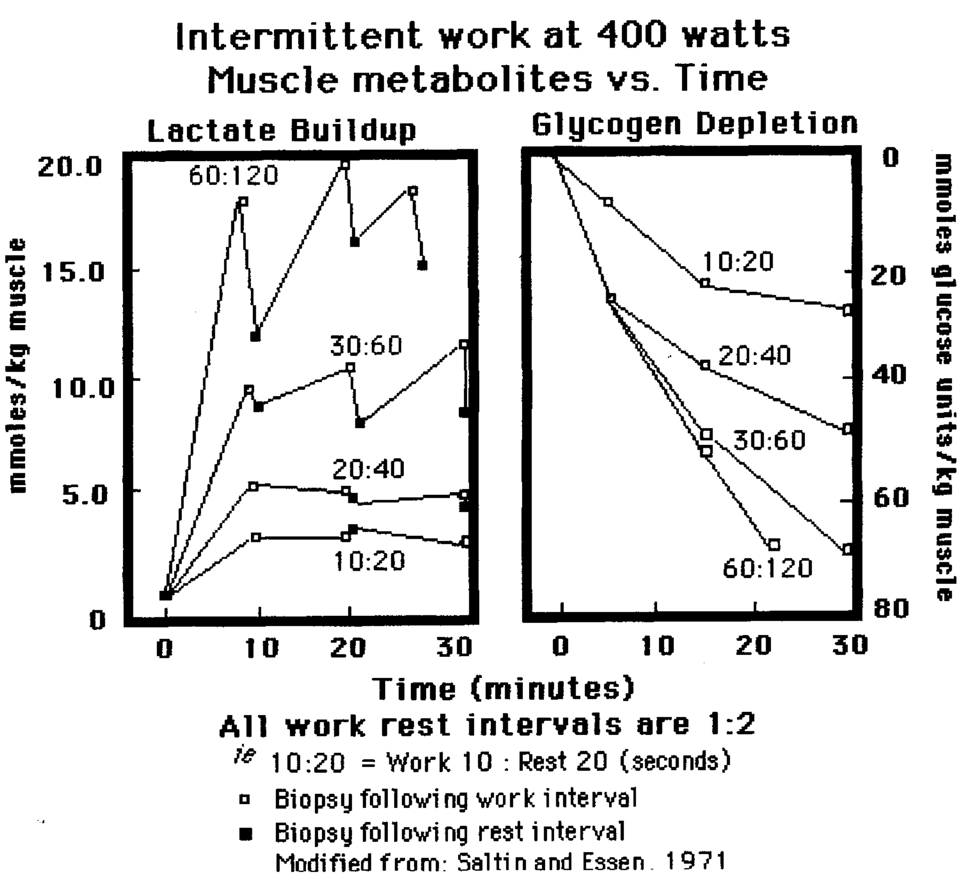
Muscle biopsy studies: The importance of short work and long rest intervals

In 1971, Saltin and Essen published a study on the effects of altering the lengths of work and rest intevals during all-out exercise testing. Students each performed four different 30 minute intermittent bicycle tests at the same work load, 400 watts. In each test the work/rest ratio was 1:2, so total pedalling time (10 minutes) and total mechanical work (240kJ) were the same in each case. The various work/rest times were: 10:20 seconds, 20:40, 30:60, and 60:120. Biochemical analysis of the muscle metabolites (lactate and glycogen) are shown in the following graph. To simplify the interpretation, remember that lactate buildup and glycogen depletion are both bad signs for the continuation of exercise.

It can be seen that shorter work intervals result in less glycolysis, as evidenced by decreased muscle glycogen depletion and lactate accumulation. Longer rest intervals allow more complete restoration even though the work:rest ratio is still 1:2. Although the graph is not shown here, it was also evident that Creatine Phosphate (CP) stores are depleted less with shorter work intervals, and replenished to a greater extent with longer rest intervals. During the 60:120 test ATP and CP were not restored and the test was not finished by the students. Similar results were found by Edwards et al. (1971) and Edgerton, et al. (1975), supporting the hypothesis that the extent of glycolysis is determined by lengths of work/rest intervals and intensity of work.

It seems amazing that total work done is less important than keeping the work intervals short and allowing longer recovery time for restoration of CP and partial removal of lactate. Investigators have shown that the half time ($t_{1/2}$)* for repletion of CP is about 21 seconds (Green, 1979c) and for blood lactate to return toward basal levels, $t_{1/2} \approx 9.5$ minutes (Sahlin, 1976).

*Half time is the time it takes for half of the remaining glycogen stores to be filled. This is an example of an exponential relationship that is fairly typical in biological systems.



The bottom line from these studies:

1) Coaches should use short shifts during games (less than 40-50 seconds) to reduce the effects of glycolysis (lactic acid buildup and glycogen depletion).

2) If the priority for a given practice is development of skill and quickness, keep the sprint intervals to 5-15 seconds and allow at least 60-75 seconds for recovery, allowing for replenishment of high energy phosphate stores.

Improvement = Supercompensation; Planning the calendar is imperative.

The goal of all training is improvement, called supercompensation. This refers to the ability of the human body to overcompensate for the stress of a given exercise.

Supercompensation requires adequate rest, 48-72 hours of rest after a stressful strength workout. Muscles become stronger by hypertrophy (enlargement) and through adaptations of the nerves. Therefore, nutrition and recovery are as important as the hard work. Traditionally, we've emphasized the value of the stress (intense effort), but we've often overlooked the role of rest and rebuilding.

This is painfully obvious in our approach to conditioning in team sports. We've over-used and misused the phrase: If there's no pain, there's no gain.

We've perpetuated the myth that conditioning is done in training camps, rather than gradually in a well-planned year. The process resembles a marine boot camp. Coaches and players have been mislead into thinking that conditioning requires a period of three weeks of hell. We're convinced we must feel run down before we start to feel stronger and faster. This has been a time for athletes to lose sleep and body weight, including muscle protein and water. Through the two-a-day workouts, players are dehydrated, depleted of glycogen, and lacking essential minerals as well as other nutrients.

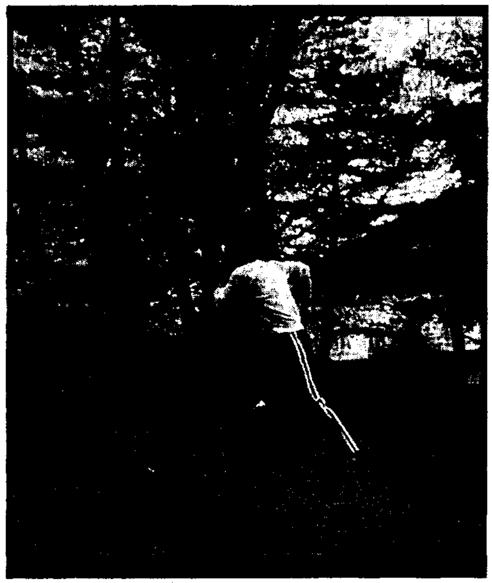
In this state athletes are prone to muscle cramps and strains and experience severe neuromuscular fatigue, including loss of strength, speed, and coordination. Injuries are probable. Spirits are low. Skills suffer. All of this in the name of conditioning.

Are we in better shape after training camp?

After three weeks of summer workouts, football practices are cut back by Labor Day weekend, by the necessity to taper off for games, and by the beginning of school. All of a sudden players start to feel rejuvenated from the rest, and coaches concluded they whipped the kids into shape in three weeks.

Hey, three weeks does not get anyone in shape. Being run down is not necessary. In fact, this traditional approach is stupid at best - - abusive might be a better word. This is a job for a twelve month calendar with general conditioning and strength training in phases of the off-season. Training camp is a time for refining skills, quickness, and team concepts.

Intense training should alternate with rest/recovery days.



Intense stress of the neuromuscular system, such as weight training, speed workouts, or plyometrics, requires much more recovery time than we've planned for in team sports. Athletes and coaches in individual sports have recognized this.

As an example, consider a hypothetical timetable of supercompensation from weight training with the same muscle group, applying the same overload either daily or by alternating work days with rest days.

As we can see in the following diagram, after one day of intense lifting, if we measure strength in that range of motion on the following day, we'd probably be weaker. If we allow a day of rest, our strength will recover, and we are ready for another workout.

On the other hand, if on the very next day we overload the same muscles in exactly the same way, and continued on this program, we would never give the muscles and nerves time to recover. We'd get progressively weaker by training intensely seven days a week with the same muscle groups.

The Importance of planning for recovery

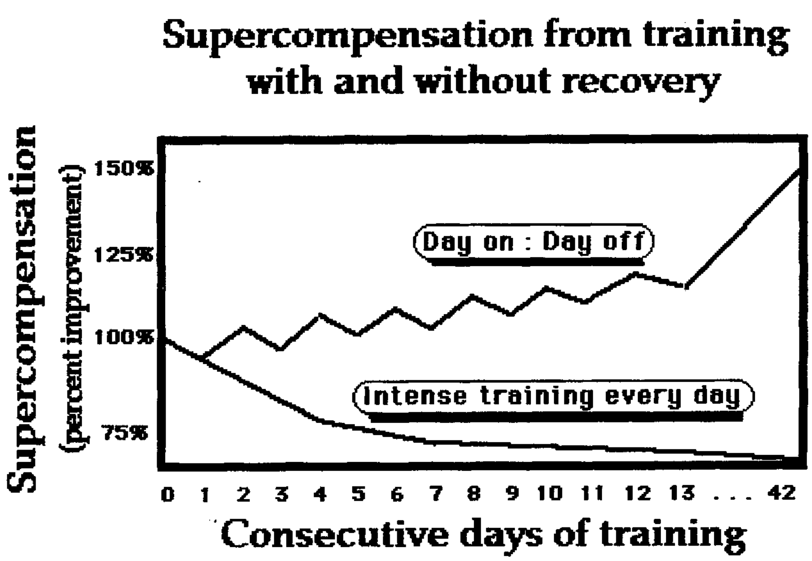
The graph illustrates why we must plan carefully this part of our coaching duties. If our six week goal is to be in the upper right region of the graph, we'd easily end up at the bottom by poor planning. Thank God for Sundays off, for Labor Day, for light workouts the day before games, and for school.

How about mental toughness?

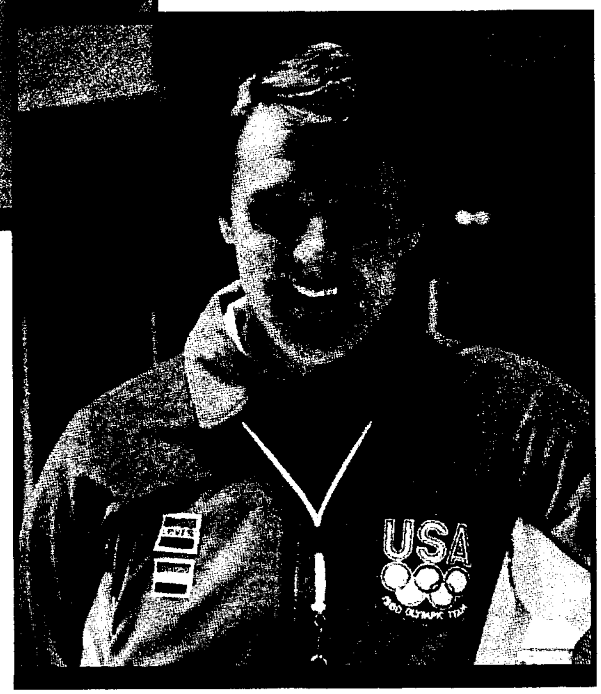
One argument for grinding athletes into the ground with two-a-day drudgery is that it develops mental toughness and discipline. Consider the workout calendar of Edwin Moses, who for 14 years dominated the 400 meter hurdles.

Fourteen years of training for intervals that might be the toughest in all of sport!!!

To be the best in this event there were grueling strength workouts, anaerobic interval days, plyometrics, hills, overspeed and overdistance training, added to the countless hours refining the skill of hurdling. To be the best in the world in this event for 80 straight track meets requires mental toughness beyond our imagination.



For a hockey player to stick consistently with a twelve month calendar of intelligent, tough training requires (and builds) great discipline and toughness. There's no need to inject a three week segment in which the coach ignores all principles of intelligent training in the name of mental toughness. In fact, track athletes would be mentally tough enough to hire another coach if there was poor work/recovery planning for a single day, let alone an entire phase.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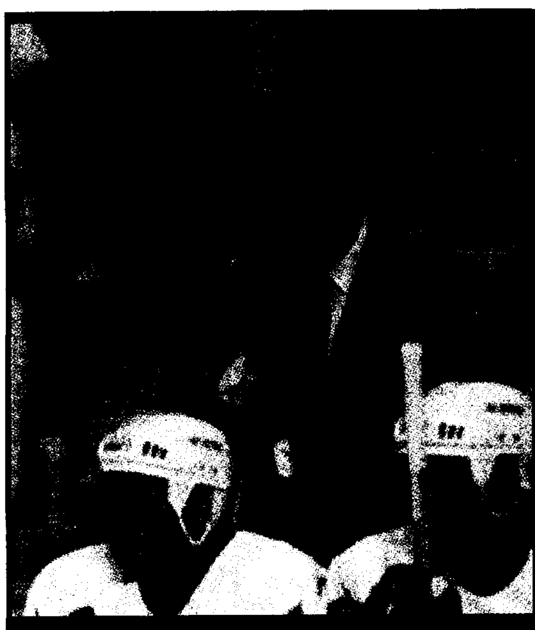


CHAPTER SIX

Creating the environment for over-speed skill development ...the psychology

"How can a real teacher not indulge mistakes?"

— John Wooden
Winner of 10
NCAA basketball
championships
in 12 years

The team that makes the *MOST* mistakes (eventually) wins.

Chapter Overview:

1 If our goal is to improve skills, we must create a perfect learning environment, focusing on the ***process***, or ***journey*** more than short-term results, immediate wins.

2 The coach's role is that of an educator, to:
- instill confidence;
- have patience with mistakes;
- diminish the fear of failure;
- promote relaxation in the face of tense competition;
- remain positive and focused on improvement in every situation;
- make the experience fun and constructive;
- prepare the student to succeed without the teacher.

3 As coaches, we sometimes act as if our role is to punish or berate players after mistakes, heightening the fear of failure, rather than diminishing it. Imagine a sixth grade teacher doing this when mistakes are made on a math assignment. We're often impatient, sarcastic, and even abusive in handling mistakes. At these moments hockey no longer resembles either a game or an educational experience.

4 We must be infinitely more patient. At the beginning of the season it is tempting to win early games by using a system that minimizes the potential for errors: dumping the puck, attempting no creative plays, and using simplistic, illegal defensive systems. We must have patience with mistakes of commission, allowing players to try new skills and fail once in a while in the heat of the battle.

5 The right environment includes protection of skills by the rules. The only other 'sport' which discourages its original style of play as much as hockey is WWF 'wrestling.' We've bent the rules so much toward illegal defensive hockey that it has become nearly impossible for skillful players to excel. Interference is never called, having the same impact it would in football or basketball if interference were ignored. Coaches have taught players that good defense is 'holding up their wing.' How does this differ from holding a football wide receiver on the line of scrimmage, pre-empting his participation in the offense?

Skillful hockey players are an endangered species. If basketball rules were ignored, wouldn't the Michael Jordans and Magic Johnsons be replaced by a bunch of Hulk Hogans? Put a big, strong linebacker on a wide receiver like Jerry Rice and you'll surely eliminate him from football if interference is not called.

If we want skills in hockey, the environment must be protected by officials who interpret the rule book the way it is written. Then, the coaches' efforts would necessarily be directed toward finding skillful players and practicing skillful hockey rather than the simplistic defenses that depend on cheating.

6 "***Coaches must return the game to its youth***," warns Herb Brooks. It is fashionable for a coach to make a name for himself by demanding strict adherence to a static system of X's and O's, drawn on a blackboard. The effect is to eliminate creative plays and instantaneous decisions in a dynamic, read-and-react game.

Olympic teams as a role model for development

The United States, Soviet, and Canadian Olympic Teams offer a role model for development that should be considered at every level:
... the end goal is never compromised for short-term success.

1) North American Olympic Teams have the necessary challenge:
... you've got one season to prepare to beat the Europeans at their own game.

2) Conditioning isn't sacrificed to the game schedule. Skill development and other long-range objectives take precedence over immediate wins.

3) The Olympic Games are officiated in a way that discriminates against the hook-and-interfere systems of college and professional hockey. Skill development is a top priority, both in practices and games. It is not a viable game plan to dump the puck to the opponent, sit back, grab your wing, and play defense. If you can catch them to interfere, you'll be penalized, and they'll beat you on the power play.

   You must control the puck to compete against talented Olympic opponents: regrouping in the neutral zone, cycling deep in the offensive zone, and breaking out with a mixture of long and short passes. In this style, teams do not dump the puck to the opponent, but use indirect passes when everyone is covered.

4) The entire season is a 'training schedule.' Wins and losses are far less important than development. This creates a relaxed, learning atmosphere, tolerant of individual weaknesses — much like a classroom where students are not put down for making a mistake.

5) The model works!

   Both the Canadian and U.S. Olympic Teams have a record of tremendous improvement over the course of a six month developmental season. We've tested and watched closely as these teams improve faster than any other level in hockey. Coaches like Herb Brooks, Murray Williamson, Bob Johnson, Lou Vairo, Dave Peterson, and Dave King are geniuses at promoting development, each in his own unique way. Witness the skillful style evolve, and you might ask the question:
   ...why don't all teams improve at this rate?

   Soviet youth programs operate under similar guidelines, and obviously their end product speaks well for this philosophy. No one would think their superior skills can be attributed to genetics. They have a well defined development program.

To improve skills we must create a perfect learning environment.

First, it is implied that the team practices. Most youth organizations schedule far too many games, in which only the very best players have the puck long enough to improve skills. An average bantam forward may play 1/3 of the game, 10-12 minutes of ice time, during which he might skate at top speed for a total of 20 seconds and handle the puck for 12 seconds. How can skills be developed this way?

Soviet youth teams practice 6 hours on the ice for every hour of competition.

Secondly, during practice, failure must be re-defined as a failure of ***omission*** not one of ***commission.*** The only way to fail in an overspeed skill workout is to not attempt new skills and new speeds. Attempting skills at uncomfortable speeds will almost certainly result in weaker shots, missed passes, and occasionally falling during an overspeed cornering drill. The coach and team must accept these weaknesses with nothing but encouragement. We must be patient and supportive.

"The team that makes the most mistakes wins in the end."

During games we must have the patience and foresight to define failure in the same way as in practice: failure to try new skills, new speeds, and new plays. It is interesting to compare the advice of John Wooden, one of the greatest coaches of all time, to recent popular opinion. Wooden asks, "How can a real teacher not indulge mistakes?" He lived by the philosophy of his own college coach, "The team that makes the most mistakes wins, for good things come to those who risk error by taking the initiative." By taking the initiative to try new skills, this team will be better in the end.

Wooden won 10 NCAA basketball championships in 12 years! Logic would argue that coaches might follow his lead. It's a shame that logic is less significant in shaping our learning environment than the coach's impatience and need to vent his frustration.

Soviet youth coaches lose their jobs if they prioritize winning over skill development.

For development to take place, players must feel free to make mistakes. Hockey especially, is a game of mistakes. Our attitude should be that we will overcome them. By the end of the season, we will be a much better team if we try new skills at new speeds throughout the game schedule. The fear of failure in games can most certainly ruin every effort in practice to raise our comfort zone of skill performance.

Worrying about mistakes before or after the fact is a sure way to paralyze ourselves in games. Many of us are old enough to remember Franz Klammer skiing to a gold medal in the giant slalom during the 1976 Winter Olympics. This individual effort epitomized the attitude of 'letting it all hang out', competing on the brink of disaster to cut a few hundreths of a second. In order to utilize his abilities, every athlete must feel free to try his thing, unconcerned about potential disaster.

Soviet youth teams practice 6 hours on the ice for every hour of competition.

I remember watching from my 3-step ladder as Jack Nicklaus teed it up on the 18th hole at Pebble Beach to win the U.S. Open in 1972. My friend asked, "Do you think he is aware the Pacific Ocean's on the left and out-of-bounds on the right?"

No way; not at that moment. If ever there was an athlete who had the ability to shut everything out of his mind but the target, it is Jack Nicklaus. Television doesn't do justice to Jack's concentration. TV may capture his swing, but it doesn't show how Nicklaus can be walking the fairway joking with spectators one minute, and switch out the entire world in the next minute before he hits a shot.

Imagine Jack Nicklaus' caddy reminding him of the negative possibilities

Would a caddy consider stopping Jack just before he tees off and warning him about the water on the left and out-of-bounds on the right? Is it likely the caddy would ever remind him of previous mistakes? Of course not. The caddy knows his role is to support the athlete — contribute to his confidence and help him focus.

How can a hockey coach see his role any differently? Psychologists tell us that constant reminders about mistakes will breed more mistakes by reinforcing negative thoughts. Coaches in team sports carry this one step further when we yell at kids and put them down for mistakes. I've watched a lot of golf tournaments and have yet to see a caddy yell at his golfer for a mistake.

The power of suggestion

An excellent Minnesota golfer had it going one day, playing well in a qualifying round for a national tournament.

Standing on the 16th tee, facing 200 yards of water before the fairway, he describes his mental approach as perfect, "I was totally focused and confident." Just as he addressed the ball, one of the tournament scorers blurted out, "Remember, if you go in the water it is a direct, not a lateral hazard." The golfer stepped away from the ball, agonized for a few seconds, hit the ball in the water twice before finishing the hole, and, of course, missed the cut.

In the heat of battle, it is usually counter-productive to address mistakes.

Negative coaching can be simply mentioning mistakes or potential problems too often.

Coaches want to be helpful, and it is tempting to correct every weakness we see. However, constant reminder of past or future problems will just as surely initiate a negative self-image as yelling at players, using sarcasm, or public embarassment. "Know the psychological makeup of your athletes," says Herb Brooks. "Pick your spots. In the heat of battle, it is usually counterproductive to address mistakes. Wait until emotions are not as high, until another time when the adrenalin is not flowing."

Correcting mistakes is part of teaching, and it is important to address some weaknesses with a positive suggestion for improvement. Other times it might be better to ignore a shortcoming, finding a positive role model instead. Imagine one of our students comes home with a report card that looks like this: [A,A,A,F,A,A]. Do we see the F, and do we *always* mention it. Maybe once in a while we should ignore it, because the kid really wants to be recognized for what he did well. In all cases, the environment must be geared toward building confidence, and at no time is it worth *winning a battle and losing the war.*

Positive coaches in Stanley Cup Final, 1991: Bob Johnson and Bob Gainey

Subjectively and based on their records, the two teams remaining at the end of the 1991 NHL season made more improvement than any in history. It is not coincidence that any player who has ever played for either of these two coaches characterizes him with words like, "Patient, optimistic when things were going bad, calm under conditions of stress, and positive...always positive."

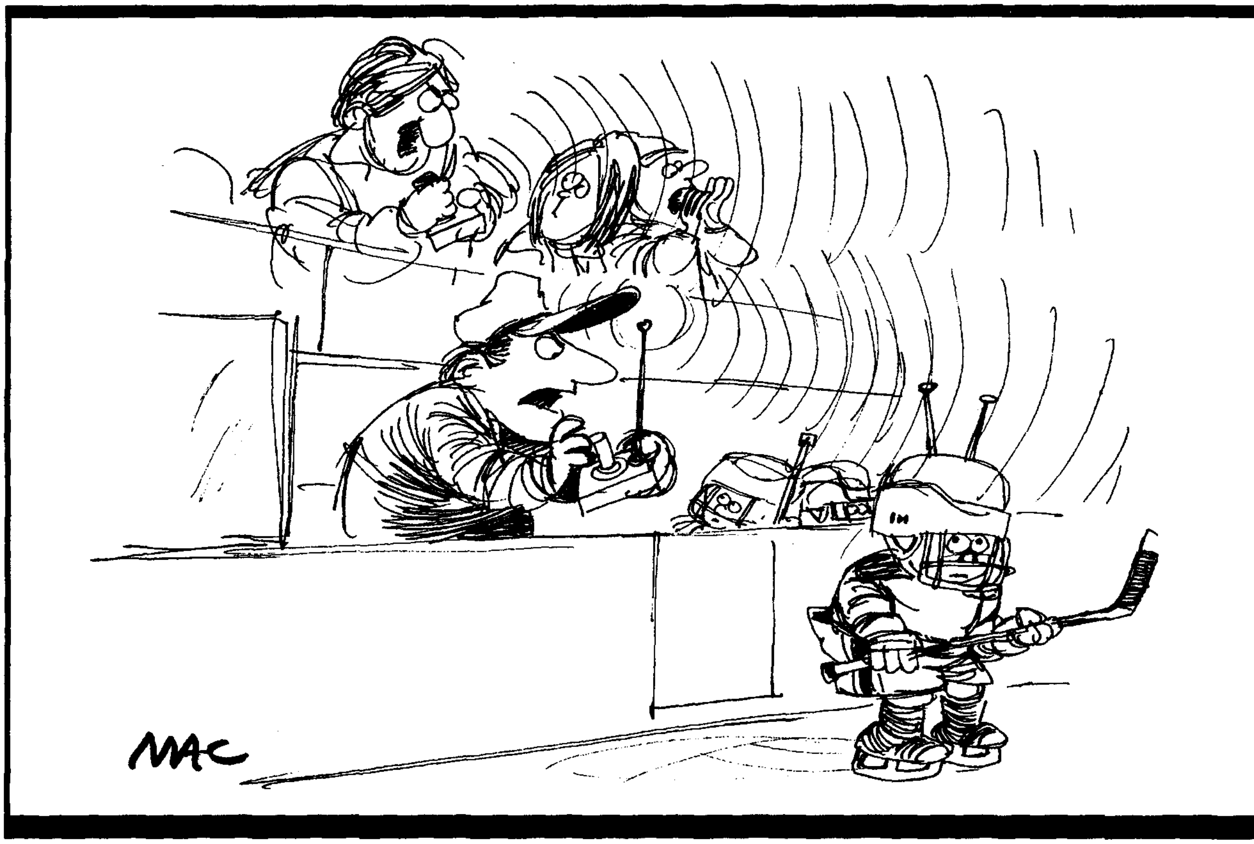
Overcoaching: taking the game from the players

Overcoaching probably comes from a frustrated need to still be on the field of competition. Herb Brooks sees this trend as, "...coaches justifying their existence." Years ago, football coaches allowed quarterbacks to call the plays. Modern technology allows for radio information from the press box and an excuse for the coach to get back into the chess match. Fran Tarkenton points out how we have lost the leadership potential of the quarterback in this process. Furthermore, the spontaneity and personality of the players has been stripped from the game, replaced by computerized logic and closeup TV shots of coaches with headphones. We have also lost a great learning experience for a high school athlete — a chance to work all week on developing a game plan with the multitude of reactions to new situations.

This overcoaching syndrome has crept into hockey. The 'in thing' for hockey coaches is to look important by expounding on systems of X's and O's. Valuable practice time is wasted while players sit watching a chalkboard — something that certainly could be done off ice. We see too much of the coach in the media explaining how a change in strategy won the last game. It's almost as if we're looking for robot hockey players — 'electronic puppets' under our complete control.

This movement has become so trendy in the college and professional ranks that youth coaches can be intimidated into thinking that creative players are undisciplined. We demonstrate our abilities with rigid systems of play, the more complicated, restrictive, and defensive minded the better. From 30 rows up, practices look more like stationary black boards than active, fast moving playgrounds.

ILLUSTRATION: CRAIG MACINTOSH, MINNEAPOLIS STAR & TRIBUNE



Certainly most of the great players we know came from backgrounds where the coach allowed them to do their thing. Next time you see the Los Angeles Kings on TV, isolate on Wayne Gretzky and ask the question: what would a college or youth coach do if he had a youngster who tried to play like Gretzky? Would that player be given the freedom to create? Would he be allowed to make plays at the offensive blue line, or would his skill be hidden by the demand to 'dump it in deep?' Does a potential young Gretzky have to chip the puck out of the defensive zone whenever he touches it? Is he required to 'finish his check' when the real Gretzky would already be anticipating and moving toward the next play? Does he have to prove to his macho coach he is "tough" by looking for body contact instead of avoiding it, like the Great One he watches on TV?

Why would any coach be so presumptious as to demand that he do all the thinking?

How many coaches allow a player to hang out deep in the offensive zone when the opponent is breaking out at the midboard? Gretzky often hides behind the net to see if his linemates can successfully forecheck the puck loose. After all, the original purpose of a forecheck was to get the puck back in order to make a play. It has become little more than fulfillment of a job outlined in depth on a blackboard. Do we allow a young kid to fly into the neutral zone on the breakout, looking for a long breakaway pass? In an entire college season we might see only two long breakaway passes, because the coaches demand that everyone is back deep coming out together. We are basically telling young players to stop thinking, "I'll do the thinking for you."

Mario Lemieux gets several breakaway chances in the finals of the Stanley Cup when everyone in the building is watching him. The Czechs get ten breakaways against a team that prepared for this very thing. Some happen by design. Some happen because the player is brilliant, and has been allowed to play with creativity. I often wonder if Wayne

Gretzky's greatest asset is that he isn't listening to the modern day system-oriented coach, who would like everyone to play like a robot.

Why would any coach be so presumptious as to demand that he do all the thinking? One of the greatest quarterbacks of all time, Fran Tarkenton, use to draw plays on the ground during a huddle — and then throw the winning touchdown pass after the computer-aided press-box information had taken the offense as far as it could. In a game as structured as football, spontaneous decisions by the athletes are still winning games. In a reaction game like hockey, athletes must be encouraged to create solutions.

Who are these games for?

Herb Brooks would respond, "We must return the game to our youth! By trying to fit every player into the same mold, we suppress the creative energy of our best players. For example, some defensemen are better suited and happier being steady, defensive players. Others have talents that are best expressed in the manner of a Bobby Orr or a Ray Borque. We lose a player when we don't use him for what he does best."

Anatoli Tarasov, the long-time Soviet National coach, was asked what he would consider the greatest failure by his players on a given day. Failure to win? Not hustling? Not backchecking? Not scoring? Actually, he didn't mention any of these. He felt the biggest mistake they could make would be to play without creativity.

"The art of creativity means that you sometimes surprise yourself." — Michael Jordan

"Most of the time I don't even know what I'm doing on the [basketball] court; it just happens. There is no plan. I just read and react."
Shouldn't hockey be a game of reading and reacting? Some coaches attempt to define precisely what every 'reaction' should be to the infinite number of possibilities that come up in a hockey game. We want players to be puppets, because we like to be in control of the strings.

In an attempt to contribute, coaches might over-intellectualize skills. In golf, many players try to think their way through the swing after reading a technical description. Gary Player calls these failures, "Paralysis by analysis." Actually, any physiological movement is best performed when it becomes a reflex movement. It follows that our goal in teaching a skill should be to eventually get the skill as far from the cerebral cortex (conscious mind) as possible.

In competition and in performance of skills, hockey is not a Captain-may-I game. Within the extremely rapid and complicated computer of our nervous system, when we must read and react in an instant to a constantly changing game, we should not complicate the decision with thoughts of being second guessed by the coach. The veteran defenseman of the Chicago Blackhawks, Doug Wilson, made an interesting analogy, "If a concert pianist has to think of every key he is going to hit, he's in trouble. Same in hockey. When you start thinking instead of reacting, then you've got problems."

Dave Peterson, coach of the 1988 and 1992 U.S. Olympic Teams, would encourage his players to come up with their own answers using questions like, "Where can you get open? How can you create time and space?" He and Bud Grant, the long-time great coach of the Minnesota Vikings think of coaching as creating an environment for players to grow and learn, rather than trying to steal the experience for themselves.

The goal of any educator is to help students grow to the point where they no longer need the teacher.

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Finally, Anders Hedberg, former New York Ranger and Swedish Olympian, writes about training, *"If it isn't fun, it isn't sport."*

Motivation toward training must rely much less on threat and much more on fun.

We adults must evaluate our approach to see if we are motivating or threatening. For example, sometimes we threaten that a poor effort or dumb mistakes will be punished with skating drills or push-ups or extra running. What have we said about the fun of skating drills or other training?

Threats, intimidation, and fear are not synonymous with 'discipline' or 'motivation.'

At levels of hockey that are called 'big-time,' college and professional coaches are threatened by the need to win games and save jobs. For players, there is the constant threat that careers and scholarships hinge on performance. In this setting, motivation often switches from intrinsic values in the game, to a fear of failure.

At one time, 'the fun of hockey' might have been defined with words like 'sticks, pucks, beautiful skating, great moves, awesome plays, crisp passes, shots, and goals.' These were intrinsic qualities that motivated players to get better, because it is fun to excel. It is fun to improve. In 'big-time hockey,' a player might be fined or lose a scholarship for not lifting weights, not improving his game, not studying for class.

When creativity and playmaking are replaced by dump-and-lock-up-your-man strategies, it becomes less fun. There is little doubt that if given the choice, players would opt for a game like the simple pick-up games on the outdoor pond. It is the adults who have decided that hockey should not be that way for kids — even though it was for us.

In order to win with less skill, 'big-time' coaches lobby to have the rules ignored, allowing for a game plan dependent on hooking, holding, and interference. By eliminating skill and speed, the game is less fun to play and the participants are less motivated to improve.

It's fun to improve!!!

Every athlete is motivated by seeing results from his efforts. After weeks in the weight room doing squats, after running miles of hills, and after hundreds of skating intervals, a player is going to see improvement. At that point he is sold on the importance of his own work ethic. Being proud of your accomplishments is fun.

Threats, intimidation, and fear are not synonymous with 'discipline' or 'motivation.'

It is no different in the classroom. As teachers and coaches, we often use extrinsic motivators like college scholarships, grade point averages, graduation rates, and the threat of losing eligibility. All of these are important, of course, and each one is correctly identified as a reason to work hard.

But, we sometimes forget the greatest motivation is intrinsic: it is fun to learn. There might well be information in a class that is truly exciting, if we study hard enough to dig it out. In the same way, it is really fun to work for months and watch your shot improve, to skate corners faster, to handle the puck at a faster pace. It's fun to dominate a game (this is what I'm told, and it is certainly borne out in my dreams).

Furthermore, as with a hard training effort, after spending long nights working on a term paper, even before it is graded, there is a great sense of satisfaction looking at the accomplishment.

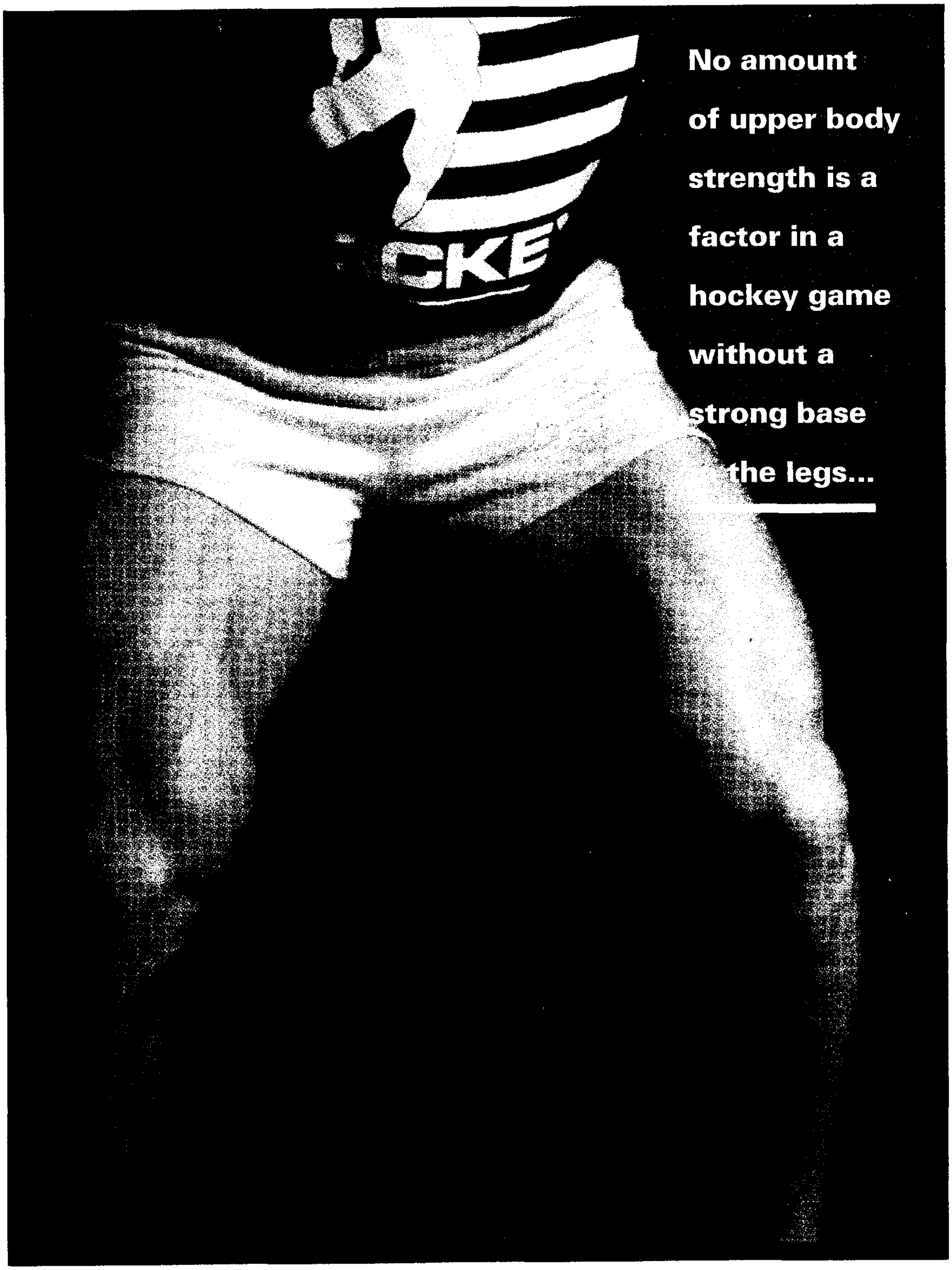
We should never forget that these intrinsic values are self-motivating.

Even without the additional reward of good grades, without the glitter of a pee-wee season featuring 75 games, without tournaments in another country, without the all-star team patches on your jacket, without the championship trophy, without a pro contract or a college scholarship...

...self-improvement is fun.

The greatest motivation to an athlete is the enjoyment that comes from working countless hours and improving those skills intrinsic to his sport.

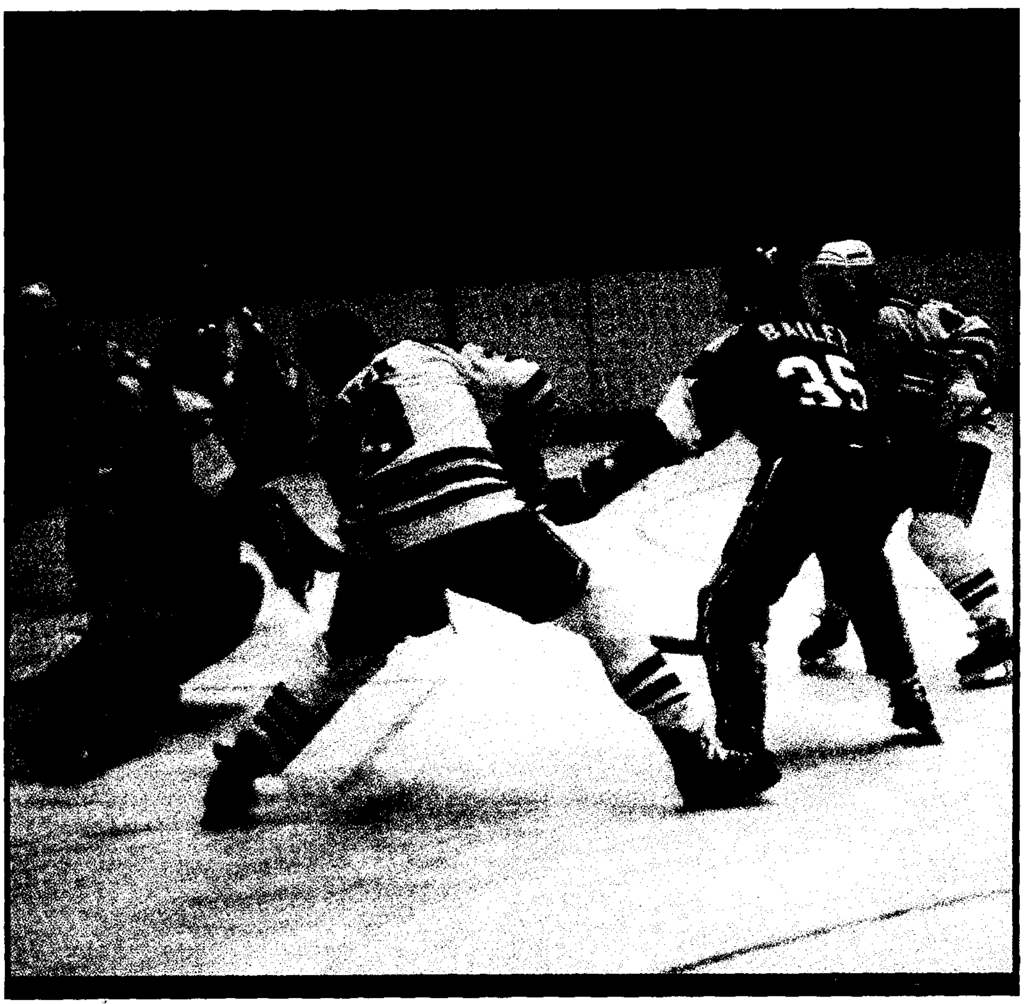
This is the *journey toward exellence* that John Wooden feels is more exciting than the end result. This from a coach whose end result was 10 National Championships!!!



"You can't shoot a cannon out of a canoe."

— Doug Zmolek, 1991

Is a strong weight lifter a strong player?



Chapter Overview:

1 It is the combination of upper, midline, and lower body strength that makes a strong weight lifter into a strong player — not one aspect by itself.

To be a factor in a hockey game, upper body strength depends on a solid base from the legs up. Twisting through traffic, getting open for a shot, warding off checks, shooting, defensive plays, and body checking certainly require upper body strength, but the real base of support starts in the legs and midline muscles.

2 Shooting, like swinging a golf club or throwing a baseball, is not done with the wrists and arms alone. A powerful shot requires the consecutive transfer of power from the legs to the trunk twisters, to the shoulders, and finally out to the arms. The action is like that of a whip, and the forearm motion is more a result of prior forces than the origin of power.

3 Improvement of skating quickness and agility requires more than just skating, because many factors are best overloaded off-ice. No single training method, by itself is as effective as the combination of all of them together. A well-planned yearly schedule should emphasize two or three factors during each different phase:

- **powerful strides:** from intense weight training or plyometrics (jumping exercises with weight vests or simply with body weight)
- **quick feet and the recovery phase of the skating stride:** from sprinting uphill, downhill, or on a flat track;
- **low center of gravity:** from weight lifting and other exercises using body weight;
- **muscular endurance with bent knees:** from skating-specific exercises like roller blades, slide board, and skating simulation;
- **body fat reduction:** by endurance training and proper diet;
- **on-ice quality interval training:** to combine the effects of the off-ice training in a skillful, smooth, yet very quick skating stride.

4 To build strength, the neuromuscular system must be challenged in two ways:

- Hypertrophy or muscular growth results from many exhaustive sets past failure.
- The nervous system "learns" to recruit more muscle fibers and activate them in a more effective sequence as a result of lifting very heavy weights or from explosive, powerful exercises like plyometrics.

5 Squats should be done with light weights and high repetitions for stretch, technique, and muscular endurance. Split squats (lunges), one-legged squats, and other drills can be used for building strength-endurance.

6 Heavy sets and sets past failure are more safely done on machines like the hip sled.

7 Keep weight training in proper perspective. We are training to improve hockey skills and should ***train like race horses, not plow horses.***

Some sports may have lost the perspective to evaluate the place of weight training.

It has become common to think the term *'work-out'* is synonymous with 'weight lifting,' that *'power'* means the ability to lift a heavy weight, and that a *'strong player'* is one who benches 550 pounds. Actually, power is the product of both force and speed, and includes those athletic movements that are very explosive, regardless of whether much weight is moved. A workout may involve running or skating and have nothing to do with weights. Even a strength workout might involve handling only your own body weight. Gymnasts work out like this all the time. ***In the past ten years we may have over-rated the place of weight training in the development of hockey players.***

A 'strong athlete' may never have determined how much he can bench press. A *strong* gymnast holds himself in an iron cross position; a *strong* football player throws bodies around; a *strong* golfer or baseball pitcher or hitter uses timing and the leverage of coiling his body, a *strong* Olympic lifter must have speed and flexibility along with power. I watched a national (Olympic style) weightlifting meet a couple years ago in which the overall winner looked like he'd never done a bench press. In fact, if you hadn't watched him prove he was the *'strongest'* in the country that day, and saw him with his shirt off at the beach, you'd never guess he ever touched a weight. No one asked what he could bench. He was called a *'strong athlete'* because a hell of a lot of kilograms moved from the floor to a position over his head. The term *strong athlete* might have nothing to do with numbers from the weight room. In fact, we may have exaggerated the value of some lifts to make us strong athletes.

It is the combination of upper, midline, and lower body strength that makes a strong weight lifter into a strong player.

A strong hockey player is one who can skate through sticks, score goals with defenders draped all over him, knock people down in traffic, hook and hold effectively, and perhaps throw an opponent on his back during an altercation. During these moments, no one asks how much he can bench — only how he uses his overall body strength.

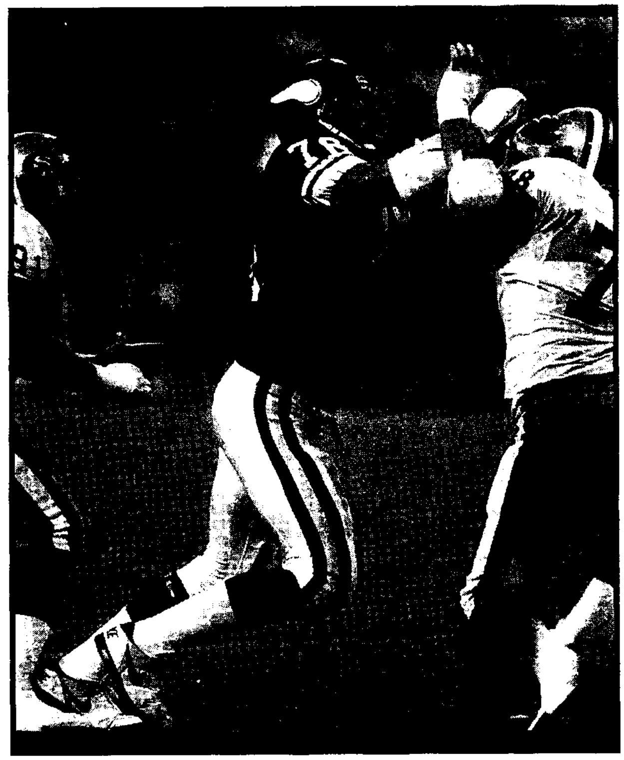
Train for athleticism and overall body strength.

When designing your own program, keep in mind your eventual goal — to become a better hockey player. ***Learn all you can about adapting strength to power and transferring that to skating performance.*** Learn how *'leverage'* on the ice translates to strength, and if your goal is to be a stronger player, train the base of that leverage (the legs, abdominals, and back muscles) as hard as you train the upper body — perhaps harder. Make intelligent choices about how you are going to expend your efforts in the weight room. Have a good reason for doing any lift.

For example, isolation lifts may have limited value in a program for hockey. These are lifts (like a bicep curl) that move only one joint and utilize a minimum number of muscles in a range of motion that will not be duplicated on the ice. Structural lifts move more than one joint. The bench press, for example, is an excellent choice because it involves pectoral and shoulder muscles to adduct the shoulder joint, triceps muscles to extend the arm at the elbow, and some forearm muscles. Squats, like skating, use muscles to extend the hips and knees together in a more 'athletic' range of motion, for example, than knee extensor isolations. Pull-ups or lat pull-downs would be a much better choice than curls to overload the biceps muscles, because they also involve shoulder movement and more muscle groups. Isolation lifts might be added as a way to 'burn' specific muscles after a lift involving more muscles, especially for those players who are trying to gain muscle mass.

Analyze the importance of upper body strength training for your individual goals.

Some players would benefit greatly from increased upper body strength, others to a lesser extent. For example, does anyone think that a Wayne Gretzky (type player) would be a lot better with great upper body strength? Actually, it might well be that because he didn't have great upper body strength when he was young, he had to learn to be a smarter, quicker, more creative player. I'm not saying that upper body strength training should ever be left out of a good training program for hockey. Injury prevention alone is a benefit that makes this training a must. Confidence is gained from being stronger. And for some players, strength training will help make a career. However, in some circles, upper body weight training has become synonymous with 'strength'. This is a mistake.



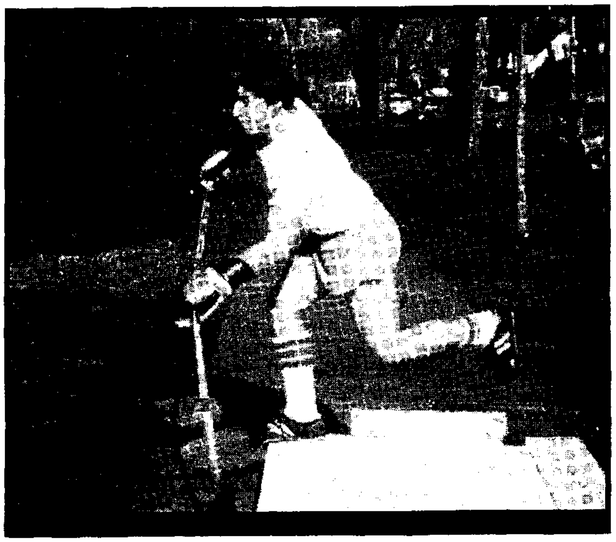
Hockey, like football, is played with the legs!!!

No amount of upper body strength will be a factor in a hockey or football game if the player has an inadequate base of strength in the legs, abdominal, and back muscles. A football lineman or a hockey player cannot move an opponent anywhere if he stands straightlegged and pushes in the range of motion of a bench press — even if he can bench 550 pounds.

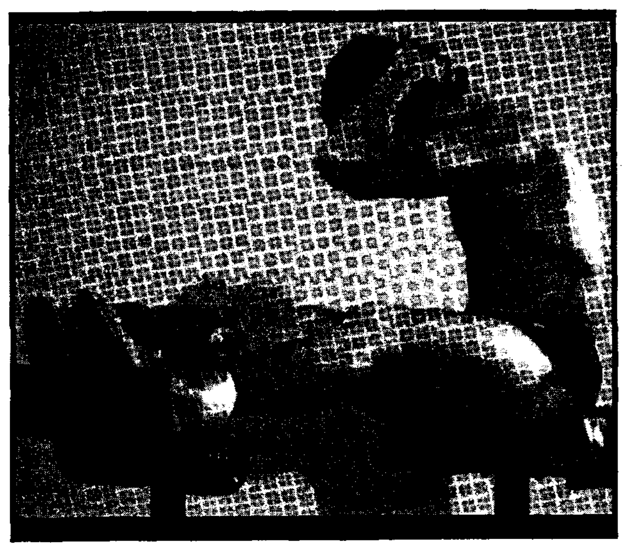
It is the combination of upper, midline, and lower body strength that makes a strong weight lifter into a strong player.

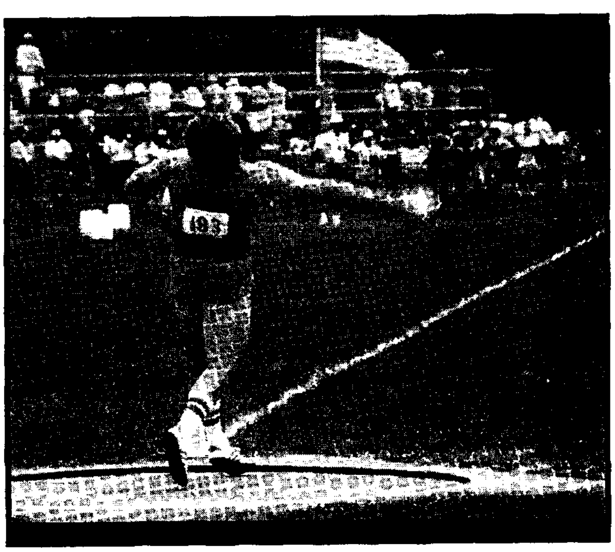
In any sport with physical contact imminent, experienced players widen their base, bend their knees (for a low center of gravity) and use leg and midline muscles to win physical confrontations.

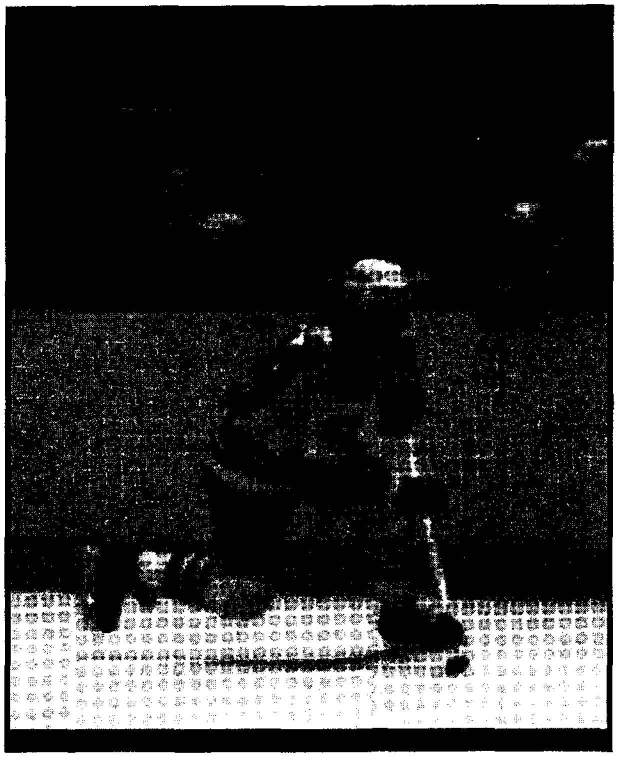
Another area where upper body strength might be a bit over-rated is in shooting pucks. Shooting uses a whiplike motion like pitching, batting, golfing, or throwing a discus. Some of the longest hitters in golf, others who can throw a baseball 100 miles an hour, and some of the hardest shooters in hockey have weak arms. Like cracking a whip, the energy is transferred outward from the middle of the body. Even though it seems forearm muscles must be strong to shoot pucks hard, the major force generation comes in a sequential manner from the legs, to the trunk twisters (oblique, abdominal, and back muscles), to the chest, shoulders, arms, and wrists.



For shooting or throwing, strengthen oblique muscles which twist the torso.







Skating speed, quickness, and the ability to change directions are dependent upon lower body strength. We've seen that learning to skate corners faster requires greater leg strength. Centrifugal force becomes so great at fast speeds that inadequate leg strength is more of a limiting factor than technique.

Note: Centrifugal force increases as the square of skating speed, but linearly proportional to body weight. This means that as we attempt new speeds, leg strength will limit our attempts more on corners than skating straight ahead.

No matter what type of player you are — whether your game depends upon great upper body strength or not — strengthening the legs, abdominal, and back muscles will make you a much better player.

How should a player train to improve skating speed, quickness, and agility?

Consider that a quick skater possesses the following qualities:

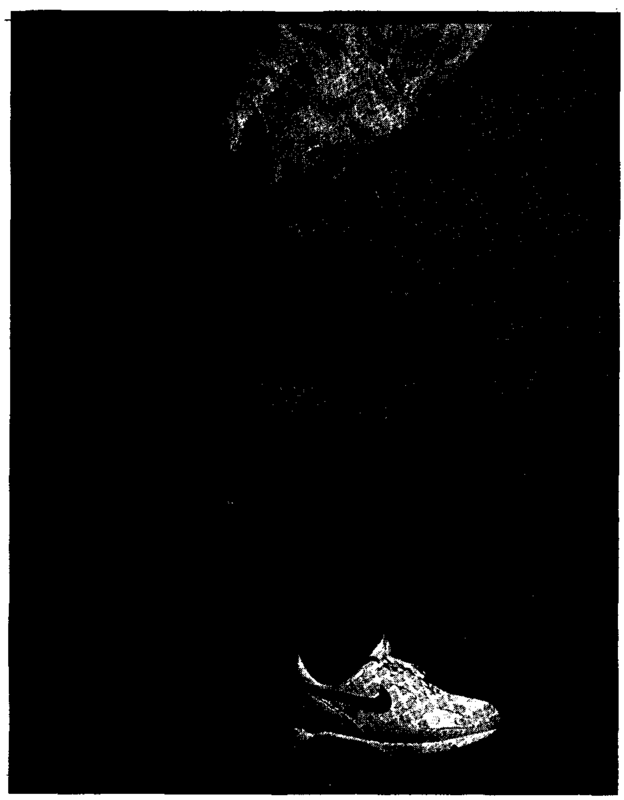
powerful legs,
quick feet,
a low center of gravity for agility,
muscular endurance with the knees bent,
very little excess weight in the form of body fat,
good skating technique.

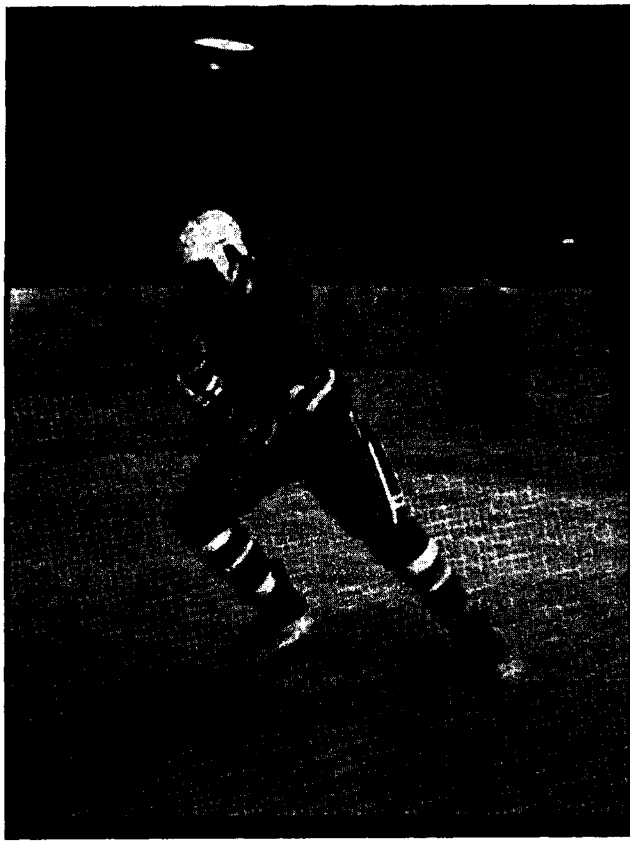
Synergistic training for skating: don't rely on just one mode of training.

It is actually a blessing we don't have unlimited access to ice-time twelve months of the year, because we can emphasize different aspects of training at different phases.

Skating alone is NOT the best way to improve skating.

Track athletes have learned that to increase speed, there has to be more diverse training than simply sprinting fast. The complex neuromuscular system responds best to a variety of training stimuli. In the case of the singular goal to improve skating speed, it would be insufficient to just train by skating, even if there is unlimited ice time throughout the year. We will see why the best training program combines skating with weight training, running sprints, plyometrics, slide board, rollerblades, other skating-specific exercises with body weight, and running up and down hills.





Slide boards or in-line rollers should be used in intervals (40:80) short enough to allow you to keep your knees bent.

No one of these training modalities, by itself, is as effective as the combination.

1) **Overload fast-twitch muscle fibers for powerful skating strides.**
The glossary contains a brief discussion of the difference between fast and slow twitch muscle fibers. It is important to note that slow, aerobic training does not recruit fast-twitch fibers. These powerful fibers are only called upon for lifting heavy weights or during all-out explosive effort.

To improve muscular power, we must challenge both the nerves and muscles sufficiently; this is the dual role of heavy resistance training. Improvement in strength or power results from two changes due to training. The first, most obvious change is that muscles get bigger (hypertrophy) when overloaded on a consistent basis. Each fiber or muscle cell (especially each fast-twitch fiber) becomes larger, because it contains more contractile elements (myofibrils). Simply stated, training, rest, and nutrition build more protein elements for muscle contraction.

The second change is less apparent, but just as important in strength gain. The nervous system "learns" from chronic overload to recruit more muscle fibers and to have them fire more frequently.

It is easy to see why we cannot overload skating muscles sufficiently on-ice to invoke both of these changes. The overload stimulus has to be so intense to promote improvement in neuromuscular recruitment patterns, it is doubtful that skating alone could challenge the system to this extent.

Furthermore, to cause the awesome muscle hypertrophy of bodybuilders, the muscles have to be overloaded beyond failure — over and over again. Bodybuilders are just getting started when they feel the intense burn of a painful set. To overload to that extent while skating may teach poor technique, meaning the painful, burning muscles will not work in the skillful way necessary to improve skating.

Weight training and plyometric exercises are the best ways to challenge the legs to grow bigger, stronger, and more powerful.

2) **Challenge the nervous system to promote quick feet.**
We must include phases of the year in which there are very intense running sprints. The faster you run, the faster you move your feet. Use a combination of sprinting on flat surfaces, up hill, or down a slight decline.

3) **Lower your center of gravity for agility — to skate corners or start-and-stop quickly.**
There are a variety of great drills off-ice to increase your strength and promote the habit of skating with greater knee bend on corners. Squats and hip-sled repetitions should be done to the same depth (well past 90°) as the optimal skating position. There are many other strengthening exercises like jumping with one or two legs, and you should overload in a variety of different ways.

4) **Skating-specific exercises for muscular endurance with the knees bent.**
Rollerblades, slide boards, skating machines, or dry skating (like speed skaters) should be used to promote the habit of skating with bent knees. None of these is likely to be so intense as to really challenge the fast twitch fibers to increase power. But, muscular endurance and hypertrophy are gained from doing intervals.

The goal is to promote knee bend, so these training devices should not be done for longer than about 40 seconds, allowing about 80 seconds rest. If you skate around the lake for a half hour, you will be unable to bend your knees enough after a minute and will be training poor habits rather than good ones.

5) **Reducing excess body fat.**
Anyone who has skated with a 20 pound weight vest knows the feeling of carrying excess baggage which has no value. If you weigh 200 pounds, carrying 10% extra fat has exactly the same effect as a weight vest.

This is a double edged sword, because if 200 pounds is your best playing weight, it means your 20 pound weight vest of fat is being supported with 20 pounds less muscle.

The best way to reduce body fat is running distances and following a long-term healthy diet containing very little fat.

6) **Over-speed skating: putting it together in a fast, fluid, powerful motion.**
Positive changes from lifting, running, and other off-ice efforts will transfer to skating improvement if there is some skating interspersed throughout your training. It would not be advisable to train in other ways and not skate for many months.

Emphasize different elements of the skating improvement program at various times of the year. Periods of six weeks where you emphasize lifting and running (spring and fall, for example) should be separated by some intense skating intervals for a period of 4-6 weeks (perhaps in the summer) along with lifting or plyometrics. Your body would probably not respond well to a phase in which you included all the different methods of overload, so plan your calendar wisely.

Squats, perhaps the best exercise for leg strength, but also very dangerous.

Barbell squats utilize many muscle groups that are important in hockey: quadriceps (front thigh), hamstrings (back thigh), gluteal (buttocks), back erectors, abdominals, and groin muscles. To prove to yourself just how valuable squats can be, do a few hard sets and skate immediately afterward. You'll feel that squats indeed utilize skating muscles in a rather similar range of motion.

When done properly, squats will strengthen and stretch many skating muscles, promoting good skating posture, knee bend, and power. For hockey players, squats should be done to a depth where the backs of the hamstrings are parallel to the ground. Keep your back locked in the same position as when you are standing erect. This is called a straight position, but obviously there is the normal curvature in the small of the back. It is best to keep your chin up slightly, so you are looking straight ahead.

Two points are very important to do squats safely and avoid back injuries.

First, you should never allow your back to become rounded (convex) or overly arched. These positions are vulnerable to high stress even if the weight is not heavy. Your buttocks will naturally stick out behind more as you go down, but keep your back in the same straight position throughout the lift.

Secondly, the bar should go up and down in a plane that is straight above your arches, and the weight should never get out over your toes.

In *the Dungeon*, the weightroom at the University of Minnesota, we never do heavy sets of squats. For beginners, squats are done with just a hockey stick or an unloaded bar. After several years of developing good technique, the college players still never do sets with fewer than ten repetitions, and never lift even close to failure at the end of a set. Our goal is to use squats for stretching and developing musular endurance.

Our goal is to use squats for stretching and developing musular endurance.

Leg strength and heavy resistance are best developed on hip sled or leg press machines.

This is where heavy sets are done to challenge the nervous system to recruit more fibers. Players also do exhaustive, long sets, past failure to promote muscular hypertrophy. Owatonna Engineering (Medford, MN) has developed a "plyometric squat sled" in which the athlete is in much the same position as barbell squats. We use these like a hip sled, but also for jumping against heavy resistance.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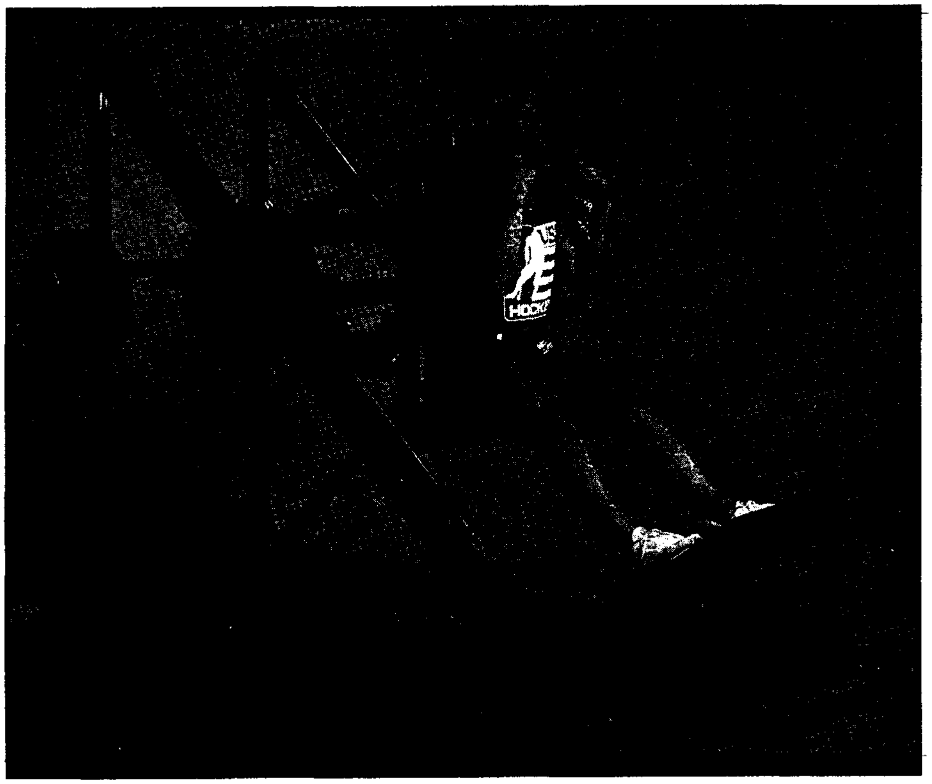


Olympic lifts (clean or snatch):

The value of the clean or snatch is that they involve a great deal of speed, power, flexibility, and technique — they are great athletic lifts. This might also be a reason to exclude them. So much technique and athleticism is involved that Olympic lifters spend their entire career perfecting them. In other words, to do these lifts safely and receive substantial benefit requires months (and even years) of practice.

Like squats, there is a great potential for permanent injury to the back. Unlike squats, the range of motion is not specific enough to hockey (in my opinion) to incorportate them into your program. Many other excellent strength instructors feel they have great value for a hockey player, and they may be right. If you decide to do cleans, make sure you take your time learning the technique perfectly (perhaps years), do them in front of a competent instructor, and never do them when you are near fatigue.

Never get hurt in the weight room!!!

Larry Hendrickson was the strength instructor for the Minnesota North Stars and a former high school and junior coach. He and his teams have found great success, partly from their efforts in the weight room.

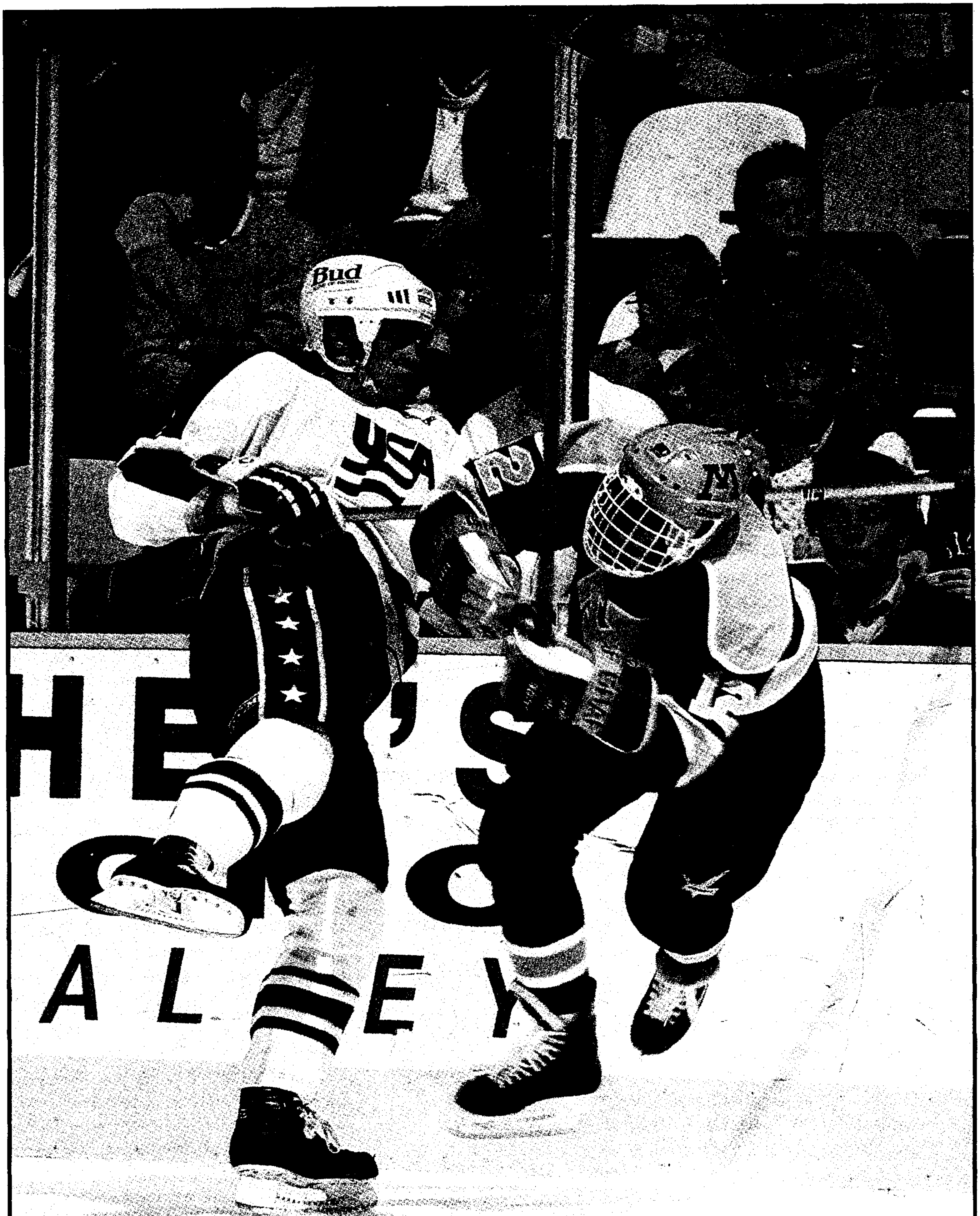
He points out that we might have to live with injuries from a hockey game or practice, but no amount of strength improvement is worth a permanent, disabling injury caused by poor technique, carelessness, or lifting too heavily. Always have a spotter, and the more dangerous lifts like squats should be done in the presence of an instructor. Even a less serious injury that postpones your training for a few weeks should be avoided at any cost. We are not trying to be weight lifters; the rewards and dangers of weight training should be kept in perspective. Weight training is a supplement to help us become better hockey players.

Weight training is a means to an end, not the final objective. Never risk injury in the weightroom.

Be consistent and have patience.

Hendrickson offers an analogy to planting a small tree at the summer cottage. While you're there, it grows too slowly to observe, but during the many months you're away, it grows enough to see the difference when you return. It's similar to punching the clock consistently in the weightroom. Day by day you'll not see much growth, but over long periods of time you will observe vast improvements. Hendy would say ...

"... The prize is worth the price!"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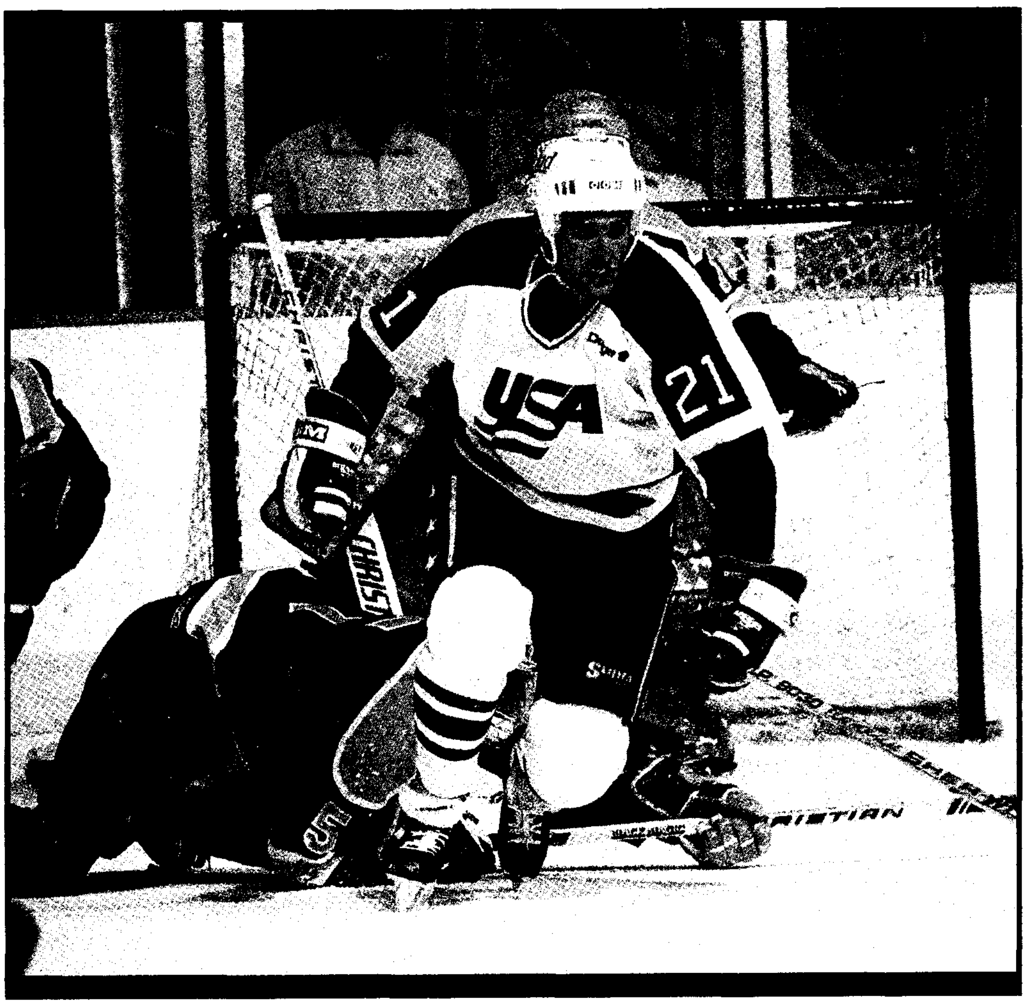
CHAPTER EIGHT

Hockey-specific endurance



Chapter Overview: **(see the glossary for definitions of terms)**

Off-ice aerobic and anaerobic conditioning are called ***'general endurance training'*** and should precede intense on-ice interval training, which we will call ***'hockey-specific endurance training.'***

1 **Aerobic endurance** is the ability to maintain submaximal effort for a long time, such as during a marathon. Aerobic endurance is beneficial to a hockey player for several reasons:

a) It is a basic building block, upon which the more intense training depends.
b) There is quicker and more complete recovery between work intervals.
c) There is a faster adjustment at the beginning of each work interval.
d) During submaximal portions of a game or practice, a player who has a high aerobic capacity would rely more on aerobic metabolism of blood glucose and fat and less on (anaerobic metabolism of) glycogen stored in the muscles. This prevents some lactic acid buildup and fatigue.

These improvements are accomplished by greater 1) ***delivery*** and 2) ***utilization*** of oxygen. This results from a stronger, more efficient heart, improved oxygen exchange from the lungs to the blood, greater oxygen carrying capacity of the blood, a proliferation of capillaries surrounding the trained muscle cells, and an increased concentration of aerobic enzymes in these specific muscles.

How should we train for aerobic endurance? Should we run distances, or intervals, or play other sports? The answer varies with your age, the length of your season, whether you're trying to reduce body fat or gain weight, whether your program should be intense or relaxing at a given phase of the year, and whether quickness, power, and other benefits of games and interval training are a high priority.

2 **Anaerobic endurance** is the ability to maintain (near) maximum effort for intervals as long as a typical shift in a game. The word 'anaerobic' literally means: without oxygen, somewhat of a misnomer, because during this type of all-out effort, much of the energy is supplied by aerobic metabolism as well.

a) Through explosive, short interval training an athlete can improve speed and power, and the ability to recover quickly from these short intervals.
b) Building anaerobic endurance for game shifts would require intervals of that same length. Because this training is difficult and stressful, it should be limited to a few weeks before the season, running hills or sprints on a track.
c) Anaerobic intervals not only increase these anaerobic capacities, but are at least as effective as distance training in improving aerobic capacity.

3 **Basketball, soccer and other games** help build endurance and other athletic attributes like quickness, coordination, and agility. For young players (or low-fat college players trying to gain weight) running or biking distances is not the best use of training time.

4 **Hockey-specific endurance** is the ability to compete (and perform all skills) in an elevated comfort zone for an entire hockey game.

Hockey-specific endurance

Students of the game

It is important for students of hockey to understand as much physiology as they can. To this end, I would suggest many excellent textbooks on exercise physiology (Astrand and Rodahl, 1977; Fox and Mathews, 1974); or articles reviewing the relationship between physiology and hockey (Montgomery, 1982; or Wilson and Hedberg, 1976). Pick up anything you can find by Howard Green, who has done brilliant research with hockey players (Green et al., 1975a,b, 1978a,b, 1979a,b,c,d,e, 1980, 1981, 1983, 1985, 1987, 1988).

As a math student and teacher, I've had a nagging, forty year toothache to discuss with authors of textbooks. Math books seemed impeccably thorough in developing every topic with deductive proofs, but just as thoroughly confusing for the average student with less comprehension than the author. This made me wonder who the book was written for — certainly not me — maybe for the ivory tower colleagues of the author. Any time I had a dumb question, the author wanted to answer it with a proof — with some math lingo rather than the vocabulary of the student.

There are many physiological terms that could be just as confusing. Some are discussed briefly in the glossary. In this chapter you will find a simplistic definition of *hockey-specific endurance* ... probably the same definition a coach would have given thirty years ago, before exercise science began to dissect the sport. Many attempts have been made to incorporate terms like 'aerobic' and 'anaerobic' into the definition of endurance for hockey, but these attempts have added nothing to the coaches' concept. The definition is simplistic, not to make it easily understood, but because it says a lot about how to train.

Hockey is a game of two second sprints, lasting for shifts of 40-60 seconds. Body contact increases the need for muscular endurance.

Definition: A player is in shape when he can play hard for each shift of an entire game without losing strength, skill, or speed.

It is easy to see why scientists have found it difficult to characterize the game by laboratory tests which isolate only one aspect. Dillman, Stockholm, and Greer (1984) have verified by high speed film what has probably been expected as long as the game has been played. A typical shift is composed of many short, almost random bursts of acceleration and deceleration, lasting only about 2 seconds and accompanying quick turns and stops and starts. Lab tests cannot duplicate this easily — nor can they quantify the twisting and turning through traffic, the skills like shooting and passing, the body-checking, the hooking and holding, falling and getting up. Taken together, not isolated in the lab, these add up to hockey-specific endurance.

Which energy system (aerobic or anaerobic) contributes most during a hockey game?
Leave the question to the scientists for now.

Extensive research has investigated the question: which metabolic system supplies the most energy during a long hockey game, aerobic or anaerobic pathways? The results from many authors have been inconclusive, at best, and certainly conflicting, because the *type of metabolism changes as a person tries harder.*

Physiologists have tried to categorize the energy supply by percent contribution during a hockey game. The percent varies between players; it varies between teams; and, on the same team it varies with the time of the season (Seliger, 1972). Not surprisingly, Wilson and Hedberg (1976) found physiological evidence that in the playoffs, the Swedish National Team tried harder than in the training season. As we might have predicted, more of the energy was supplied by anaerobic metabolism in these important games.

Do we need a high Vo_2 max. for competition and as a training base?

There is agreement among physiologists that aerobic endurance is important for hockey .... yet, no published research shows that elite hockey players have a high aerobic capacity when compared to endurance athletes. In fact, bantams, professionals, and untrained college students look very similar using this criteria.

Because of the low values for elite players, most physiologists have concluded that hockey players need more work in this area. We might also have objectively concluded: perhaps this measure is less important to a hockey player than to a scientist.

The following table summarizes the team averages for max Vo_2 as reported in many scientific articles. The number reported in each case is the maximum volume of oxygen that can be consumed per minute (ml/minute) divided by body weight (kg).

At this point in history, the scientific research can be summarized easily ...

Max Vo_2 is highly related to success in distance events. It is not related to success in hockey — but, skating speed and acceleration are.

Other measures related to aerobic endurance might be more appropriate for hockey.

Howard Green points out that a player with a high aerobic capacity will rely less on glycolysis at any given submaximal workload. This means less glycogen depletion, less lactic acid buildup, and fewer biochemical and neuromuscular problems from fatigue (Green, Ibid.). Perhaps we should measure our conditioning level by the (anaerobic) threshold point for lactic acid buildup in the blood during increasing exercise. This is a more direct measure than Vo_2 max of the point at which glycolysis begins to be a problem for continued exercise. It is an even better predictor of success in distance events than max Vo_2, (Farrell, 1978), and changes to a greater extent with training (Davis, 1985).

Is hockey an aerobic or anaerobic game?

While much research has focused on this question ... the answer is: it depends upon how much effort goes into any shift.

Since hockey is an intermittent game perhaps we should see how quickly players adjust to, and recover from a short exercise bout. On page 80 is a graph for a two minute constant exercise, showing the rate at which oxygen consumption approaches a steady state level and returns to our resting, or basal metabolic rate, BMR. The exponential math is not important in this discussion. The point is that upon starting a constant work load (Wss) your muscles need energy at that rate (Vo_2ss) immediately. It takes many seconds (~60 seconds in the graph) for the energy requirement to be met by aerobic metabolism. In the mean time, you are using stored glycogen and building up lactic acid and a considerable oxygen deficit.

The ability to quickly reach the steady state value of oxygen consumption is highly trainable as is recovery rate (Ceretelli, 1979; Fox, 1976; Hagberg, 1980a,b; Hickson, 1978). Some of the glycogen depletion and lactic acid buildup during a game occurs while we are building this oxygen deficit each shift.

Relationship between Max VO_2 and Age or designated Level of play

Summary of literature on hockey and aerobic capacity

TEAM OR GROUP	AGE	VO_2 MAX	INVESTIGATOR
CANADIAN "HOUSE" TEAM	10.1	56.6 [A]	PATERSON, 1979
CANADIAN "MINOR" PLAYERS	11.3	51.1	BLIMKIE, 1978
CANADIAN "COMPETITIVE" TEAM	10.7	58.8	PATERSON, 1979
CANADIAN "MINOR" PLAYERS	12.7	65.5	BLIMKIE, 1978
MICHIGAN "A" BANTAM TEAM	13.3	57.8	STEPHENS, 1983
CANADIAN "MINOR" PLAYERS	16.3	60.1	BLIMKIE, 1978
CANADIAN JUNIOR "A" TEAM	17.9	55.9	HOUSTON, 1975
U.S. NATIONAL JUNIOR TEAM	18.2	50.6	SIM, 1978
UNIVERSITY CLUB TEAM	20.1	56.3	HUTCHINSON, 1979
DIVISION II COLLEGE TEAM	20.2	53.6 [B]	BLATHERWICK, 1983
CANADIAN COLLEGE TEAM	20.9	54.1	HOUSTON, 1975
CANADIAN UNIVERSITY TEAM	20.2	55.0 [S]	FERGUSON, 1969
CANADIAN UNIVERSITY TEAM	20.8	58.9	GREEN, 1979
NCAA CHAMPION DIV.I TEAM	20.0	58.4	ALEXANDER, 1980
CANADIAN "MINOR" PLAYERS	23.5	62.8	BLIMKIE, 1978
MINOR LEAGUE PROFESSIONAL TEAM	24.6	55.0	BURKE, 1982
U.S. NATIONAL TEAM	25.1	61.1	STEPHENS,1983
SWEDISH NATIONAL TEAM	25.7	56.3	WILSON, 1976
CZECHOSLAVAKIAN NATIONAL TEAM	24.4	54.6 [B]	SELIGER, 1972
N.H.L. PROFESSIONAL TEAM	24.9	53.4	AGRE, 1988
N.H.L. PROFESSIONAL TEAM	25.1	51.7	ROSENTHAL, 1981
U.S. OLYMPIC TEAM		58.7	ENOS, 1976

A = VO_2 MAX NORMALIZED BY BODY WEIGHT; (ML/MIN/KG) AS REPORTED BY INVESTIGATOR.
S = SKATING TEST; B = BICYCLE ERGOMETER TEST; OTHERS TESTED ON TREADMILL.

The table categorizes teams by age first, and then is broken down into groups of approximately the same age. It can be seen that older players do not have a greater aerobic endurance capacity (VO_2 Max). Teams of the same age, but competing in different (designated) levels of play, also show no difference in VO_2 Max. This is a dramatic contrast to the difference in skating ability with age.

Interval training is

... the best way to raise anaerobic threshold. Distance running is done in a "comfort zone" below the threshold and therfore is not an effective way to elevate this point.

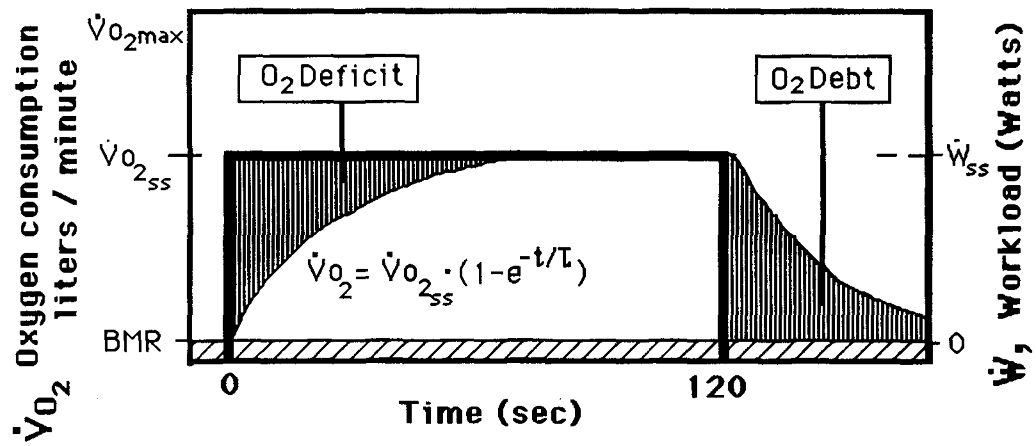
... the best way to change the shape of the curves below, reaching the steady state value and returning to BMR more quickly.

increased uptake and utilization in trained muscles; (For a review on exercise and C-V disease: Research Review, 1989).

Greater endurance is a function of increased ***delivery*** of oxygen and increased ***uptake*** and ***utilization*** by active muscles (Astrand, 1977). Elevated Vo2 max from training appears to be about equally reliant upon both of these factors (Holloszy, 1976).

Two minute square-wave workload plotted vs. time and oxygen consumption

(Astrand, 1977; Whipp, 1971, 1980)



Training for aerobic endurance is important for your hockey and for future health.

Scientists have demonstrated the benefits of regular aerobic exercise in reducing the risk of future cardiovascular diseases and increasing functional work capacity:

1) elevated VO_2 max and anaerobic threshold;
2) reduced glycolysis and blood lactate coincident with increased utilization of free fatty acids (FFA) as fuels during aerobic exercise;
3) reduction of resting plasma levels of FFA and increased HDL or 'good' cholesterol;
4) decreased body fat;
5) increased insulin sensitivity, so the body is more efficient at utilizing its own fuels;
6) reduced work (or increased efficiency) of the heart by reduction of heart rate and blood pressure, increased stroke volume, and

Increased *delivery* of oxygen and removal of end products of metabolism results from:

1) a bigger, stronger heart muscle which pumps more blood per beat;
2) lungs which become more efficient in the exchange of oxygen to the blood;
3) increased blood volume and oxygen carrying capacity.

Local adaptations are reflected in the increased uptake and utilization of oxygen and are associated with anatomical and biochemical changes within the muscles:

1) proliferation of capillary supply to muscle fibers;
2) increase in myoglobin, a molecule in the muscle cell that binds oxygen;
3) proliferation of mitochondria (size and number). These are the small organelles in cells

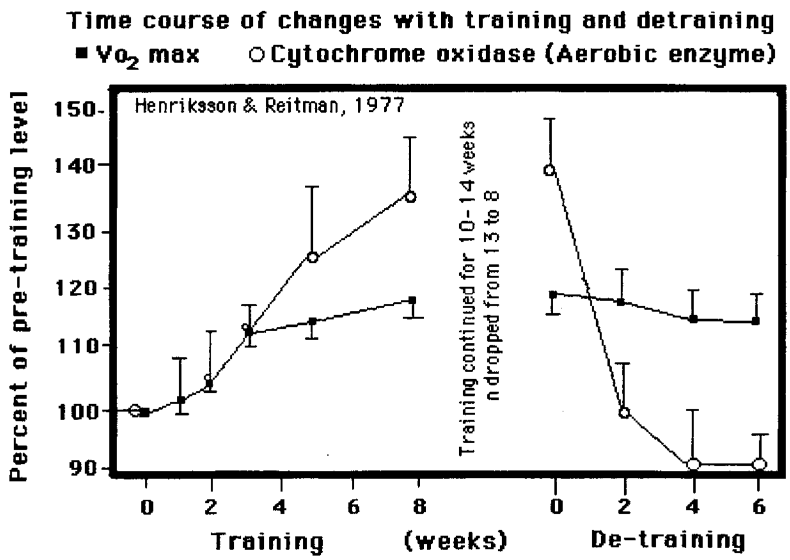
that contain the enzymes of aerobic metabolism;

4) increase in concentrations of aerobic enzymes
5) beneficial changes in the rest and exercise concentration and/or utilizaton of ATP, free fatty acids, and carbohydrates.

The rate at which these improvements take place is shown in the following graph. Note that the changes in enzyme concentrations (local changes) are much more rapid and larger than the change in measured functional capacity (VO_2 max). Research also shows that the increase in capillaries within trained muscles (another local change) might begin within days (Andersen and Hendriksson, 1977).

The bad news ...

Notice how quickly the local biochemical improvements are lost with detraining compared to VO_2 max, which has previously been the major criterion by which a person's conditioning level has been judged.



Note: Cytochrome oxidase is a rate limiting enzyme in the electron transport chain. It is one of the 'markers' of the potential for aerobic metabolism in the mitochondria of muscle cells. Changes in other aerobic enzymes were shown by the author, but left out here for simplicity.

The question is not whether we should improve aerobic endurance, but how!

The aging professional should probably emphasize aerobic distance work (jogging or biking) for most of his off-season endurance training. Intense interval training is too stressful for someone in this category who's season is already too long and stressful. Speed training is helpful for an older athlete, but tough anaerobic interval training should be restricted to just three or four weeks before the season.

For any player who needs to shed some body fat, distance training is the best. These workouts should last from 40 minutes to a couple hours in order to burn as many calories as possible. Also, because we should do distance work as many days of the week as possible, switch forms of training every day from jogging to biking, swimming, basketball, etc. For these workouts, remember, the slower the pace, the more likely the fuel that is burned is fat, rather than glycogen.

The question is not whether we should improve aerobic endurance, but how!

On the other end of the spectrum, the young player with low body fat, should gain aerobic endurance as a byproduct of his other training. For those trying to gain weight, distance work is counterproductive — especially jogging. In this case, aerobic endurance is gained from the sum of all workouts: skating, sprinting, plyometrics, other sports, strength training, and from intense anaerobic interval training. ***Distance training is just a building block that puts you in postion for the more intense training to improve athleticism.***

Interval training for anaerobic endurance is the most stressful.

For every person, no matter what shape you're in, a maximum effort will require that some energy is supplied by anaerobic processes. Hopefully, this will happen several times per shift — every shift of your career. A well-conditioned player would not rely on anaerobic glycolysis until higher workloads, but no amount of aerobic training will prevent glycolysis and lactate buildup that results from a ***maximum*** effort.

Running hills or 200 meter sprints on the track will increase a player's tolerance to lactic acid, allowing greater performance with high levels of acidity. This means better endurance for a forty second shift. These intervals are tough duty, and should be restricted to four weeks pre-season, and perhaps in the spring. But, they have great value in the off-ice program, because this type of training on-ice compromises skating skill.

It is important to realize that through aerobic distance training, there is no improvement in anaerobic qualities like speed, strength, power, or anaerobic endurance. On the other hand, in training for each of these, there will also be improvement in aerobic endurance, the tougher the anaerobic intervals, the more gain in aerobic capacity.

Basketball, soccer, raquetball, speedball, tennis

Games like basketball, soccer, speedball, raquetball, and tennis (no delays; hustling after balls between points) combine great conditioning workouts with athleticism: agility, quickness, etc. Soviet athletes in every sport, do some of their conditioning while playing other sports (Yessis, 1987). These workouts should last 1-2 hours.

The 1984 and 1988 U.S. Teams used two different versions of basketball during the early part of the season. The 'Chub Club' composed of a group trying to reduce body fat played 'aerobic' basketball with little or no rest. Outdoor soccer would have been a similar activity, mainly aerobic in nature, with occasional bursts. Indoor soccer played in a hockey rink on synthetic turf, can be more anaerobic, because there are line changes and regular rest intervals, and the pace of play is often quicker than outdoors.

'Anaerobic basketball'

The '84 U.S. team played 'anaerobic basketball' as a vigorous early season interval workout. The rules were modified to promote speed and playmaking. The entire squad was divided into three-man teams for full-court 3-on-3 competition. Players avoided fouls to keep the game moving safely and quickly. On any whistle, the ball was given immediately to one of the two referee/coaches, who would pass it to a player. The ball wasn't passed in from out of bounds, but played immediately from the referee's pass, sometimes creating fast breaks.

To keep the play moving up and down the court, another coach kept a 15 second clock and blew a whistle if no one had taken a shot. Two teams played for 60-90 seconds and rested twice as long while four other teams competed.

Research summary: a season of hockey does <u>not</u> improve aerobic capacity; dry-land training does.

Green and Houston (1975) investigated the cardiorespiratory and anaerobic changes over the course of a hockey season on Canadian Junior players (age=16-20). There were no significant changes in body weight, percent fat, VO_2 max (ml/kg/min), blood hematocrit, or hemoglobin. However, there was a 14% increase in anaerobic endurance measured by the time before voluntary exhaustion on a treadmill run, also velocity (4.6%) and "power" (6.8%) while performing a stair running test.

Alexander et al. (1980) examined the effects of a season of training and competition on aerobic capacities for a national champion university team. Max Vo_2 did not change. This is typical of results reported by many others (reviewed by Montgomery, 1988).

Green et al., (1980) found that during a six week "detraining" period following a competitive college season, VO_2 max decreased by 5.2% and was accompanied by significant decreases in aerobic and anaerobic enzymes.

College pre-season distances, weight training, and intervals on the stadium steps:

The effect of 6 weeks of dry land training prior to a college hockey season was examined (Hutchinson, Maas, Murdoch, 1979). In the first two weeks of training, subjects warmed up with calisthentics for 30 minutes, followed by weight training for 30 minutes, and then ran for 2 miles. By the third week, there were six (1½ hour) workouts per week. Each subject ran 5 miles per day, lifted weights 3 days, and later ran 12 intervals (20:60) on stadium steps. By the end of the training period VO_2 max had increased 10.8% ($p<.001$) to 62.5 ml/kg/min. However, over the course of the season maximum oxygen consumption dropped to 54.9 ml/kg/min, and the authors advised that aerobic conditioning be maintained throughout the competitive season.

Supplementing on-ice training with aerobic bicycle workouts; testing on and off-ice.

Daub, et al. (1983) supplemented a normal hockey season with aerobic bicycle pedalling (three times per week for 30-45 minutes at 70% intensity). Ten college players and a control group were tested pre and post-season using maximal and submaximal ***skating tests*** in addition to similar tests on a ***bicycle ergometer.***

There was no change in maximum VO_2 measured either during the skating or bicycling tests for either group. During the submaximal skating tests, no greater efficiency was observed. Only the group that had done the extra bicycle training had significantly lower heart rate during the bicycle test. This illustrates a specific adaptation to the supplemental bicycling which appeared to have no beneficial effect on the aerobic capacity for ice hockey.

College pre-season sprints, plyometrics, hills, and off-ice anaerobic interval training.

Twelve college hockey players met three times per week (six weeks) for 45-60 minutes of intense interval training (Blatherwick and Knoblauch, 1983). Players ran all-out sprints for 25 minutes (5: 55, followed by longer sprints of 20:100). Workouts concluded with 10-14 minutes of hill running (30:90) and 10-14 minutes of weighted plyometric jumps. Heart rates were monitored telemetrically and after five minutes usually reached maximum during each sprint interval and recovered to 65-80% during rests.

During the six weeks players had only two optional recreational skating hours per week, and there was no aerobic training (bicycling or distance running). Much of the test protocol was ***non-specific*** to the training, in terms of the metabolic systems used, the range of motion, and the neuromuscular recruitment.

Following six weeks of training, there were significant improvements in most of the aerobic and anaerobic parameters measured. Total work during an incremental bicycle test improved by 28.7%, Max VO_2 increased 6.2%, and 5km run times improved by 5.5%. Most measures of anaerobic performance also improved significantly ($p<.01$): skating acceleration (but not top speed) improved by 1.3%; off-ice forty yard dash time by 1.8%; vertical jump by 6.6%; a 12 second sprint on the bike by 11.2%. Anaerobic endurance improved 10.4% on the Wingate 40 second bicycle test and by 5.4% during a six-length stop-and-start skating shuttle test that takes about 42 seconds on the average.

These results demonstrated that rigorous off-ice anaerobic interval training can help improve not only sprint speed and jumping ability (specific to the training), but skating power and endurance, and aerobic endurance measured by distance running and bicycling (non-specific to the training).

How is endurance defined for hockey?

Forty years ago, coaches and players might have answered without hesitation. There was no intimidation to incorporate terms like 'aerobic' and 'anaerobic' into the definition. Since that time scientists have tried to categorize hockey endurance as some ratio of these, partly because laboratory tests evolved with these capabilities. But, hockey didn't fit the laboratory model.

Ask any 1950's coach what he wanted in the way of endurance for an important hockey game, and his answer might have been simply ...

... Players are in shape if they can play at 100% intensity and not lose speed, strength, or skill for any shift of the entire game.

One thing physiologists have shown over and over is that performance will be enhanced most effectively when the training closely approximates the competition or testing.

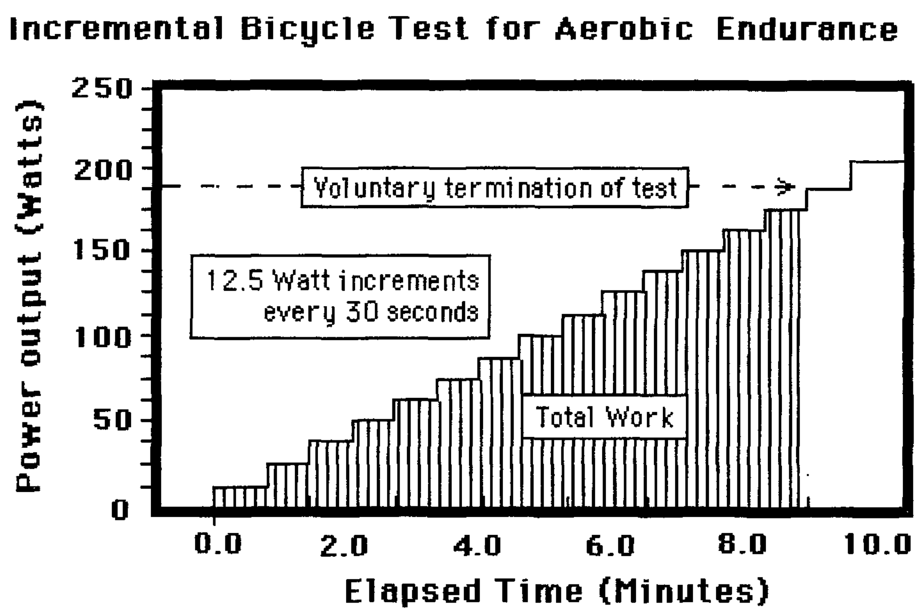
Training is specific!
... muscle specificity
... metabolic specificity
... skill specificity
... speed specificity ...

Training is specific to the muscles used, to the precise range of motion in which they are conditioned, to the speed of training, to the duration of exercise, and to the metabolic supply of energy. Therefore, off-ice aerobic and anaerobic training should be thought of as 'general' endurance training. Jogging and bicycling are not skating. Local improvements in the muscles trained are not specific to the range of motion, and certainly not to the quick bursts of acceleration and changes of direction of a hockey game. The value of this general endurance training is in the improved efficiency of the heart and lungs and the reduction of body fat — and this is considerable value.

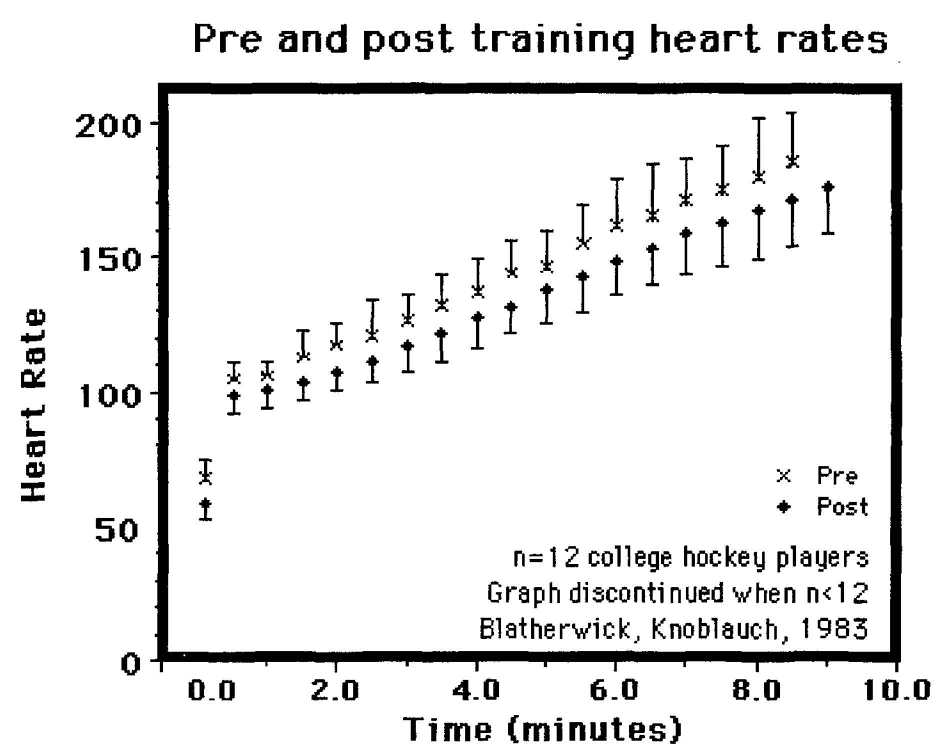
Even if the conditioning is done on roller blades, a slide board, or using a skating-simulation machine, it should be thought of as general endurance training. It may certainly improve endurance capacity for skating muscles, but it isn't called 'hockey specific' because it lacks the quickness, the stopping and starting, the agile turns in combination with other skills.

1) Roller In-line skating, ice skating, or simulation training should never be done as a distance workout. Observe the stride of anyone skating around the lake, and you will see slow strides, inadequate knee bend, reliance on gluteal muscles for hip extension, with little power coming from the quadriceps (knee extensors).

2) These tools can be used for an important purpose: to develop muscular endurance with the knees bent — training a habit through intervals of about 40 seconds (with 80 second rest). Exaggerate the knee bend. Don't worry about quick feet during these drills.



As listed on the previous page, measures of performance improved significantly. There were apparent physiological adaptations as well. Max VO_2 was elevated by 6.2%, and ventilatory threshold by 20%. Heart rates during the incremental bicycle test were significantly lower at rest ($p<.01$) and at every work load but two, and the time to reach 85% of HR max was delayed 1.23 minutes. The graph below shows this increased cardiovascular efficiency during the incremental bicycle test.



All pre-post HR differences significant at $p<.05$, except:
a) at rest and at 2.0 minutes ($p<.01$), and
b) at 5.0 and 8.0 minutes (not significant).

Hockey-specific endurance training:

If we want players to perform all offensive and defensive skills at top speed every shift for an entire game, we must practice specifically in that manner.

1) We must have two or more practices a week that eventually last as long as a game. The practices must have only planned rest intervals — there are no untimed stoppages for lengthy explanations. Every interval must be done at maximum speed — none can be slower, whether the player fails to concentrate or because the coach hasn't allowed the proper rest. Any drill qualifies (even scrimmages) if the intensity is sufficiently high.

2) The conditioning stimulus must get harder and longer as the season progresses:
   - the total time of the workout increases gradually up to the length of a game;
   - work intervals can be extended slightly (up to 5 seconds longer);
   - rest intervals can be slightly reduced as players get in better shape;
   - weight vest (bent knee) intervals should be added near the end of practice;
   - progressively more anaerobic sprints are added (15-20 second all-out sprint, starting a new sprint every 90 seconds). These can be stops-and-starts.

3) When the quality drops, the practice is over. We want only quality shifts in games.

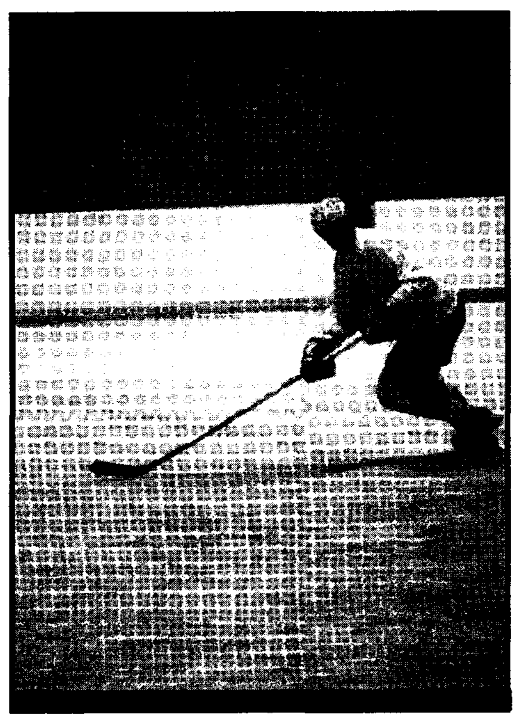
4) This weekly schedule must be maintained consistently for several months.

5) This is only one phase of a year-long training calendar including strength training, sprint intervals, plyometrics, hills, and general (aerobic and anaerobic) endurance workouts off-ice. The more effort is put into endurance and leg strength in the off-season, the more we can use ice time for high quality skill work in-season.

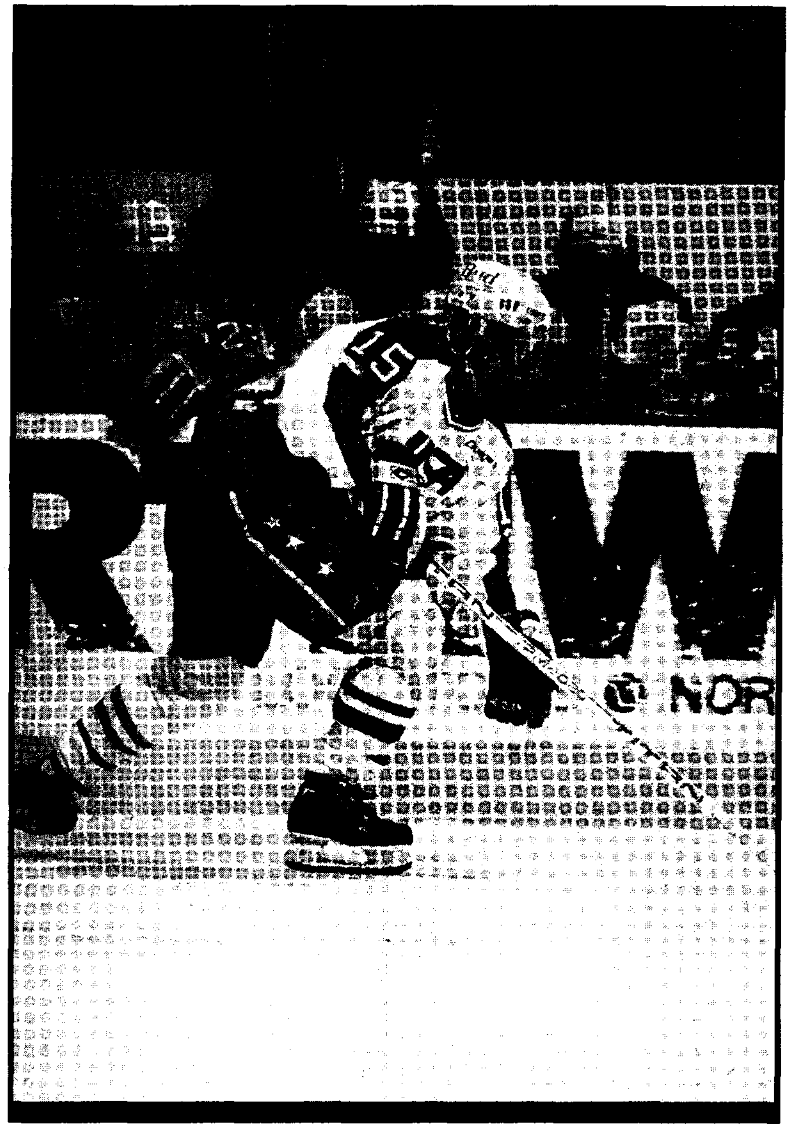
There are no short cuts to building hockey-specific endurance. A couple grinding stop-and-start drills at the end of practice won't do it (and of course, we've already seen how these can ruin the skating stride if they last more than 20 seconds). Ten minutes of these crushers won't do it either, nor will 30 or 40 minutes. A coach who ran drills like this told me he had three objectives: to improve skating, to improve aerobic and anaerobic endurance, and to build mental toughness. Just because a drill is painful does not mean it accomplishes these goals.

After the first 20 seconds there will not be enough quality to improve skating. In fact for the rest of the hour, skating is getting worse. After about five minutes, the pace was so slow there was no improvement in anaerobic endurance. If players are pushed through an hour of these, there might be improvement in aerobic capacity and mental toughness.

My suggestion is to build these last two another way — the cost is too great when skating skill and quickness are compromised.



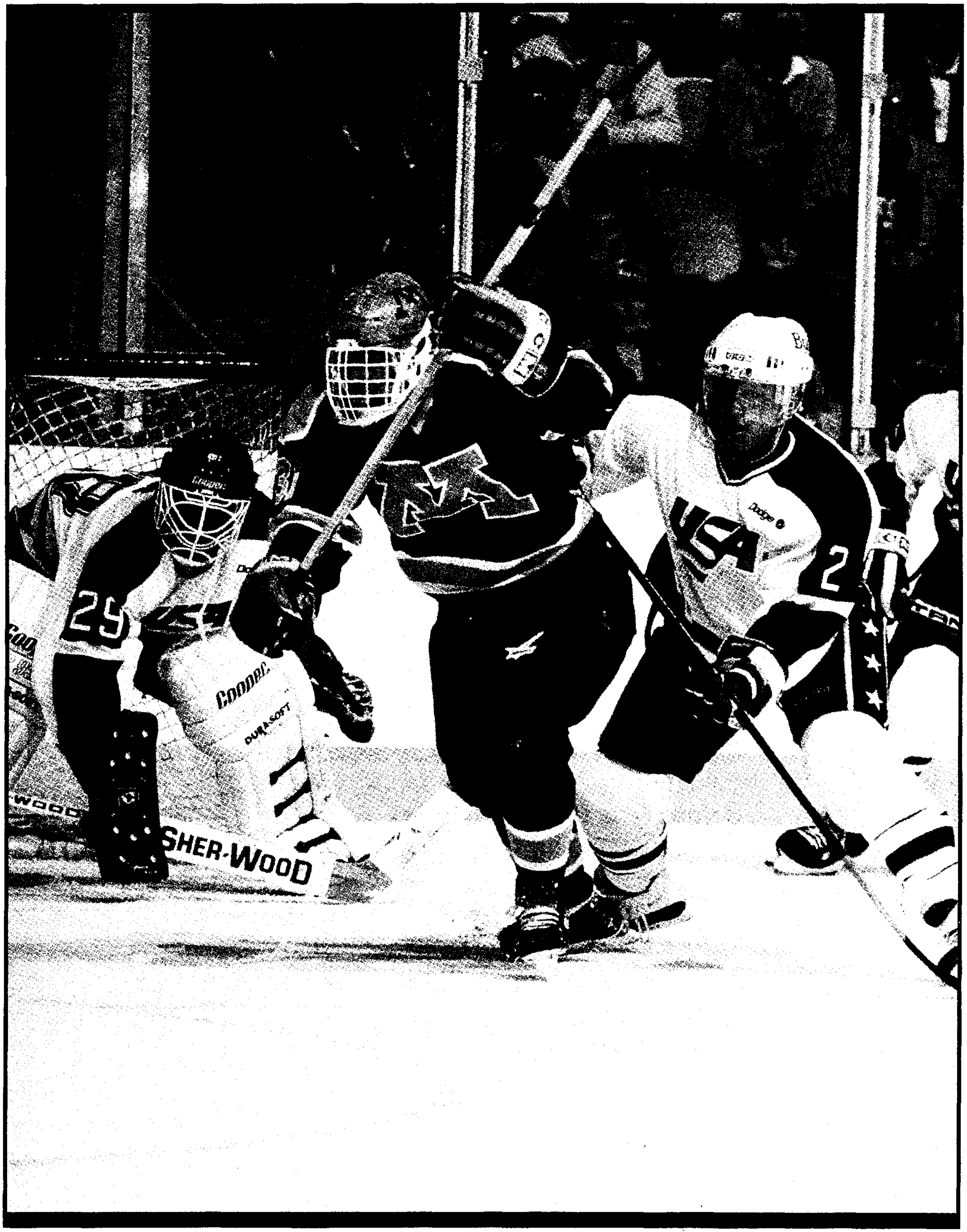
This is hockey-specific endurance training.



If you want full-speed effort for entire games, your training must fulfill both conditions:

1) every drill is done at full-speed;

2) any conditioning practice lasts as long as a game.


SHER-WOOD
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USA
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Dodge
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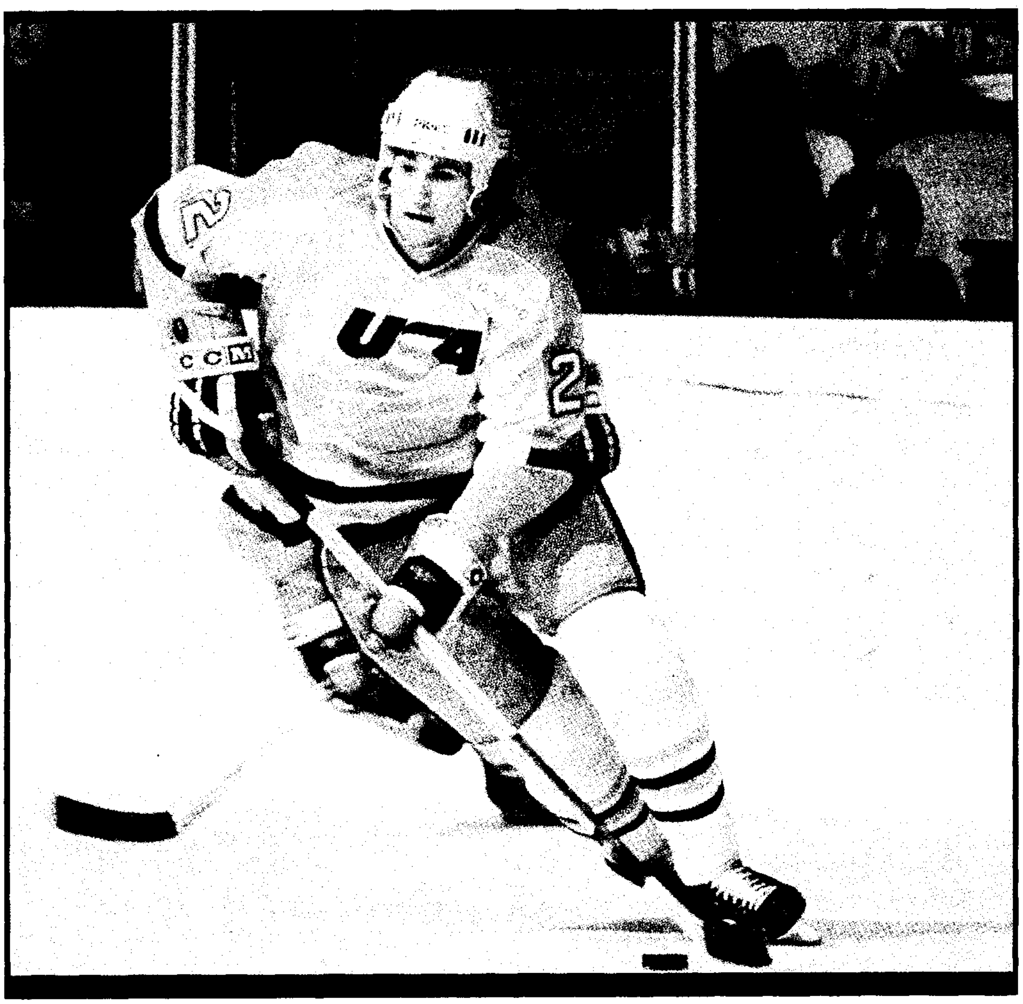
Nutrition for a developing athlete



Chapter Overview:

1 In summary, an athlete should consume much more complex carbohydrate, slightly more protein, and a much lower percentage of fat, especially saturated fat, than is recommended for the average person.

2 Given that an athlete maintains a well-balanced, intelligent diet, the scientific community has not found any value in supplements or ergogenic aids including: steroids, protein powder, amino acids, and even vitamins or minerals. In fact, most of these are harmful if taken in large quantities. Beware of lofty claims by people who have an economic reason to boast about their product or testimonials by individuals who "... used this product and became Mr. Olympia or a gold-medal sprinter." The scientific community can't possibly keep up with all the claims of people trying to make a buck, but so far, none of these claims has passed the test of scientific research. This doesn't mean they won't pass future tests, but be cautious with what goes in your body — you know the salesman isn't.

3 No matter how hard we train, there would be no supercompensation (improvement) without a healthy diet and adequate rest. Between workouts, muscles get bigger, stronger, and more efficient at converting energy, but this process requires time and nutrients from our diet.

4 Every person, but especially athletes, should begin a healthy diet at a young age to reduce the risk of future cardiovascular disease and improve the quality of adult life. Saturated fats and dietary cholesterol lead to harmful plaque buildup in the arteries (atherosclerosis), and because an athlete is consuming many more calories than a sedentary person, he must cut way back on the percentage of fat in his diet.

5 Read product labels and learn the percentages of carbohydrate, protein, and fat in various common foods. A summary table follows this chapter.

6 Weight gain might be vastly overrated and inappropriate for many players. However, for those wishing to add muscle mass, guidelines are summarized in this chapter. To gain muscle weight, your strength workouts must be intense, emphasizing large muscle groups, especially the legs. The importance of rest and nutrition is magnified.

7 Permanent weight loss by reducing calories is unlikely to work, thanks to our evolutionary history. Reducing body fat requires a very consistent program of endurance and strength training, with less emphasis on intensity and more emphasis on consistency and volume of work than in the regimen to gain weight. Rest intervals during and between workouts are minimal. There are no days off.

8 Carbohydrate loading before and carbohydrate replacement drinks during any single hockey game are of little physiological value. The more relevant issues in avoiding fatigue are drinking enough water during a game or practice (up to 10 pints for some players) and replacing water and carbohydrate between games (or practices) when you have several events in a short period of time, like a weekend tournament, a back-to-back series, or in the case of two-a-day practices.

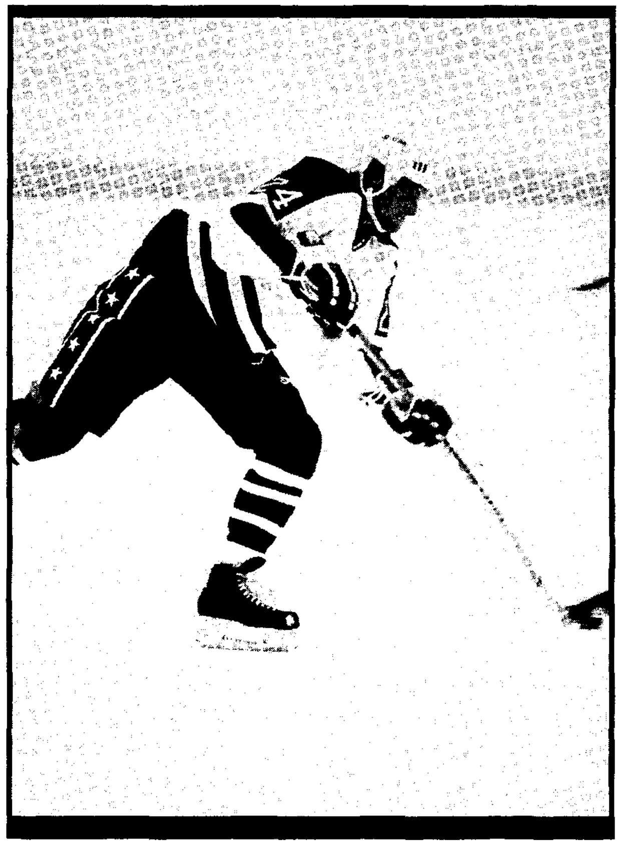
Nutrition for a developing athlete

Exercise Supercompensation

Supercompensation refers to the ability of the body to adapt to (in fact, overcompensate for) the stress of exercise. This is very similar to adaptations the body makes to other types of stress, such as living at high altitude; acclimatization to heat or cold; and immunities built up after contacting certain diseases.

We've all seen that muscles not only adapt to a consistent heavy stress, but actually overcompensate by becoming much bigger and stronger. A weight that causes failure in the initial days of training will be much easier to lift after a few weeks. On the other hand, if the exercise stress is a daily endurance run, the supercompensation takes several forms, not as visible to the naked eye. Strengthening of the heart muscle, enables it to pump a larger volume of blood with each beat, so it doesn't have to beat as fast at a given workload. Local changes in skeletal muscles are better seen with a microscope, because from endurance training, the muscle, itself, may not hypertrophy. Each small muscle cell has more (and bigger) mitochondria (the energy center of any cell), giving it a greater capacity to convert oxygen and other fuels to energy. Furthermore, there will be many more capillaries (microscopic blood vessels) surrounding each muscle cell, so more oxygen can be delivered. If the exercise stress consists of many short, fast sprints, the supercompensation will eventually allow us to run or skate faster with quicker recovery during the rest intervals.

But, as important as it is to train consistently, improvements from hard work will only be realized when there is as much attention paid to diet and recovery as there is to the training regimen. Muscles will only become bigger and stronger if there is adequate protein in the diet, available as amino acids in the bloodstream at precisely the time the muscles are rebuilding after the workout. This means we must eat enough high quality protein, with all the essential



amino acids that cannot be synthesized by the body. Furthermore, because of the need to have the right amino acids available to the muscles at the right time, several meals per day and at least one at night after working out, must contain quality protein.

Dairy products, eggs, and meat contain the highest quality protein, because they provide all the essential amino acids. However, by eating more of these products, you must make a concerted effort to eliminate the animal fats. Protein from legumes is of lower quality, because any one by itself is incomplete, and it would take the proper mix of several different varieties of vegetables to provide the optimum blend of amino acids.

How much protein is necessary?

The amount of protein recommended in a day for a non-athletic person has been set at about one gram of protein for every kilogram of body weight (Note: 1 kg = 2.2 pounds). Many athletes and coaches claim that muscle building is enhanced by taking more protein, but scientific research has not verified this, and the amount needed during periods of training is the topic of ongoing discussion and research. There appears to be a need for slightly greater protein intake as the intensity and volume of work increases, and some nutritionists feel that an athlete in training should consume up to a gram of protein per day for every pound of body weight, twice the amount recommended for a sedentary person. This can easily be achieved with an intelligent, well-balanced diet, and eating much more than this might be harmful; therefore, protein or amino acid supplementation appears to be unnecessary and wasteful at best, and unhealthy at worst.

Cardiovascular disease, the greatest killer in our country hardly exists in Asian countries with carbohydrate diets.

Americans have become comfortable with a lifestyle that leads to cardio-vascular diseases: heart attacks, strokes, high blood pressure, and adult-onset diabetes. These diseases kill as many people in our country as all other causes combined!

We also increase the chances of future cardiovascular disease by not exercising, by eating too much fat, and by being even slightly overweight. To a healthy, young athlete these middle-age diseases might seem so remote that their mention goes unnoticed. Furthermore, your lifestyle probably doesn't include smoking, obesity, and lack of regular exercise. ***But, please keep reading, because what you eat right now determines your future risk.***

When thousands of dead American soldiers were autopsied after World War II and the Korean War, they were found to have very advanced stages of atherosclerosis (buildup of fatty plaque in their arteries). Asian soldiers had none.

Athletes especially must reduce the percentage of saturated fat in their diet.

A relatively common diet, similar to that of most high school and college kids I've known, leads to the (atherosclerotic) thickening of artery walls. This process gradually narrows and weakens your arteries starting at a very young age and leads to future diseases. Middle-aged men (including you someday) will often modify their lifestyle when faced with the grim reality of impending heart attack or stroke. ***But there is no way to reverse the atherosclerotic process. This can only be prevented by a healthy diet and lifestyle starting at a young age.***

While these facts are important for every person, they are critical for an athlete, because you are burning and eating more calories than the average American your size and age. If your diet is like the rest of your friends, by increasing your total caloric intake, you are consuming much more total fat than they are — and their fat consumption is already way too high.

For everyone in our country, but especially for an athlete, the percentage of 'bad fat' (saturated fat) must be reduced. Finishing your grueling workouts with a Big Mac, fries, and milkshake might be more hazardous to your future health than skipping the training completely and eating less.

Cholesterol, saturated fats, and atherosclerosis. Time-out for a little (very little) physiological chemistry.

Our body manufactures an important chemical called cholesterol, because it is an essential component of cells and a precursor to natural steroid hormones. However, an abnormally high blood concentration of cholesterol is associated with atherosclerosis and eventual vascular diseases. When the caliber of the artery in one local spot is narrow enough, it can more easily be completely blocked by a clot (thrombosis) moving along in the bloodstream. A stroke or heart attack would result if this occurs in the brain or heart. Also, the artery wall becomes stiffer and weaker and may even rupture (aneurysm).

A different molecule altogether from cholesterol, a fat is given the name "triglyceride" by chemists, because it is composed of three long chain fatty acids (carbon chains) bonded to a molecule called glycerol. The triglycerides are further classified as to the degree of saturation of hydrogen on the carbon atoms. The triglycerides coming from vegetable products are usually poly-*un*saturated (missing some hydrogen atoms along the carbon chain) as opposed to the animal fats which are more ***saturated*** (having the maximum number of hydrogen atoms).

Polyunsaturated fats contain the same number of calories per gram as saturated ones, twice as many calories as sugar. However, both saturated fat and dietary cholesterol increase our blood cholesterol and therefore, lead to atherosclerosis.

There is no way to reverse the atherosclerosis. It can be prevented by a healthy diet, by not smoking, and by exercise.

An athlete must choose carefully when he eats high protein meals, because these often contain too much saturated fat. Instead of fatty red meats, whole dairy products, and egg yolks, the better choice would be lean meats, fish, poultry, egg whites, skim milk and non-fat cottage cheese or yogurt. Non-fat foods contain the same vitamins, minerals, and complex carbohydrates, and should be included in large quantity for athletes who do not have a problem digesting lactose (milk sugar).

Note that preparation of the food is critical. Removing skin and fat, and baking or broiling the meat is much healthier, because ***any food will sponge up fat if it is fried in grease.*** Don't be fooled into thinking that fast-food, southern fried chicken is a healthy choice, just because its last name is chicken!

The great marketing scams: hiding some important facts and fats.

Obviously, the meat, dairy, and other food industries are vital to our country. They have just as obvious reasons to cover up facts about their products which are known to be associated with vascular disease. Knowing the consumer is aware that high cholesterol has a bad name, they often market a given product as "...low in cholesterol," not mentioning that it might contain a lot of saturated fat. Other food producers know that health-conscious consumers are reading labels to buy more vegetable oil rather than the slightly sweeter lard, butter, and animal fats. Palm and coconut oils are often called vegetable oils, but have a very high degree of saturation. Another trick is to hydrogenate the polyunsaturated (unhydrogenated) oils to give them properties people like, and market the product as, "partially hydrogenated vegetable oils." Most people don't equate the words "hydrogenated" and "saturated" except for biochemists, dishonest marketing types, and those who studied the preceding section.

The healthy answer would be to sell only skim milk, non-fat cottage cheese, and meat from lean animals. But fat animals bring more money at the stockyard, and skimming fat off dairy products makes expensive waste. We've also grown accustomed to the taste of popcorn and cookies loaded with saturated oils, so healthy answers aren't just around the corner for the majority of our obese population. ***But, healthy answers would be in the minds of every young hockey player, if coaches were informed educators.***

Carbohydrate: "composed of carbon, hydrogen, and oxygen"

Carbohydrate foods are categorized as simple and complex. The various sugars or alcohol are called simple carbohydrates. They have no nutritional value other than supplying calories, but this should not be interpreted to mean that sugar is a terrible poison. It is not associated with high blood cholesterol, nor is it as fattening as saturated (or polyunsaturated) fat.

We would all be well advised to increase the percentage of calories coming from complex carbohydrates such as: bread, pasta, cereals, and other grains, vegetables, fruit, and non-fat dairy products. This is especially true for athletes. High carbohydrate foods help replenish the stores of muscle glycogen depleted by strenuous exercise. They are also a source of fiber and energy (calories), and are comparatively low in fat.

On gaining weight — the myth about size

There exists a misconception in hockey, perpetuated by the NHL, that bigger players are better, and college coaches have fallen into this trap. With the emphasis on hook-and-hold defense, coaches argue they need bigger, stronger, tougher players. But, we should not confuse strength and toughness with size. Every team needs strength and toughness; no team needs size without other assets.

NHL coaches feel they need a few "policemen" on the roster — goons who look impressive until the national anthem is finished. It's amazing we buy into the "fight-fire-with-fire" nonsense, thinking the only way to beat a goon is with goons of our own. Water has worked well in the battle with fires; and, in the same way, the quick, skillful, little competitors have beaten the ones who have nothing to offer but size.

Preoccupation with size among college scouts is an even greater mistake than in the pros. Even in the present state of the college game, in which interference is not called, and hooking and holding are not only allowed, but taught every day, the fact remains at all amateur levels, the best players, the ones with the most skill, speed, agility, and playmaking ability are not necessarily big. For example, the tallest player on the All-WCHA team in 1990 was 5'9".

In a game of agility, the shorter man wins. Consider the simple physics of centrifugal force. A shorter player has an advantage in cornering and changing directions quickly. His low center of gravity makes him more agile, for the same reason a sports car has an advantage over a jeep in a race with lots of cornering. Furthermore, in a contact sport, the lower the center of gravity, the more effective a player will be in a battle of strength. If we improperly advise the smaller player to gain a lot of weight, even if it is excessive upper body muscle, his center of gravity and agility could be effected. The best advice is to emphasize skating and lower body strength to accentuate his assets.

The only size that matters in hockey is:

1) the size of the heart, not the size of the player;
2) the size of the commitment and work ethic;
3) the size of the rink. Make them Olympic sized and watch skills improve.

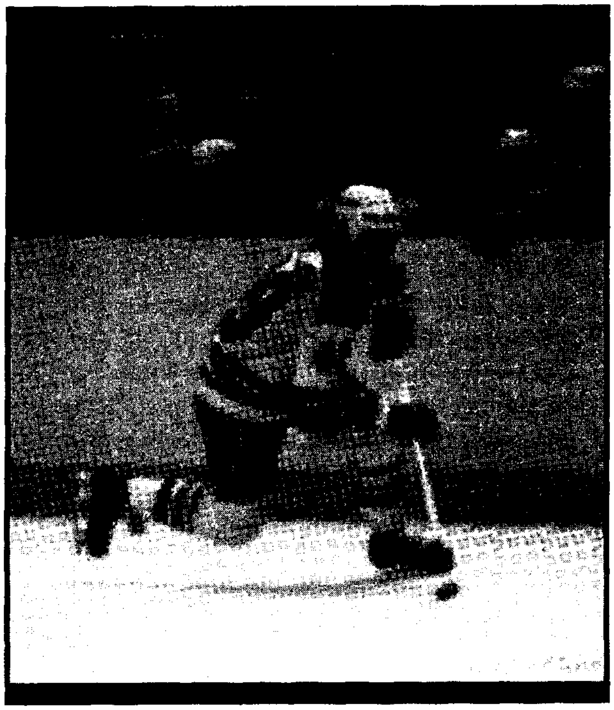
An argument against gaining weight if you're not tall

If your game and career depend on agility, skill, and quickness, and if you are not very tall, it may be counterproductive to add weight, especially upper body weight. Your low center of gravity is an asset. Small, skillful players should never try to compete on the same basis as big players. Use your assets. Don't lift weights to play a big man's style. Don't lift to gain excessive muscle mass. Gain strength to be more agile, quicker, improve skills, avoid injuries, and to be able to skate through sticks. For the bigger player, since size and strength may be among your assets, you might decide to add to them by building muscle mass — but never fat.

Anders Hedberg, former Swedish Olympian and New York Ranger star, argues against over-rating size and strength at a young age. A small, weak player who dominates at the high school level is likely to have gotten there by skills, intelligence, determination and playmaking ability. A player who was always bigger than his opponents from the moment he stepped on the ice may never have needed skills and intelligence to dominate. He might have been able to bull his way around the rink without broadening his horizons and learning more of the game. This is not to say many big players don't also have great skills. But, if a 17 year-old dominates without size, he is likely to have a great deal of rink sense and playmaking ability. Then, if strength is added to his game later, he will be able to play his same skillful game at future, more physical levels.

We've become so preoccupied with size that we are more likely than ever to miss young stars in the mold of Corey Millen, Mark Pavelich, Phil Housley, Tony Granato, or Wayne Gretzky. In fact, players like Bobby Hull and Gordie Howe may not excite the present generation of "talent" scouts, because the scouts have become less capable of differentiating between size and strength.

Gain muscle mass, not fat



Many self-proclaimed experts offer vague advice to gain weight; as if a young player might eat his way into the National Hockey League. Then, to compound the problem further these "experts" often suggest a weight gain diet rich in saturated fat — fairly standard advice.

For many players a realistic goal might be to gain muscle mass, but never fat, and always more muscle gain in the legs than upper body. No amount of upper body strength will help in confrontations on the ice without a solid base of strength in the legs. Furthermore, gains in upper body muscle mass disproportionate to the legs might raise the center of gravity slightly, making it even more difficult for the big player to compete in a game of agility.

I've worked with dozens of players who wanted to gain muscle mass and who had a history of unsuccessful attempts. In every case, if the athlete stuck to certain guidelines, he was successful in reaching targets of weight gain and body composition. I've seen many college players gain 20-30 pounds of muscle in a year, but in no case was it easy, and never were steroids even remotely considered. Intense workouts and a good diet were the critical factors.

The most agile skaters are short. Adding too much upper body weight (even excessive muscle) will raise your center of gravity and reduce your advantage. Train to be a sports car — not a jeep.

Key points for a hockey player trying to gain weight are:

a) All of the weight gain should be muscle, not fat.
b) A majority of the increased muscle mass should be in the legs.
c) Intensity is the key to this weight training regimen. There must be many, many sets past failure, and heavy weights must be lifted. For this type of lifting, it is true at times, "If there's no pain, there's no gain."
d) There should be days off, with adequate recovery between workouts. Those who are trying to lose body fat should include some kind of workout every day, adding aerobic workouts to the weekly calendar. Jogging is the best way to keep your weight down, so do more sprints than jogging if you are trying to gain weight.
e) Choose lifts that emphasize large muscle groups and utilize more than one joint. Isolation lifts done by body builders are less beneficial for hockey.

f) For gaining muscle mass, the diet should contain up to a gram of protein for every pound of body weight. If you have no problem digesting dairy products, drink a lot of skim milk (up to a gallon per day) instead of water. In order to increase your caloric intake, supplement your high carbohydrate diet with poly-unsaturated fat.
g) The value of supplementing your diet with amino acids or protein powder has never been established, and is probably doing nothing more than creating expensive urine.
h) Contrary to popular belief, there is no conclusive scientific evidence that artificial anabolic steroids will enhance muscular development. On the other hand, the evidence is compelling that there can be very unhealthy side effects.
i) If the scouts think you should be bigger, tell them you are.

Intentionally adding calories to gain muscle mass compounds the problem of high saturated fat intake further. It might be standard advice for weight gainers to load up on foods like ice cream, whole milk, red meat, and eggs. We've seen why this is extremely hazardous, because the buildup of harmful plaque in the arteries begins at a very young age and is not reversible.

Losing weight: fighting evolution.

It is an arithmetic fact that to lose weight, a person must take in fewer calories than he uses. So what? Reduced calorie diets fail 95% of the time in the long run. It would never work for an athlete undergoing intense, developmental training to reduce calories. ***The key to success is to build muscle mass and reduce body fat.*** Change body composition, and don't be concerned about weight.

We'll see why evolution, and therefore probability, favors this approach as opposed to that sold for billions of dollars each year to dieters, whose on-and-off attempts resemble the feast-or-famine lifestyle ages ago. The problem of survival for our earliest ancestors was never one of obesity. Food of any kind was scarce. In order to survive with the constant threat of famine, the human body best able to conserve energy by storing fat was most likely to survive.

The human body – best equipped to conserve energy by storing fat – was most likely to survive evolution.

Not only was food scarce, but a corollary to Darwin's theory is that middle age diseases of any kind would not change the evolutionary direction of any species. Even if the most prolific hunters could have killed enough to become obese, they still could have survived to puberty, long enough to pass down their genes. So, millions of years of natural selection would not have equipped our ancestors with tools to deal with middle-age diseases like heart attacks and obesity.

Our bodies have learned how to adapt to periods of famine. When we restrict calories for many weeks, our basal metabolism is lowered. Whereas, 1500 daily calories may be few enough to lose fat at the onset of a diet, as we continue, this same amount may even be enough for fat storage.

A second problem is that in periods of reduced calories, enzymes in our fat cells become "turned on" for storing, rather than mobilizing fat into the blood for energy. While our bodies learned to store fat energy, they tended to use muscle protein as a fuel source. The bad news for dieters is that muscle burns more calories than any other tissue, so if muscle is lost, so also is some potential for consuming energy. The great master plan of evolution was more concerned with survival than maintaining large muscles for Mr. Olympia contests. We needed to conserve fat stores when food was scarce. Given this history, our body can't be blamed for thinking our latest fad diet is another famine.

The fact is, reducing calories could correctly be called "training" to store fat. Our body *overcompensates* for the stress of a low calorie diet by getting better at storing, rather than using fat. Through thousands of generations, when a species developed a physiological strategy to overcompensate for a given stress, that species was more fit to survive. We are the unlucky offspring when we stress our body in ways it was not stressed millions of years ago, like obesity from overeating saturated fat. On the other hand, we are fortunate our ancestors passed on bodies that supercompensate for the stress of lifting heavy weights or running fast and far.

Fortunately for many hockey players, the problem of losing body fat is not one of losing weight, but simply exchanging an equal amount of fat for muscle. In this case it is not necessary to consume fewer calories than you burn. Better news yet if your goal is to lower body fat percent by gaining more weight in muscle than you lose in fat! For those unfortunate few who must actually lose weight, your best bet is to choose new evolutionary ancestors. Second best is to lose the weight very, very slowly by consistent, mild aerobic exercise and a nearly adequate diet in terms of calories.

Reducing calories could be called "training" to store fat.

Losing body fat and gaining muscle mass can be achieved by anyone who is willing to stick to the following program. ***The key word is*** **CONSISTENCY**. In the program for those trying to gain muscle mass, remember the key word was **INTENSITY**. Guidelines for lowering body fat percent are:

a) The more often and longer you train (without overtraining) the better chance of replacing fat weight with muscle weight.

b) Aerobic workouts are the best for shedding fat. Long, slow jogging, interrupted by walking is ideal, as are bike rides and swimming. The longer the workout lasts, the higher percentage of the total fuel is fat.
c) Sprints do not burn many calories, and the fuel of choice for sprints is carbohydrate, not fat.
d) Days off, while giving your muscle cells time to grow, unfortunately provide your fat cells the same opportunity.
e) Include an aerobic workout seven days a week. It is best for your back, knees, hips, and other joints to alternate forms of exercise from one day to the next: walking, jogging, biking, swimming, etc.
f) Strength training can be less intense, but must be more frequent than for those trying to gain weight. Rest is less important, so during a workout, stay on schedule (perhaps 2 minutes between sets).
g) Contrary to popular misconception, strength training is important in reducing body fat. Building muscle mass will help keep your metabolism high, because muscle tissue is the best at burning calories.
h) Circuit training is a great way to add aerobic endurance to your strength workout. The shorter the rest, the more your workout will emphasize endurance rather than strength.
i) Your diet should be high in complex carbohydrates. In fact, you can almost overindulge here if there is no fat in the food.
j) Practically eliminate saturated fats and cholesterol, and reduce poly-unsaturated fats, because they all have more calories than sugar.
k) Eat often — up to five or six light, carbohydrate meals per day. If we went many hours without eating, our brain would send strong hunger signals (thanks to evolution). Then, once we begin eating, the satiety center in our brain, which signals when we are full, does not keep up with the rate at which we are stuffing food down. So we tend to eat more than we would if we were just matching our metabolism.

   Carnivorous animals eat like most Americans. They feast on a high fat meal of meat (and whatever else comes with it) and then lie in the sun for hours. Herbivorous animals must eat almost constantly, because their food is lower in fat and therefore, calories. Now, don't tell me this strategy has made cows fat. Put them back into their natural habitat where they'll be chased by lions, and see how fat they are in a month. So, ***we should graze rather than fast-and-feast***.
l) To demonstrate the lag time in your response to satiety, try eating a reasonable amount and stopping while you're still hun-

gry. Wait an hour, and chances are you will not still be hungry.

m) Throw away the bathroom scale. Forget your weight, and concentrate on percent body fat. ***Gain muscle and lose fat.***

n) The biggest factor is consistency over time. In fact, to maintain a low body fat percent is a lifetime commitment. To stop the program abruptly and reward ourselves with a feast would invoke all those mechanisms passed down by evolution, and our hungry fat cells would seize the opportunity to store energy.

Pre-game and post-game nutrition

For most hockey games, it is more important *when* the pre-game meal is finished than *what* is eaten. If the meal is high in carbohydrates and low in fat it can be digested and absorbed in less than 3 hours. But, by including fat, the time course is slowed to 6 hours or more.

There should be plenty of water or other liquids, but high sugar drinks should be avoided within 2 hours of competition, because the sugar precipitates a cycle of insulin/blood sugar changes that are counterproductive during exercise. By consuming sugar, you can actually end up with low blood sugar.

Unlike a 3 hour marathon race, the total number of calories burned during a hockey game is insignificant. Therefore, carbohydrate loading is not likely to have a physiological impact. The most important consideration before the game is to eat foods which are easily digested during the four or five hours prior to competition.

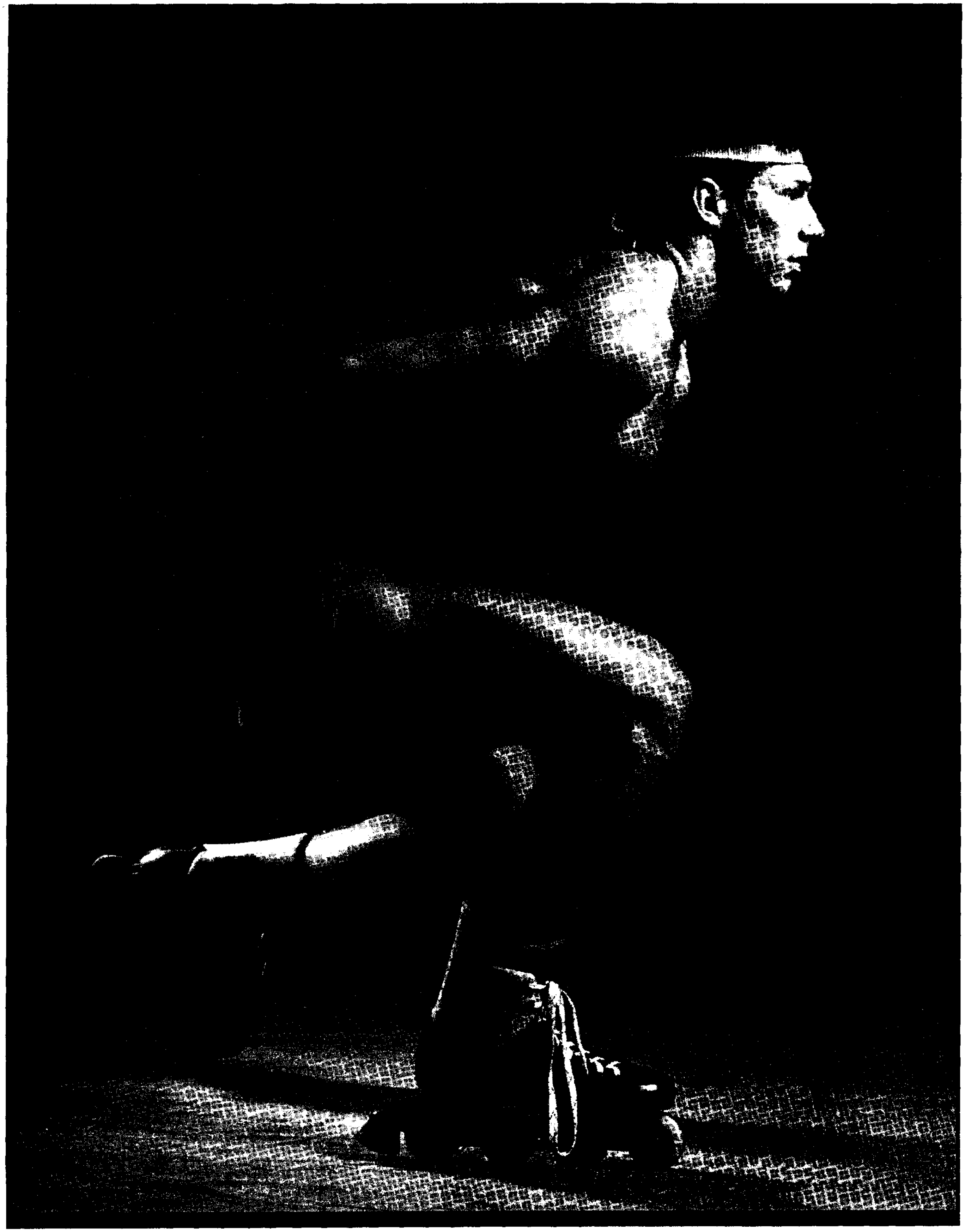
To reduce body fat — your training needs to be *consistent* rather than *intense.*

On the other hand, it is typical for college teams to play two games and youth teams to play three or four games in a weekend. In this situation, glycogen depletion and dehydration can be significant fatigue factors, and we should make every effort to replenish carbohydrate and water. Immediately following any game, the meal should feature plenty of fluids and carbohydrate. This is also true for breakfasts. Fluid replacement drinks with mineral and carbohydrate supplements would have their greatest impact after a game or practice that is to be followed by other games or practices.

Keep in mind that water must be consumed in large quantities during practices and games. If players lose too much water (even 2% to 3% of their body weight), their chances of performing at a top level are greatly reduced. We will often see up to 10 pound (5%) dehydration, and this is a much bigger fatigue factor than loss of glycogen during a game.

Is nutrition really a big deal?

The importance of pre-game nutrition for a youth coach is insignificant compared to educating and selling lifelong nutritional and conditioning habits. One goal should be to teach young players to train and eat in a way that broadens their career potential and complements their work ethic. Another coaching goal should be to demonstrate and encourage a lifelong commitment to nutritional habits that reduce the risk of future cardiovascular disease and cancer. Now, that's a big deal.



TYPE OF FOOD One pound (or print) contains the following:	Protein grams	Fat grams	Saturated * Fat	CHO grams	Calories per pound
MEAT					
PIKE (Boiled, broiled, or baked)	88	4		0	408
TUNA (Canned in water)	127	3		0	576
TUNA (Canned in vegetable oil)	109	93	Low	0	1306
SALMON	91	17	Med	0	540
TURKEY or CHICKEN (broiled or baked; not fried)	71	20	Med	0	480
BEEF (Lean round steak)	98	21	Med	0	612
BEEF (Regular hamburger)	81	96	Med	0	1216
BEEF (Lean hamburger)	94	45	Med	0	812
PORK LOIN (fat trimmed off)	92	52	Med	0	857
PORK SAUSAGE (Links)	42	230	Med	0	2259
HOT DOGS	60	125	Med	11	1402
BACON	38	314	Med	4	3016
COMPLEX CARBOHYDRATES					
LETTUCE	4	t		13	56
PEAS	15	1		56	259
POTATOES	7	t		63	279
PASTA: SPAGHETTI, MACARONI (Noodles only)	57	5		341	1674
RICE	30	2		365	1647
WHOLE WHEAT BREAD	48	14	Low	216	1102
SOUPS					
BEEF BROTH SOUP (Canned, condensed)	19	t		10	118
VEGETABLE BEEF SOUP " "	19	8		36	295
CREAM OF MUSHROOM SOUP " "	9	36	High	38	503
DESSERTS					
SUGAR	0	0		451	1746
COOKIES (Only if baked with polyunsaturated oil)	24	136	Low	273	2341
DOUGHNUTS (Raised) (Fried in polyunsaturated oil)	29	121	Low	181	1878
ICE MILK (one pint)	22	23	High	101	689
ICE CREAM (one pint)	12	73	High	82	1007
CHOCOLATE FUDGE	20	160	Med	263	2395
HARD CANDY or JELLY BEANS	0	2		400	1700
JELLO	6	0		64	268
PEACHES (or just about any fruit)	1	0		35	180
SPREADS					
JELLIES (per tablespoon, not per pound)	0	0		321	50
BUTTER (per tablespoon)	0	12	High		100
MARGARINE (per tablespoon)	0	12	Low		100
MAYONNAISE (per tablespoon)	t	12	Low	1	100
PEANUT BUTTER (per tablespoon)	4	8	Low	85	95
BUTTER (per pound)	3	367	High	2	3248
MARGARINE (per pound)	3	367	Low	2	3266
EGGS					
EGG YOLKS (per pound)	73	128	Med	3	1579
EGG WHITES (per pound)	49	0		4	231
EGG WHITE (1 egg white, not one pound)	3	0		t	20
DAIRY PRODUCTS					
MILK (Skim; one pint)	17	t		23	163
MILK (Chocolate skim; one pint)	17	2		23	300
MILK (Whole; one pint)	16	16	High	22	299
MILK (2%; one pint)	16	8	High	22	230
COTTAGE CHEESE (non-fat; one pint)	77	1		12	390
CHEESE (Cheddar or American)	113	146	High	10	1805
YOGURT (non-fat; no sugar added)	15	t		24	190

* Saturated Fat represents the percentage of total fat which is saturated
t = trace; less than one gram

TYPE OF FOOD One pound (or print) contains the following:	Protein grams	Fat grams	Saturated * Fat	CHO grams	Calories per pound
CHOW MEIN (Canned, chicken chow mein)	12	2		32	172
SPAGHETTI (Tomato sauce, no meat)	15	2		100	300
FRENCH FRIES	13	59	Med	118	1090
PIZZA (Plain cheese)	54	38	Med	140	1002
SNACKS					
POP CORN (Cooked in coconut oil, not buttered)	44	99	High	368	2048
POP CORN (Air popped, no oils or butter)	58	23	Low	348	1751
POTATO CHIPS	24	181	Low	226	2576
PRETZELS	44	20		344	1769
NUTS	26	50	Low	19	568
BEVERAGES					
BEER (16 oz.)	1	0		17	191
GIN, WHISKEY, VODKA (Pint)	0	0		0	1100
COLA (16 oz.)	0	0		50	200
TOMATO JUICE (16 oz.)	4	0		20	86
ORANGE JUICE (16 oz.)	3	1		47	218

THE BOTTOM LINE FROM THE CHART ABOVE:

High complex-carbohydrate, low fat foods

BREADS (Cory Everson eats a loaf a day, so she won't eat a lot of fat)
CEREALS (Read labels. There's more fat in granola than some of the generic cereals.)
PASTA (without meat or cheese)
VEGETABLES, POTATOES
FRUITS
JELLO
SOUPS (clear broth, not cream-style)

High protein, low fat foods

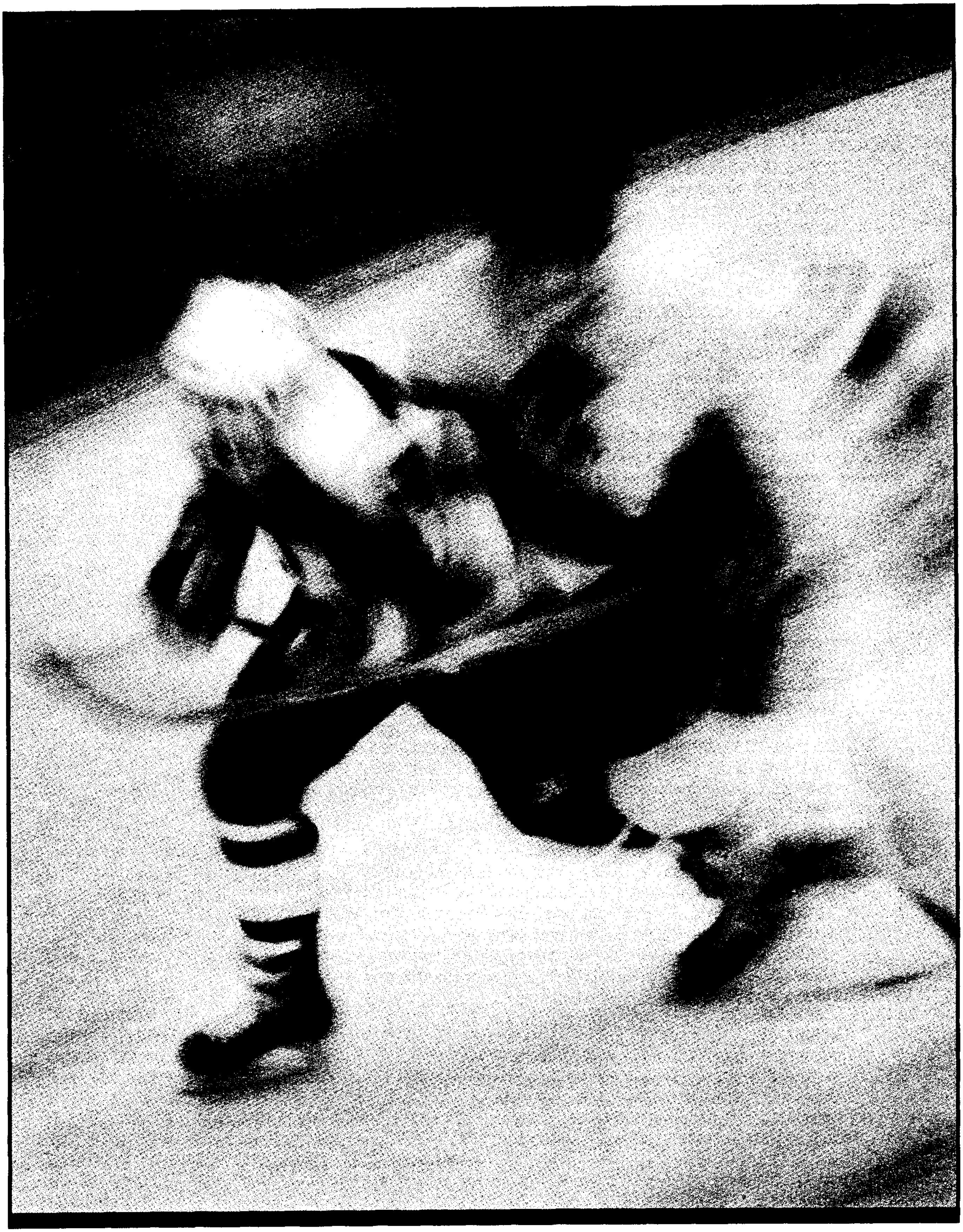
TUNA (canned in water, not oil)
FISH, CHICKEN, TURKEY, LEAN BEEF (Broiled or baked, but not fried)
SKIM MILK (Since you should increase the volume you drink, even 2% has too much fat)
NON-FAT COTTAGE CHEESE (Awesome, healthy food with potatoes and vegetables)
NON-FAT YOGURT (like milk and cottage cheese, also a good source of carbohydrate)
EGG WHITES
LEGUMES (vegetable protein is not as high quality as dairy or meat proteins)

Illegal foods

BUTTER (100% fat — much of it saturated fat.)
ICE CREAM (Protein, carbos, and calcium on the + side — fat, sugar, and fat on the - side.)
HOT DOGS (Saturated fat plus a lot of shady preservatives.)
BIG MAC (Fatty hamburger + cheese + mayonaise, but the rest is fine: bun, catsup, onions, pickle)
BACON, SAUSAGE (Pork, fat, gut, and nitrates - - worse than drugs, Nancy Reagan!)
EGG YOLKS (Especially if fried in butter, bacon grease, or lard the way grandma cooks eggs)
CHEESE (The fat outweighs the good stuff: protein, calcium, carbohydrate)
COOKIES, CAKE, PIE, DOUGHNUTS (This list is starting to look threatening)

When making a choice...

CHOOSE	**INSTEAD OF**
PRETZELS	POP CORN, POTATO CHIPS, NUTS
FRUIT OR JELLO (These are great...those are bad.)	COOKIES, CAKE, CANDY
NON-FAT YOGURT (A great tasting dessert with no guilt.)	ICE CREAM, ICE MILK
NON-FAT COTTAGE CHEESE (Infinitely better...)	BUTTER, SOUR CREAM
JELLY (Sugar's not great, but comparatively...)	BUTTER, MARGARINE, PEANUT BUTTER
POLY-UNSATURATED FAT (Vegetable oil...)	(Dairy or animal fat) SATURATED FAT
OLIVE OIL	PALM, COCONUT OR PARTLY HYDROGENATED OILS
HARD CANDY	CHOCOLATE
MUSTARD or KETCHUP	MAYONAISE
BAKED or BROILED FOODS	FRIED FOODS



Sample: Over-speed interval practice on-ice

"There are 3 types of speed that are important in ice hockey:
1) speed of hand;
2) speed of foot;
3) speed of mind...Practice them all."
— Anatoli Tarasov, father of Soviet hockey

Chapter Overview:

1 To break old habits from years of practice at comfortable speed, we will use a combination of drills to improve foot speed, knee bend, and powerful strides.

Changing habits amounts to, "***neuro-muscular shock treatment.***"

Intensity and ***quality*** repetitions are key factors in order to make positive changes.

a) On-ice sprint intervals are done at top speed for only 5-12 seconds.
Rest intervals allow nearly complete recovery (60-75 seconds).

b) Skating corners, quick stops-and-starts, and short bursts following a change of direction are probably the most important and most difficult drills. But, incorporate enough straight ahead sprints to reinforce habits of quick feet.

c) Underload workouts should be added to the training calendar. This is analogous to the tow training or downhill running done by track athletes. Wear lighter equipment, removing shoulder pads and breezers, so you feel faster and are psyched up to skate faster than ever. Longer rest periods can augment this effect.

d) Emphasize powerful strides, quick feet, and good knee bend at the very end of each drill, when lactic acid would tempt you into slowing down or compensating with poor technique. Push yourself at the end of each sprint.

e) Contrast skating drills begin with 'perfect technique' at a comfortable pace and gradually accelerate to top speed, by maintaining the same smooth technique, but with quicker feet. Visualize a perfect stride throughout the drill.

f) Weight vests raise the center of gravity and increase the centrifugal force on corners. The goal: emphasize greater-than-normal knee bend around corners. Work:rest intervals should be from 15:60 seconds, increasing the difficulty to 30:90 seconds, up to 40:80 seconds at the very end of practice.

2 The players' job is to attempt the highest possible speed ...

... the coach's job is to time the intervals, allowing enough rest so that quality is possible on every repetition.

3 In a sprint interval drill, if the puck becomes an anchor and slows the player's speed, or if he loses the puck, he should continue through the drill without it.

4 Some very simple drills follow. Use your imagination to create new ones, but the drill should not be complicated enough to slow the pace.

Over-speed practice on-ice

The goal for over-speed practices is to elevate the present comfort zone of skills.

This means that each player must venture into new territory — attempting to corner faster, shoot and handle the puck while skating at top speed, pass and receive in full stride, and make defensive plays at a quicker tempo. Every skill is attempted at an uncomfortably fast speed, so that in a few weeks, this speed will be the new comfort zone.

Have patience with mistakes !!!

It is no problem to lose the puck or fall once in a while, when you're trying to go faster. When shots are first attempted at top speed without coasting, they'll be weaker. The only way to fail in over-speed drills is to not attempt faster speeds. Both players and coaches have to be patient with mistakes of commission — it's not easy to perform skills at superfast speed.

There is a reluctance to be less than perfect in front of peers. No one wants to shoot a weak shot because it's never been tried before with feet moving that fast. It's more impressive to crank a slap shot with a comfortable time to wind up. This is precisely what is meant by practicing above your present comfort zone. It's uncomfortable.

But it's better to be uncomfortable here in practice than in the biggest game, where the pace will be the fastest possible.

The progression over a season:

The first step is to convince players to attempt cornering as fast as they would skate straight ahead if they were racing for a $10 bill. Straight ahead races are a good starting point, but also a vivid reminder when the pace of more skillful drills slows down a bit.

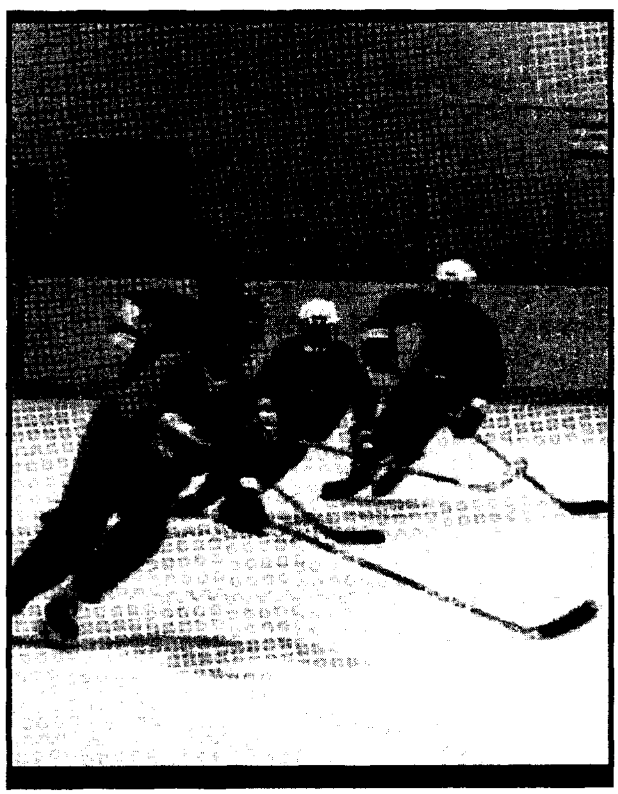
Next, skate corners at top speed while carrying a puck and shooting. Passing should be added, and later some spontaneous decisions and creativity, such as getting open for a pass without a route designated by the instructor. The final step is high speed scrimmage and competitive drills.

The progression in a single practice is usually just the opposite.

The most skillful, creative drills and high speed flow drills are done first while the ice is good and players are not tired. This is usually followed by simpler skills like carrying the puck and shooting. When the ice is not good enough for stick skills, work on skating quickness and cornering. Finally, the last 10-20 minutes use the weight vests, not trying to move the feet quickly, but keeping the knees bent and chest up.

Quality repetitions to raise the comfort zone !!!

Intervals must be timed in order to allow enough rest. If you're doing a total of only 15 minutes of intervals, start a new sprint every minute. If the workout is longer, start a new sprint every 75 seconds.



Sample:
Over-speed interval workout on ice

SKATING, SHOOTING, PASSING AT OVER-SPEED — **25 MINUTES**

Each drill should last about 5-12 seconds
Start a new sprint every 60-75 seconds
Emphasize cornering drills: quick feet, bent knees
Shooting while moving your feet

SKATING WITHOUT PUCKS AT OVER-SPEED — **20 MINUTES**

Each drill should last about 5-12 seconds (up to 20 seconds later in the season)
Start a new sprint every 60-75 seconds
Emphasize cornering drills, quick stops/starts, tight turns

SKATING CORNERS WITH WEIGHT VEST — **15 MINUTES**

Emphasize bent knees, not quick feet!
Intervals of 15:60 or 30:90 or 40:80

Use a watch with a sweep second hand taped to your hockey glove.

Attempt speeds fast enough to lose the puck or fall once in a while.

If a player loses the puck or is slowed down, leave the puck and skate at top speed through the rest of the drill.

If the quality suffers at any point, return to simple sprints without pucks.

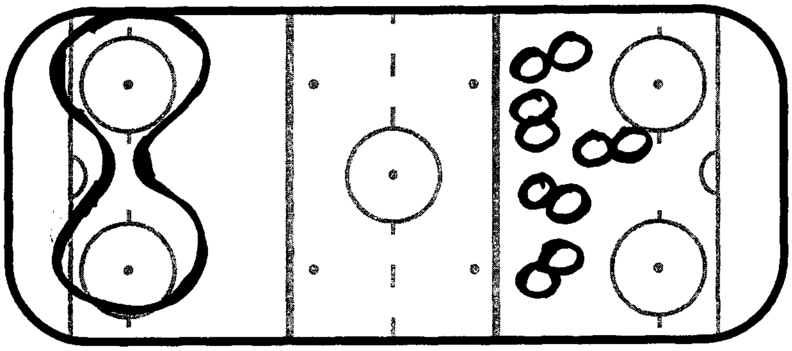
Some examples follow, but add your own ideas

However, MAINTAIN THE WORK : REST RATIOS

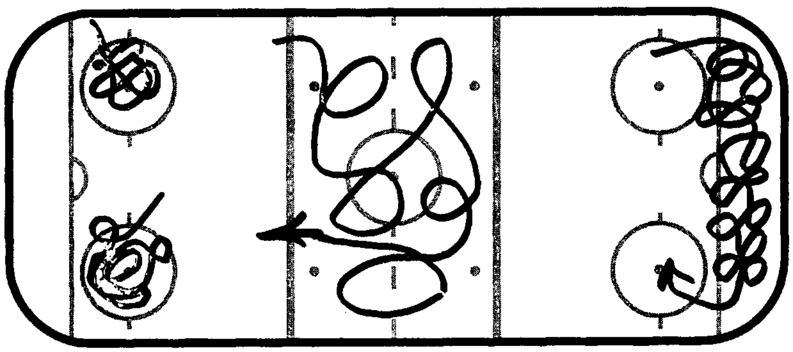
Skill warmup: carrying pucks

Not done at Overspeed:

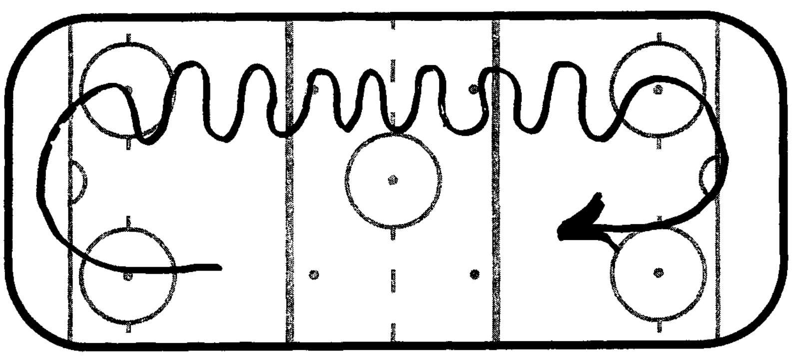
Stretch between drills



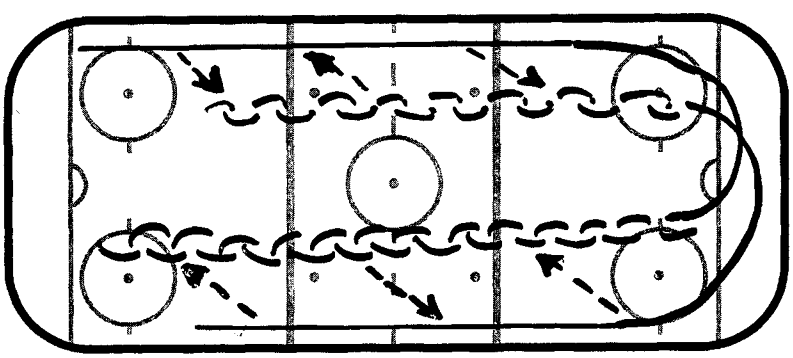
➤ Quick turns with puck.
5 players at a time.
Work 15 : Rest 30



➤ 5 at a time in traffic carrying pucks.
Start every minute



➤ Zigzag:
Head and shoulders moving while feet are crossing over.



➤ One-touch passes while skating backward or forward.
Reverse roles coming back up-ice.

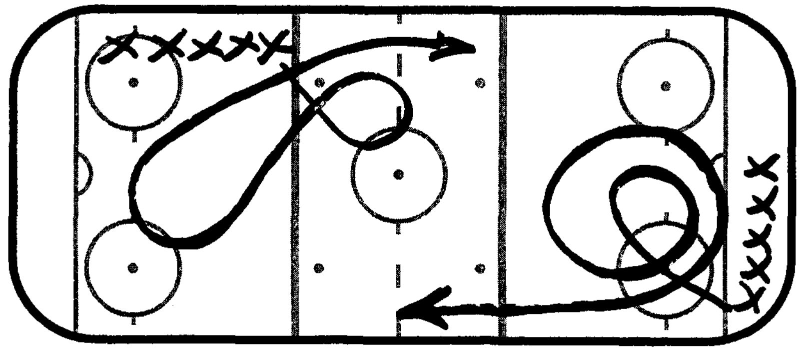
Sprints without pucks; corner at top speed

Not done at Overspeed:

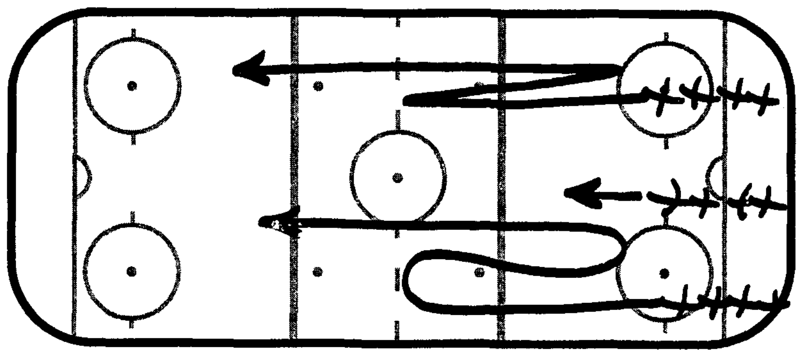
Stretch between drills

➤ Tight turns, followed by wider turn.

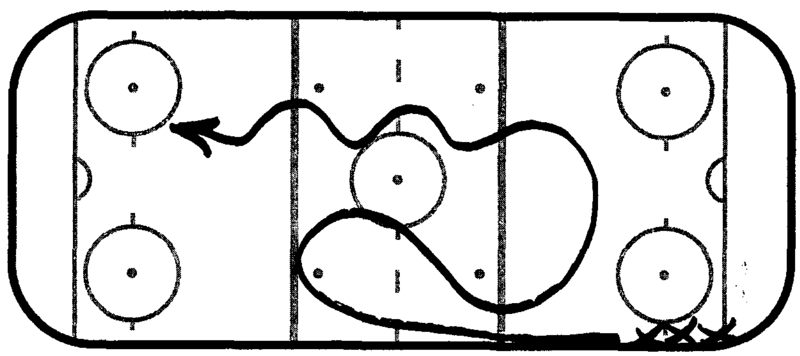
Also try contrast skating where the first circle is under control, then keep accelerating to max.



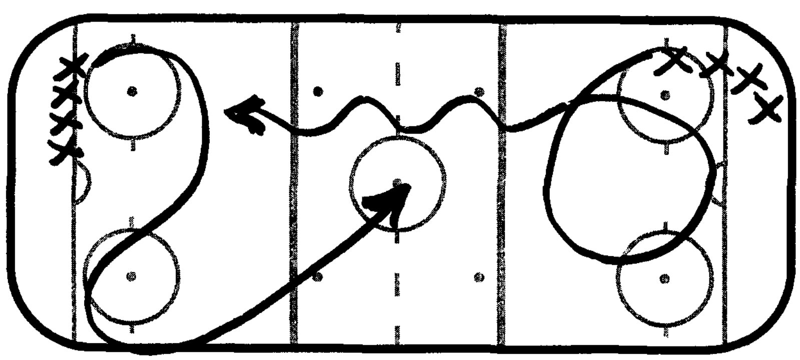
➤ Stops and starts or quick turns for intervals up to 15-20 seconds at most.



➤ Accelerate out of the last corner and zig zag up-ice.



➤ Bend your knees and use the quickest strides possible while continuing to skate the corners. Drive under with the inside skate, don't just 'run' the corners.



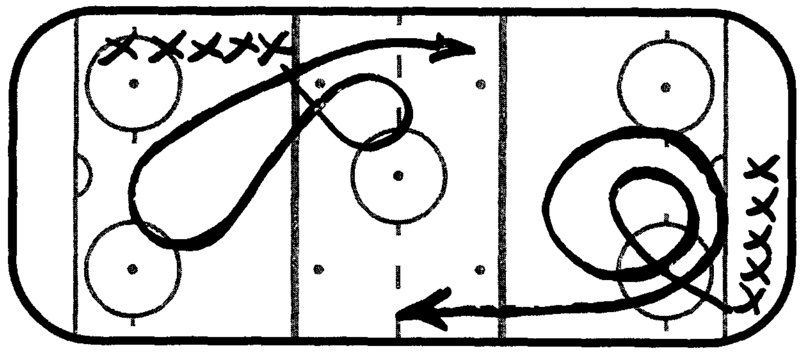
Sprints without pucks; corner at top speed

Not done at Overspeed:

Stretch between drills

➤ Tight turns, followed by wider turn.

Also try contrast skating where the first circle is under control, then keep accelerating to max.



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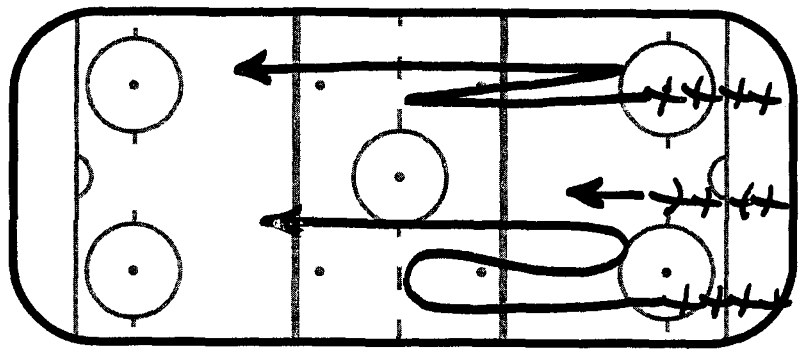
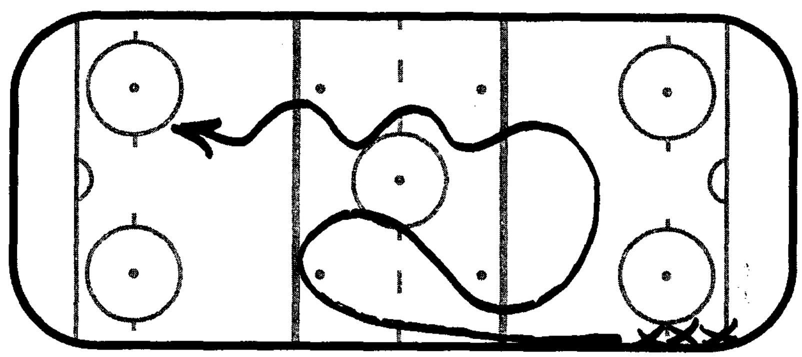
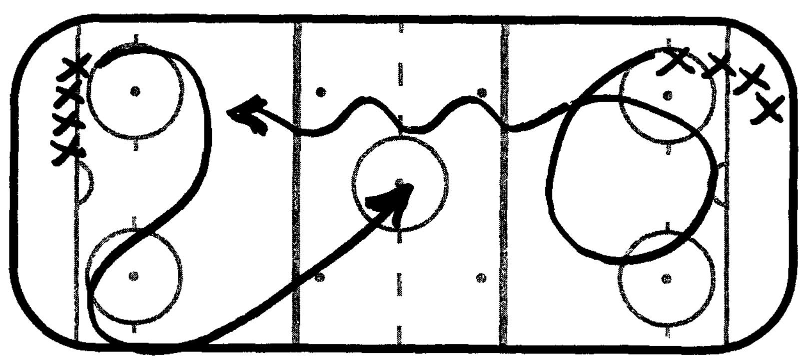


➤ Accelerate out of the last corner and zig zag up-ice.

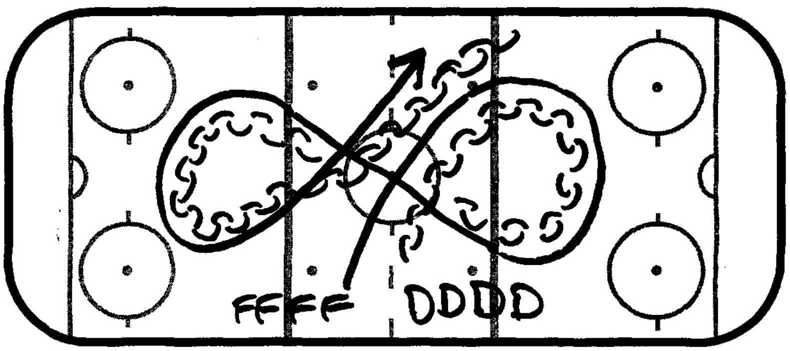


➤ Bend your knees and use the quickest strides possible while continuing to skate the corners. Drive under with the inside skate, don't just 'run' the corners.



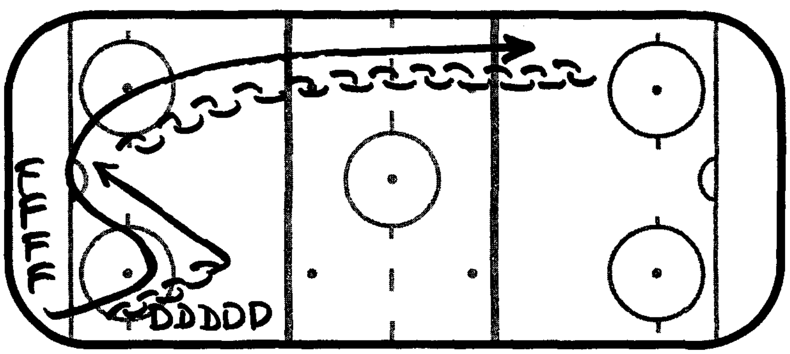
Pursuit sprints without pucks: D mirrors F

Start a new sprint every: **60 seconds if you are doing fewer than 5 sprints**
75 seconds if you are doing many sprints



- D skates backward, F skates forward

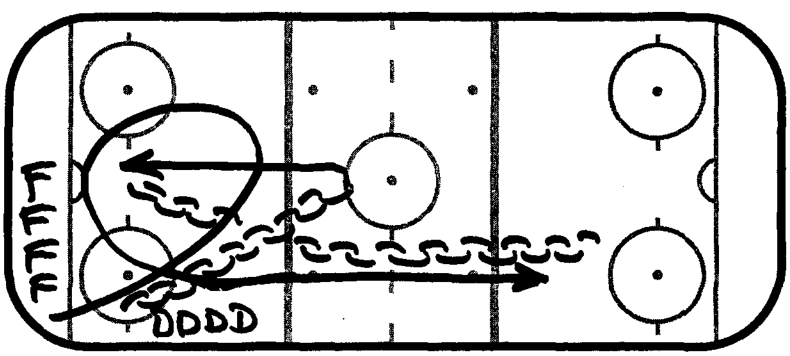
  Note: give the D a head start of about 15 feet.



- D backward
  forward
  backward

  Stay in forward's face;

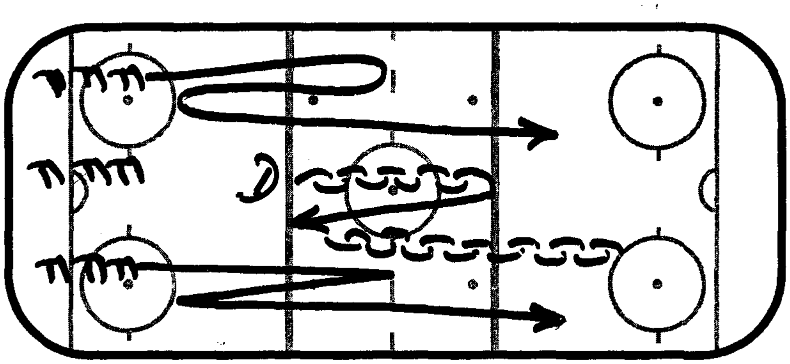
  Take away space.



- D backward
  forward
  backward

  Stay in forward's face;

  Take away space.



- 3 forwards do stops and starts, all forward

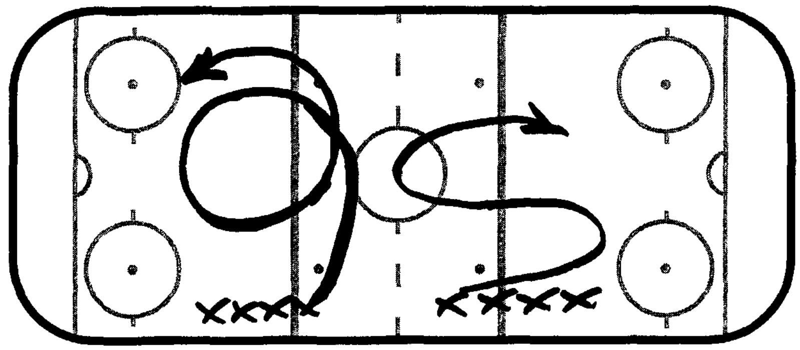
  2 Defensemen skate
  backward
  forward
  backward

Carry pucks and shoot at overspeed; no passes

Start a new sprint every: **60 seconds if you are doing fewer than 5 sprints**
75 seconds if you are doing many sprints

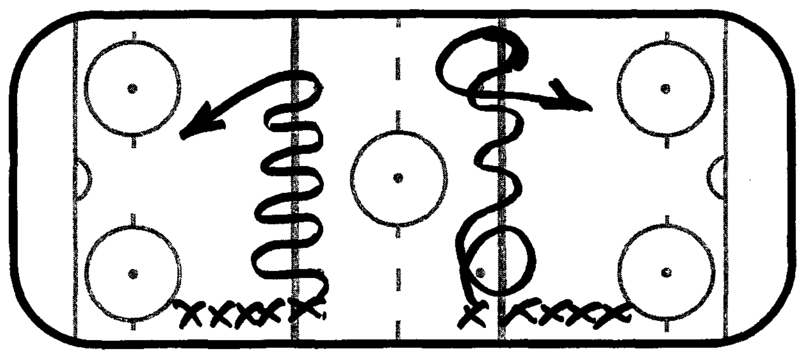
- Shoot while moving feet or with minimum coasting.

  Slap shots only if you can release very quickly on the move.



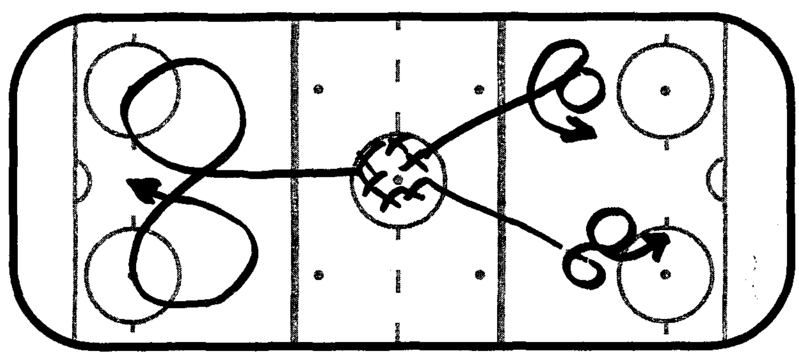
- Zig zag: keep stick moving, feet crossing over.

  Head and shoulder fake at the end and release shot or carry in on fast breakaway.



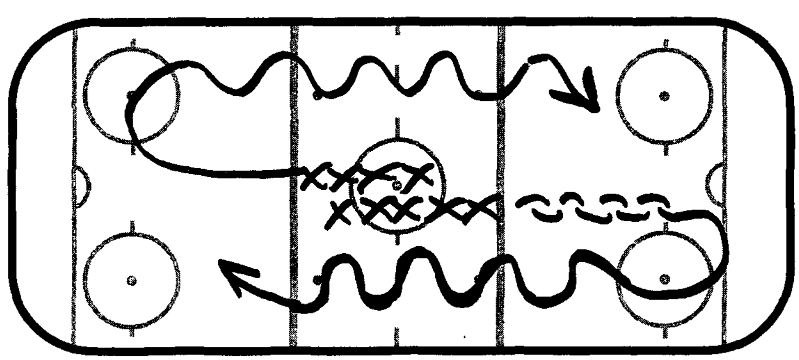
- Figure 8s.

  Large circles or very tight.



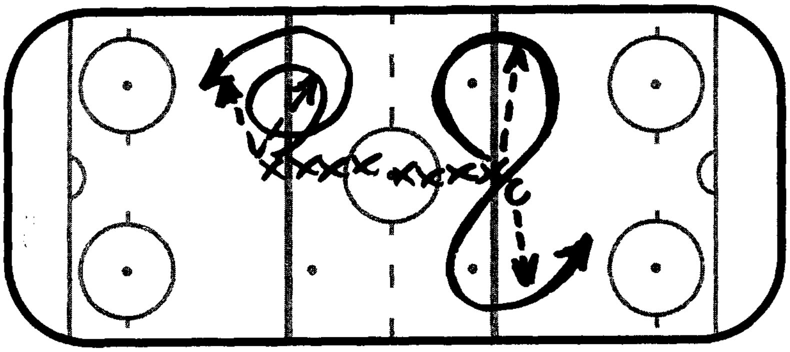
- Carry Forward, zig zag, and release shot.

  Carry backward, pivot, zig zag, and release shot.

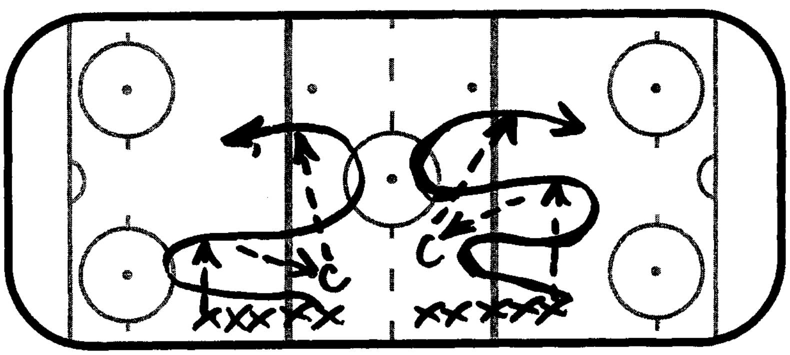


Passing, receiving, shooting at overspeed.

Start a new sprint every: 60 seconds if you are doing fewer than 5 sprints
75 seconds if you are doing many sprints

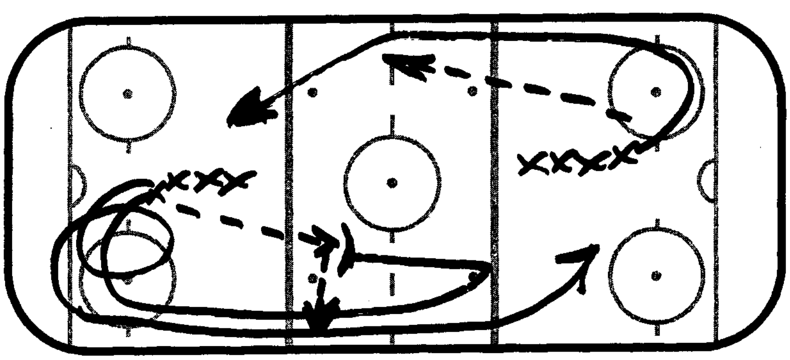


- Receive 2 passes, shoot after 2nd pass.



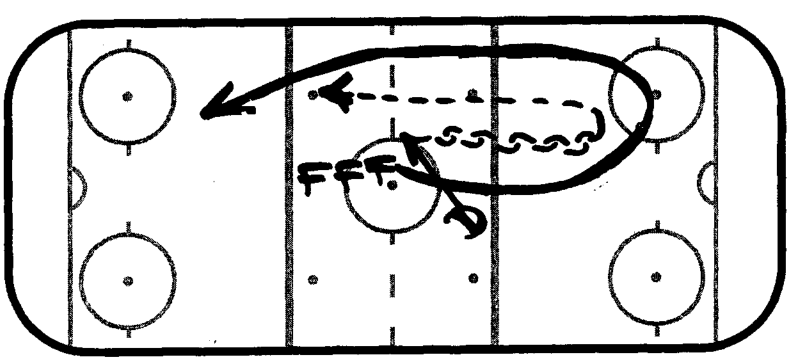
- 2, 3, or 4 passes, 1 shot.

  Use either forward crossover turns or mohawk turns, facing the passer.



- Breakaway pass; or

  First man flies, stops and deflects pass to second player who skated an extra circle.



- D forward, backward while carrying puck.

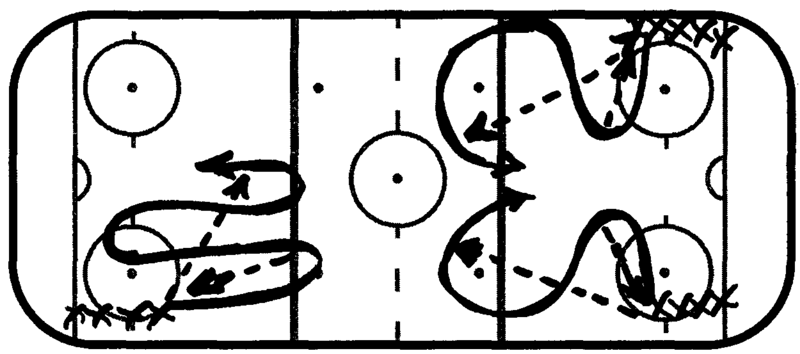
  Forward corner thru the dot and fly.

  Long, breakaway pass.

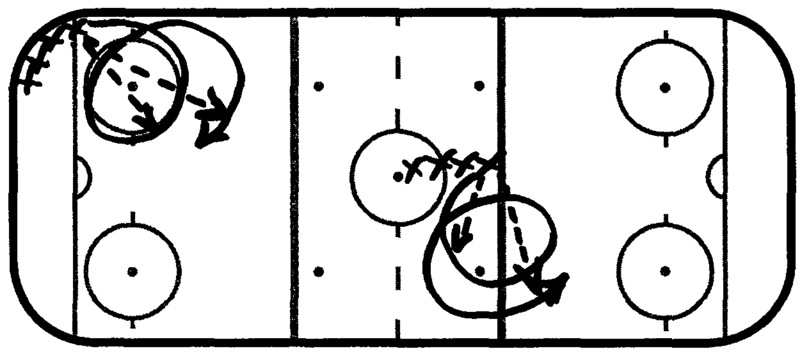
Half ice for forwards: receiving, shooting, skating

Start a new sprint every: **60 seconds if you are doing fewer than 5 sprints**
75 seconds if you are doing many sprints

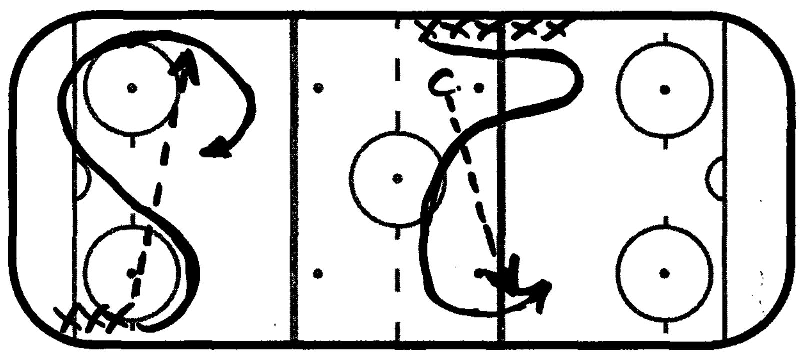
- Pass, receive, shoot.



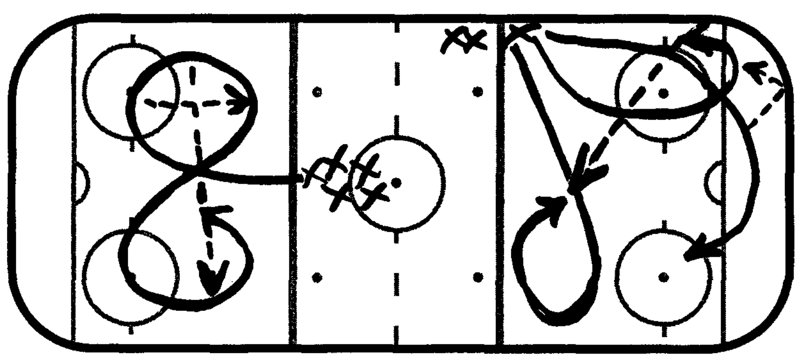
- Receive two passes
  shoot once.



- Cross rink pass.
  Can go 2 at a time.

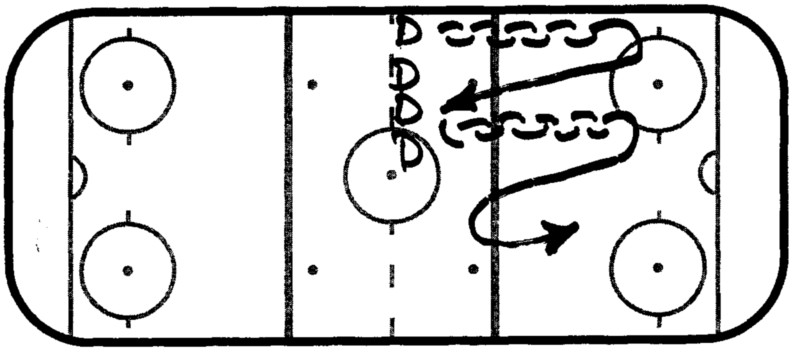


- Carry, pass, receive, shoot.
  2 or 3 at a time.
  Quick passes, cycle, shoot.

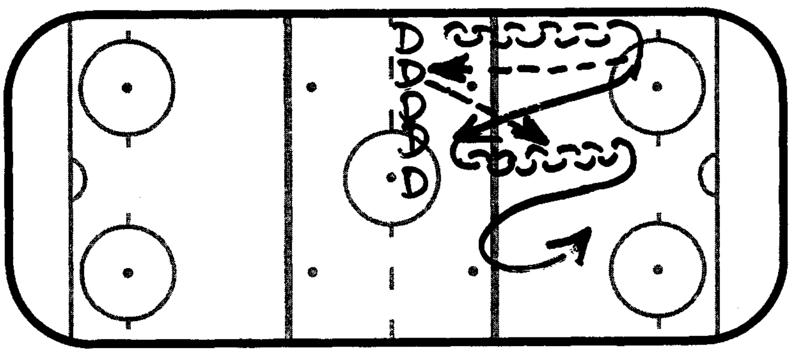


Half ice for defensemen

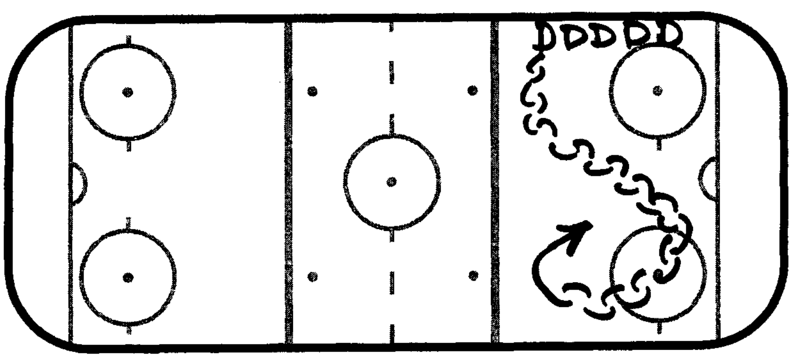
Start a new sprint every: **60 seconds if you are doing fewer than 5 sprints**
75 seconds if you are doing many sprints



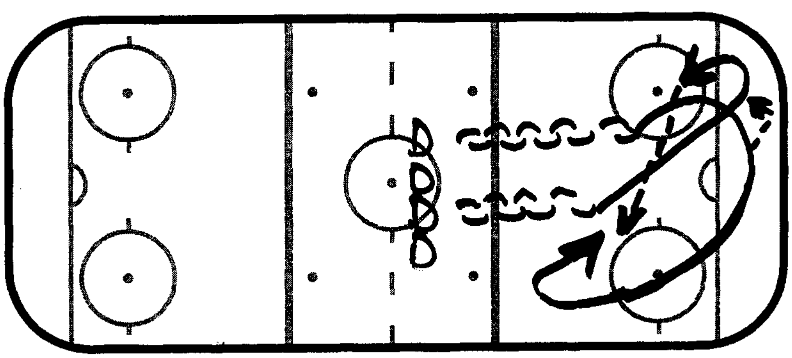
➤ Forward, backward, pivot to forward, sprint, shoot.



➤ Back up with puck, pass, sprint, back up, receive, sprint, shoot.



➤ Backward figure 8 and shoot at the end.



➤ First D carries back, pivots, reverses to second D.

Both D sprint up to top of circle, pass and shoot.

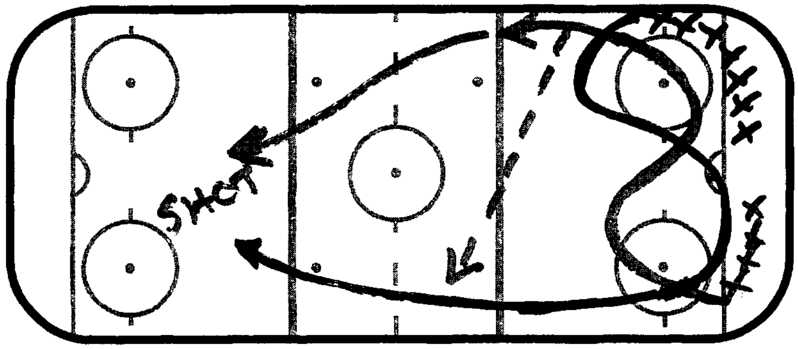
Creative flow drills:
3 or 4 on 0; breakout, regroup

Start a new sprint every: **60 seconds if you are doing fewer than 5 sprints**
75 seconds if you are doing many sprints

➤ 2 on 0 from both circles.

Both players skate S and come out on opposite board.

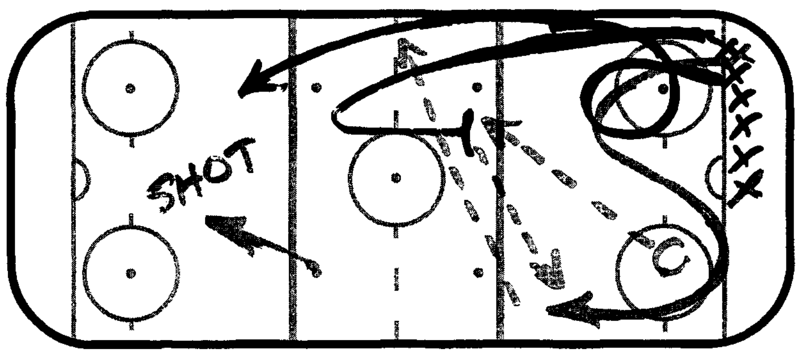
Add regroup.
Add 3 or 4 players.



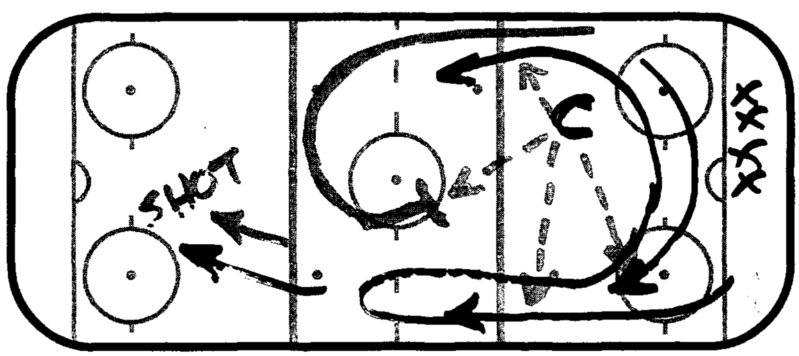
➤ 3 on 0 from one corner.

First man flies & posts; second skate circle; third skates S.

Many passes.

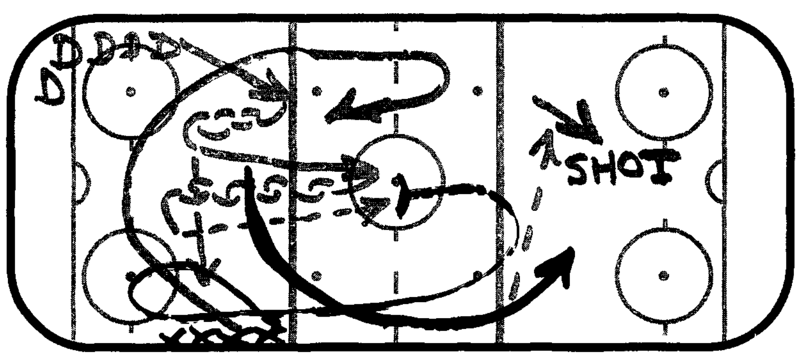


➤ Same as above, but when players reach far blue line, throw puck back to coach or D and regroup.



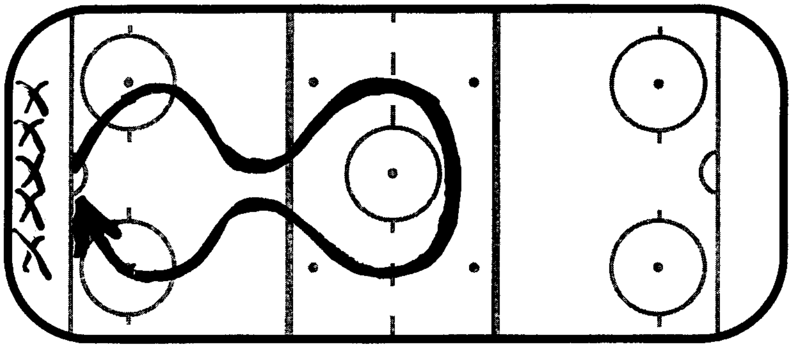
➤ D retreats with puck, passes, steps up, back.

3 forwards skate to open ice as on a regroup. Once over far blue line, pass back to D again and regroup.

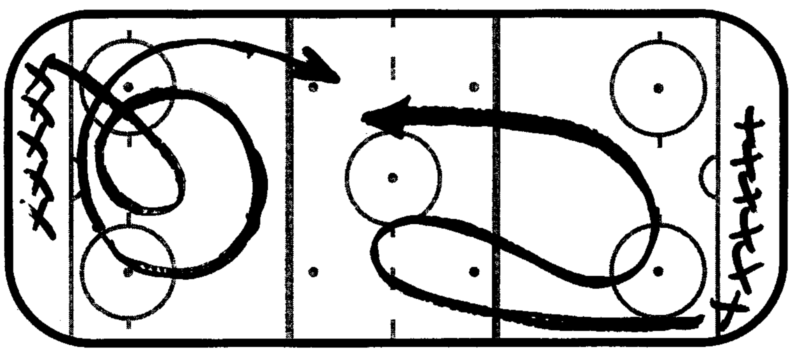


Cornering with or without weighted vests

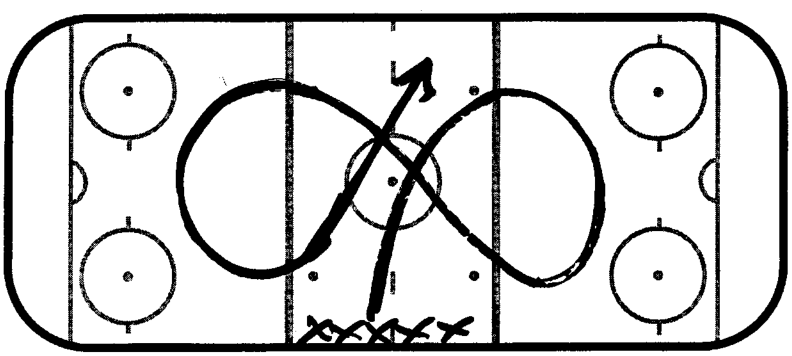
Objective: **exaggerate knee bend to lower the center of gravity**



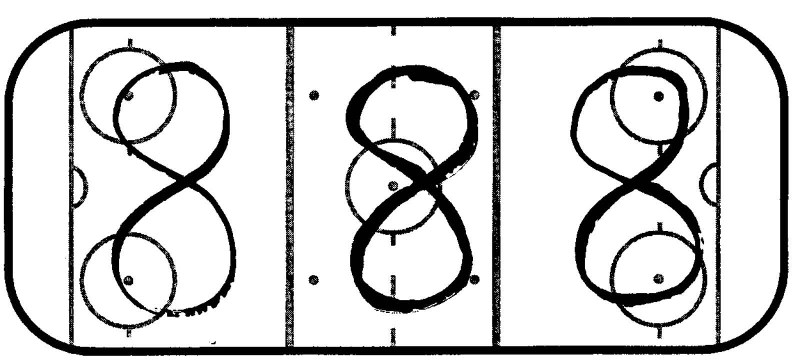
➤ Twice around peanut.
5 at a time.
Start every 75 seconds.



➤ Start every 60-75 secs.
5 at a time.
Once through.



➤ Start every 60-75 secs.
Once around.
Figure 8.



➤ One per 2 minutes.
Continuous for
40 seconds.
Rest 80.

If you could do only one drill...

Chapter Overview:

1 High speed practice competition is the final stage in the step-by-step elevation of our comfort zone. The progression:

a) Skating straight ahead at over-speed; learning skills at slow speed;
b) Skating corners without pucks at over-speed;
c) Handling the puck and shooting while moving at top speed;
d) Passing and receiving passes during over-speed skating;
e) Adding creative decisions to the over-speed drills;
f) Practice competition at over-speed.

2 Timing the shifts (and rest periods) in scrimmages or competitive drills is just as important as during sprint interval training. A scrimmage shift should last no longer than 40-60 seconds, and the rest should be 2-3 times as long. Additional rests are necessary if the scrimmage lasts more than 30 minutes.

3 The first over-speed scrimmages need to have no-checking and fewer players on the ice, so there is time and space to make plays at a faster competition speed. Less equipment is recommended to gain the feeling of quicker pace. When more players are added or competiton drills are devised for tight areas, coaches have to encourage players constantly to keep the pace fast.

4 As coaches, we should not be intimidated into thinking that scrimmages are not valid practice drills — in fact, it is impossible to find a better drill. The only time a scrimmage would be inappropriate is when players are doing many things wrong.

Dave Peterson (twice Olympic coach) and Bob Johnson (Olympic coach and Stanley Cup Champion) say, "If you could do only one drill, it would be a scrimmage."

Anatoli Tarasov, longtime coach and father of Soviet hockey, feels the best practice is, "... high tempo scrimmage."

Herb Brooks feels,"Unstructured scrimmages (3-on-3, 4-on-4, 5-on-5) are where we develop the brilliant, creative players, the Wayne Gretzkys, Neal Brotens, and Mark Pavelichs."

Years ago, a hockey coach was busy shoveling snow and flooding the rink, so very often he just tossed out a puck and let the kids scrimmage, and the great players of today developed in that environment. "A funny thing happens in a scrimmage," commented Ben Smith, one of the 1988 Olympic coaches. "There's a lot of hockey going on. It'd be hard to find a drill that creates these game-like situations."

5 Some competitive drills and scrimmages are summarized briefly on the next page.

Competitive scrimmage drills

3-4-5
3-on-3, 4-on-4, 5-on-5, timed shifts (40 seconds); change on whistle

OVERSPEED
Maintain highest possible speed: no-checking, light equipment, 40 second shifts; emphasize moving at top speed without the puck.

ONE-TOUCH
Think one play ahead, look at options before receiving; think like puck carrier, get open, talk to each other; full-ice, half ice against cut-off sticks.

CUT-OFF STICKS
Full ice, one team working on forecheck, neutral zone check, D-zone; coach throws pucks in any zone to change pace, regroup.

CROSS ICE
2-on-2, 3-on-3, 4-on-4, 5-on-5 in tight areas.

EITHER GOAL
Same as above, but allow either team to shoot at either goal.

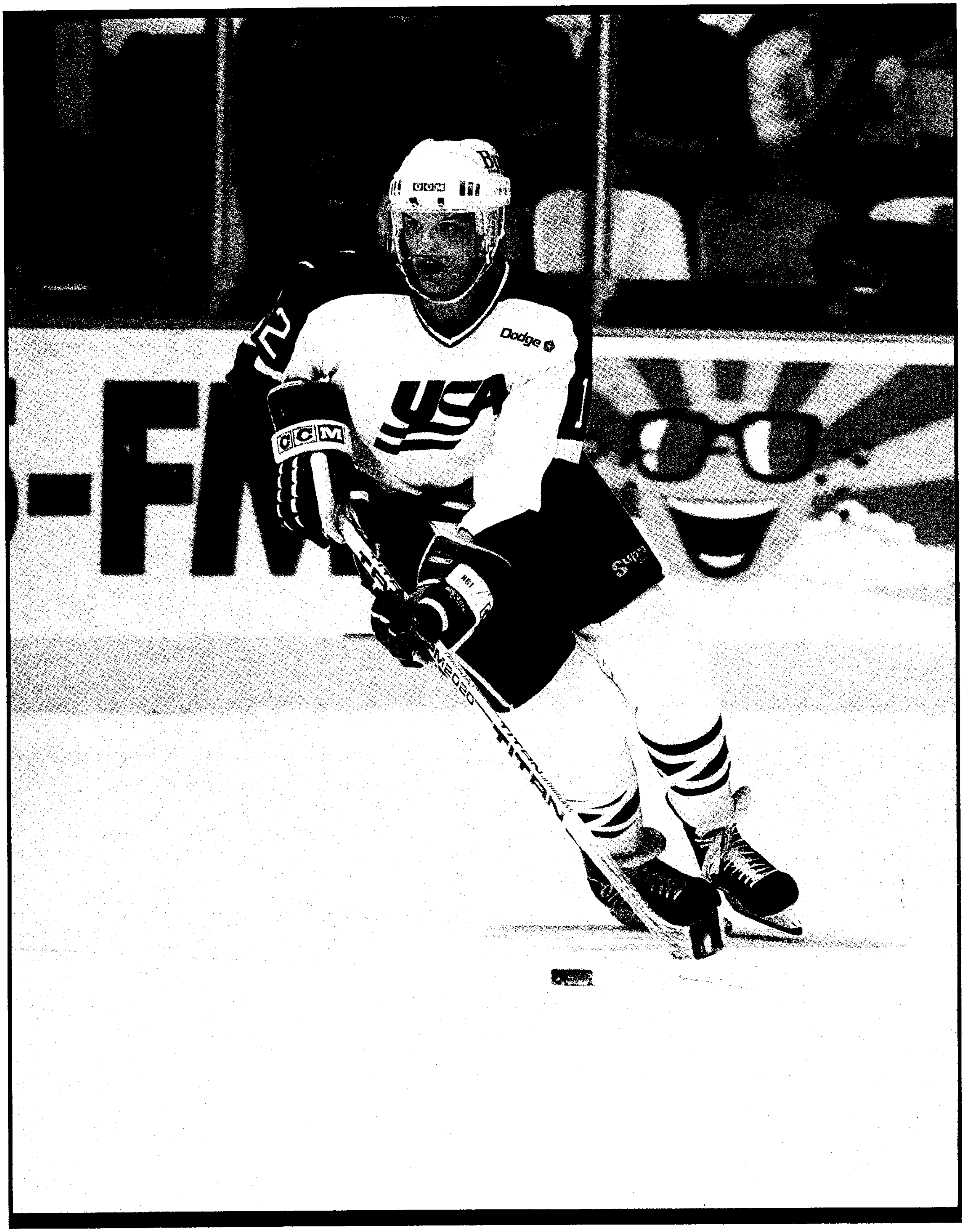
HALF ICE
3-on-3, extra players are point men; to change from defense to offense, pass to point.

HALF ICE
Defensive zone coverage, 3-on-3, 4-on-4, 5-on-5, 5-on-6, 5-on-7, with or w/o cut-off sticks; play D when slightly tired (rotate from offense for 40 seconds to defense); use scoreboard to simulate last 40 seconds of the game.

POWER PLAY
Full ice, half ice against cut-off sticks

BEHIND GOAL LINE
Offensive zone play: 1-on-1 controlling the puck; 2-on-2 or 3-on-2 cycling, picking, and controlling the puck behind the net; another option: play against defensive players with cut-off sticks.

BEHIND GOAL LINE
Defensive zone play with puck: same as above for defensemen and centermen: reversing, controlling the puck along the boards, etc.


Dodge
USA
CCM
TITAN

Periodization:

planning for year-round training and recovery in different phases

Chapter Overview:

Periodization is the changing of training or recovery emphasis periodically throughout the calendar year. We must find ways to utilize this concept for individual development in hockey.

Individual sports, like track, swimming, and weight lifting have found great success in their training because of this concept. Ironically, however, the periodization model probably fits better and offers more to individual development in team sports.

Hockey, like any team sport, demonstrates how an individual's athletic and skill development is enhanced through periodization, and a simple example is helpful. Suppose, a player wants to develop greater skating speed over the next year.

Team improvement takes precedence in-season over individual development. During the season, much practice time is spent on team systems, like the forecheck, power play, or team defensive positioning and coverage. Furthermore, games and travel interrupt the ideal physiological schedule for development.

Finally, each of the factors leading to skating improvement is most effectively trained during a phase of the off-season.

1 Leg strength requires intense overload, which would not be possible in-season. Players would be too tired to skate effectively and would not find time for adequate rest/recovery between strength workouts.

2 Quick strides or foot speed can be enhanced by sprinting, especially downhill sprints.

3 Reduction of excess weight is almost impossible in season, when distance running and a strict diet would leave the player too fatigued to compete effectively.

4 A player can train in the off-season for a lower center of gravity by using the slide board or roller skates. Like weight training, these intervals emphasizing bent knees cannot be effectively overloaded in-season.

5 Skating itself is best modified in the off-season. Technique and speed can be isolated from the distractions of competition, so a player can concentrate specifically on the factors of skating he or his coach feel are important for him. In-season, we often develop bad habits due to fatigue or because our top priority is competition, rather than technique.

IN-SEASON:

Change the training stimulus drastically each month!

1. Early season phase: Weight vests to overload legs; no stops and starts.

2. Regular season phase: build endurance gradually over the entire season.
On and off-ice, change emphasis every 4 weeks.
Overload with weight vests, longer sprints, stops/starts, or resistance.
Underload with lighter equipment than normal or longer rest intervals.
Strength training maintenance; very short workouts, but high intensity.

3. Playoff phase: Emphasize quickness, rather than overload.

OFF-SEASON:

Change your training; outline very specific PERSONAL GOALS for each phase.

1. Active recovery phase (1-3 weeks)

2. Spring: Conditioning phase: Building the base ... toughest weeks of the year!
Aerobic conditioning for endurance and reduction of body fat.
Emphasize sprint intervals and hills if body fat is low.
Basketball, raquetball, tennis, soccer, etc. Baseball and golf don't count.
Lower body muscular endurance, hypertrophy (Sets of 20, light weight).
Upper body hypertrophy: High volume workouts: high reps, minimal rest.
Begin sprinting gradually using buildup sprints.
Plyometrics done as a team just for learning (inadequate strength base).
Training for bent knees (Slide board, roller blade intervals 40:80).
No intense skating or competition; fun scrimmages at most.

3. Summer: Skating/Strength phase: more rest between sets and workouts.
Upper body weights for strength (High weight, low reps, more rest).
Lower body weights for strength (Sets of 8-15 reps, 3-6 minutes rest).
Skating for speed, individual skills (Intervals 5:55 or 10:80 or 20:100).
Off-ice sprints if you are not doing intense skating workouts.
Aerobic conditioning if body fat is high.

4. Early Fall: Speed•Strength phase: Plyometrics, Anaerobic conditioning.
Sprints for speed (5:115). Sprints down a slight hill (5%).
Uphill sprints and sprints for anaerobic endurance (20:100 or 30:90 or 40:80).
Upper and lower body weights for strength. Squats never done heavy!
Weighted jumps using plyometric sled or weight vest.
Plyometrics for explosive power and knee bend (30:60).

5. Pre-season phase: Speed work, Anaerobic sprints, Plyometrics, No weights.
Sprints for speed (5:115). Sprints down a slight hill (5%).
Anaerobic endurance sprints (30:90) and hills (20:100)
Plyometrics for explosive leg power and knee bend (30:60)
Fun scrimmages: skating to prevent groin and hip flexor injuries.
Strength training with body weight outside the weight room.

Periodization: changing the training stimulus periodically during the year

We've all experienced the phenomenon illustrated below. At times our progress slows down or regresses slightly. Whether we are measuring and training for strength, endurance, speed, or jumping ability, we reach plateaus in improvement.Our body adapts to exercise by overcompensating for the specific stress. This is called exercise supercompensation. By regularly lifting a weight which is very difficult to move, we become stronger and in a short time, we're not just equal to the task, but able to lift an even heavier weight.

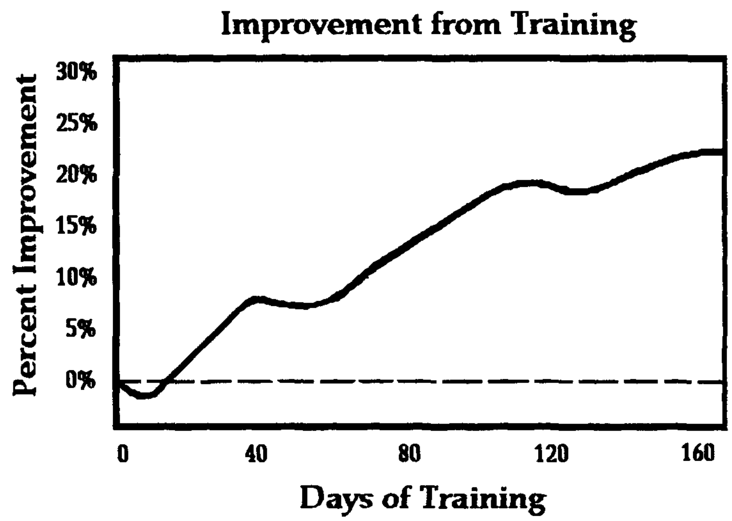
At that point we need to increase the load: either by adding weight, by increasing the speed at which we lift the same weight, or by increasing the number of repetitions with that weight. The same concept applies to all forms of training. This was originally called progressive overload training. But, simply making the training progressively more difficult is not enough change to ensure continuous, steady improvement. Psychological staleness and physiological factors require a drastic change in the mode of exercise.

Phases of training: planning for changes in the type of stimulus, not just the difficulty.

More recently, Soviets (Verhoshansky xxx) and East Germans (Schmidtbleicher, 1985) studied the effects of changing the exercise stimulus in different ways to avoid plateaus in improvement. It is advisable to vary the volume of work from one phase to another, allowing your body to recover more or less completely by changing the ratio of work to rest during and between workouts. Some weight lifters change lifts completely, working many of the same muscles in a different range of motion, perhaps at a different speed, sometimes isometrically or isokinetically. For variety, I would suggest having a period of a month or more each year, in which all of the strength training is outside the weight room, handling your own body weight.

Besides avoiding physiological and psychological staleness, periodization allows you to plan for different emphases at different periods of the year.

Call in the experts !!!



After considering your own unique goals for the off-season and the specific requirements for a given phase, it might be wise to consult an expert in training for that period.

Let's say for example, you have decided to gain muscle mass, reduce body fat, and get as ripped as you can during a given phase of the off-season. It certainly wouldn't be dumb to talk to a knowledgeable bodybuilder. No one knows this training better than he. During another period you might want to really work on sprint speed. Why not visit the best track coach in your area? He can show you plyometric drills and a strength workout to supplement a sprint schedule he has tested with his athletes for years.

A successful power lifter or coach might be able to help you design a program of weight lifting specifically for strength, an Olympic lifter knows how to lift for power.

Recognize the limitations of experts !!!

A point was made at the beginning of the book and is worth repeating here. None of these people is as qualified as you and your coach to determine your overall training goals. They may not be as capable as you are to determine the major goals for each training phase. Therefore, it is not wise to begin a workout schedule written and used by someone else before your specific goals are incorporated into it.

Let's say I (as a 15 year old hockey player) ran into Lee Haney while visiting Venice Beach. I'd be impressed and somewhat intimidated if he wrote out a 'perfect' program for me in the weightroom, regardless of whether or not he even knew I was a hockey player. He's awesome — almost as awesome as Cory Everson. It's easy to be intimidated into thinking that whatever program works that well for them should probably help me.

But, if bodybuilding goals don't fit into that period of my calendar, their program is not best for me. Perhaps at another time I should follow it religiously. But, at this phase I might have decided to train like Florence Griffith Joyner. Or maybe I'm not ready for that intensity yet and need to build up strength, speed, and endurance.

Plan ahead. Don't just throw random choices onto a calendar like darts at a target.

We must keep in mind our goal is to improve as hockey players, and the schedule must ultimately fit into that framework. Skating, skill work, shooting pucks into a tarp outside, hockey camps, fishing trips, or running hills can involve time and energy. Our off-season program should be thought out in advance, and plans should be made to accomodate these activities, because improvement in any area requires a very concentrated effort for a period of 4-6 weeks.

Furthermore, training is consecutive — meaning one type of training prepares for the next phase. For example, in the weight room it is best to build a base of muscular endurance early in the spring by doing many sets and reps and by allowing minimal recovery. This increases endurance and the ability to recover between sets, partly by increasing vascularity in the trained muscle. Later, heavy weights might be incorporated with much more rest between sets. But, to reverse this order would not be wise. The ability to recover more completely allows you to lift with more quality during each set, and when lifting for strength or power, quality lifts are essential.

Strength training and sprinting should precede plyometric training. Muscles and tendons that are strengthened from running and lifting are much more suited for the shock and large forces of jumping or hopping.

Intelligent training is synergistic, another reason for well-planned periodization

As an example, let us consider plans to improve skating in the next twelve months.

Obviously, the in-season period will include much skating, but because team concepts also require practice time and drain our time and energy, this is not a good period of the year to improve leg strength. We would be doing well just to maintain our strength in the weight room.

Many players participate in hockey camps, leagues, or skating clinics in the summer, so the spring might be the best time of year to emphasize running sprints and leg strength in the weight room. Skating improvement and lower body weights might be the emphasis over the summer months. Then, after establishing these bases of strength and speed, we can work on very powerful exercises like plyometrics and running hills in the fall. With the long season coming up, it's probably better to limit skating to fun scrimmages at this time.

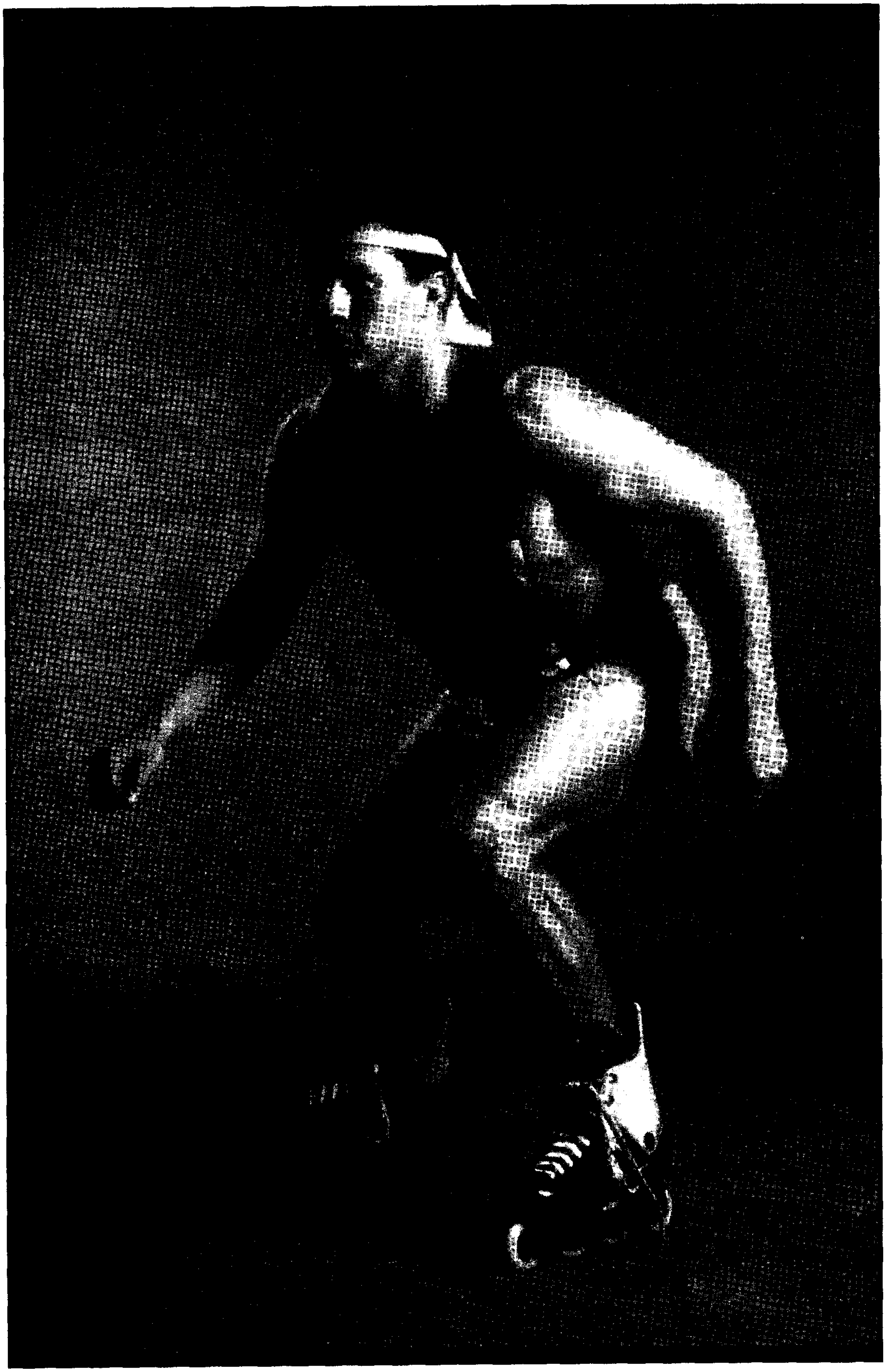
Plan ahead. Train smart, not just hard !!!

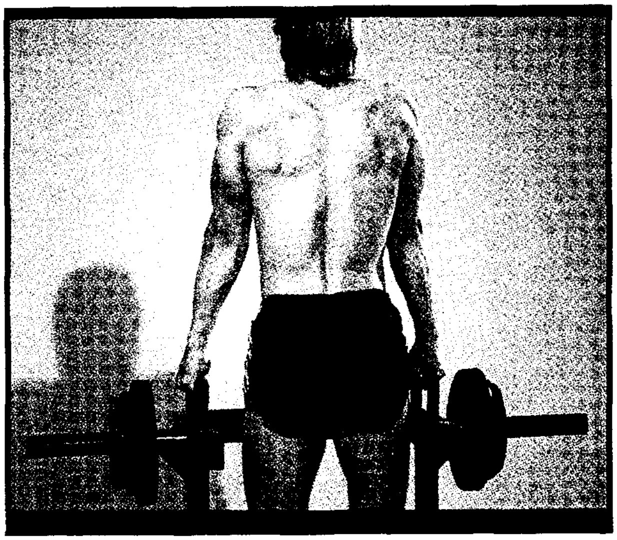
If you spend time to look objectively at your personal calendar, it is easy to see that some periods of the year are best suited for certain types of training. Like building a house, this is simply planning to fit each of the building blocks into its most effective position.

Off-Season Training Goals:

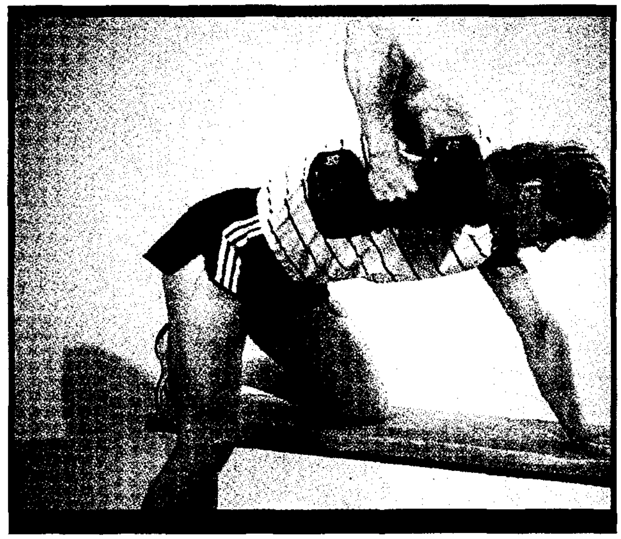
Use this calendar to see at a glance where you're going and where you've been.
Set very specific **training/recovery/nutritional goals** every week.
Write them down somewhere else, and abbreviate them here on the right of each week.
After each day in which you accomplished your goal, fill in that date with a colored marker.

	SU	M	TU	W	TH	F	SA	Off-Season calendar
April								
May								
June								
July								
August								
September								
October								

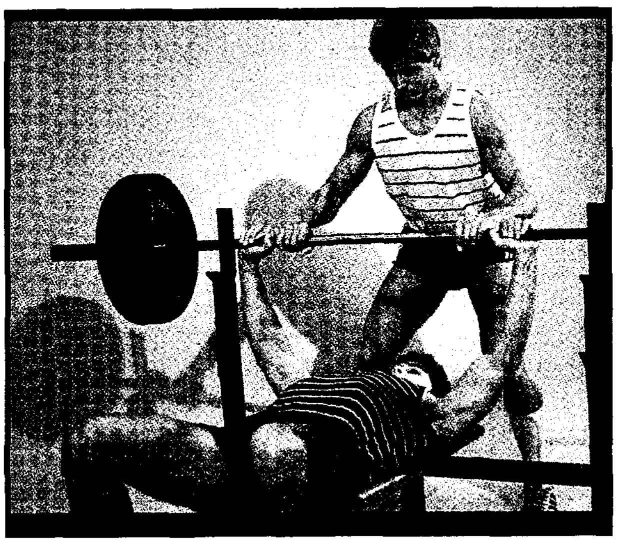




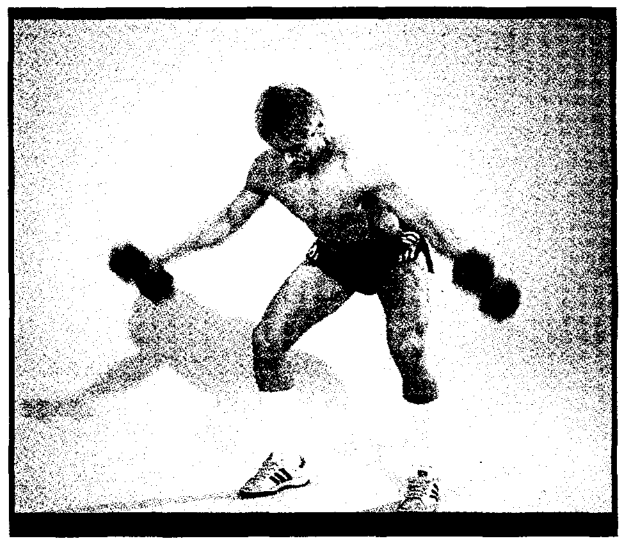
Shoulder Shrug



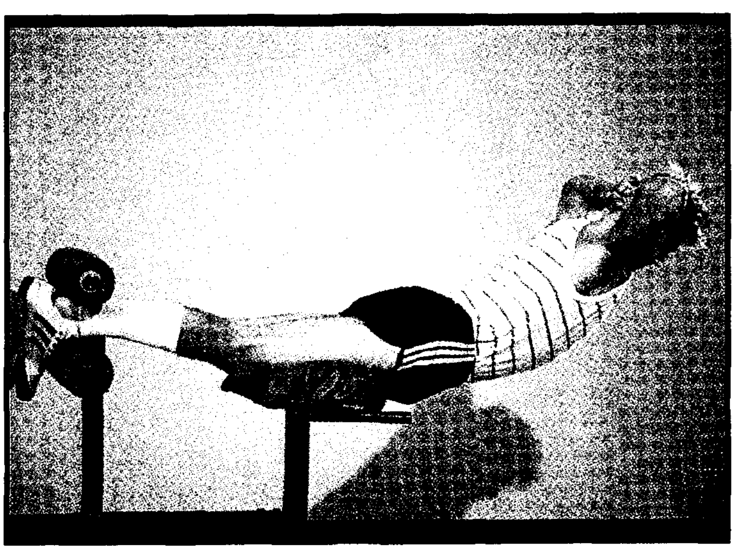
Lawn Mower



Bench Press



Back Extensor



Shoulder Flies

Dumbell Press

Off-season training phases:

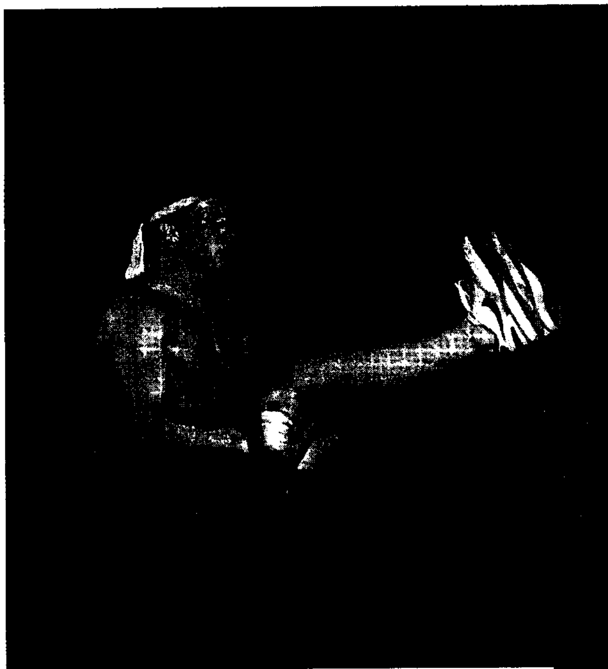
Post season recovery

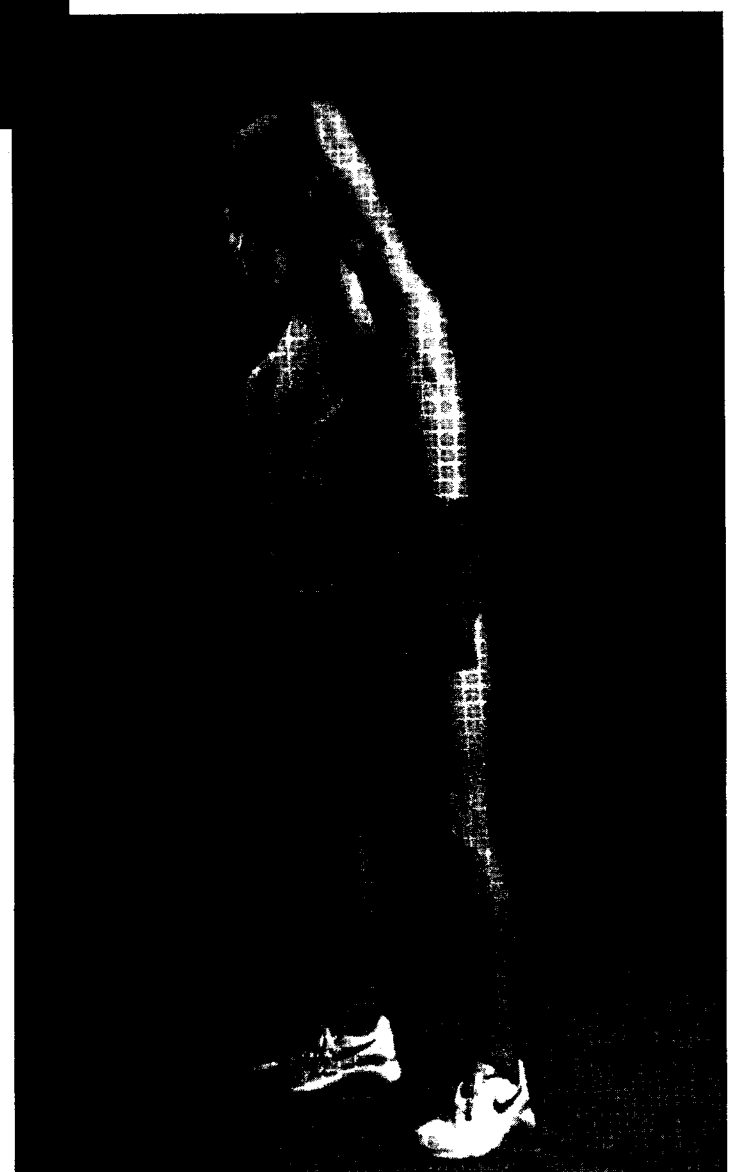
Spring — Conditioning

Summer — Strength and skating

Early Fall — Speed, power, anaerobic intervals

Pre-season – Anaerobic endurance





Post-season Phase
Active Recovery: 1-3 Weeks

GOALS:

➤ ACTIVE REST/RECOVERY: SPEND MINIMUM TIME TRAINING

Maintain conditioning level with 3 aerobic activities per week
- Bicycling (45-60 minutes)
- Basketball
- Tennis
- Raquetball
- Jogging (30-45 minutes)

Some minimal activity every day
- Golf
- Walking

Start strength training gradually (get in and out of the weightroom)

1 or 2 Light lower body workouts per week (Max 30 minutes)
- Squats with just the bar for stretch and endurance
- Light hip sled with high reps (sets of 25)
- Hamstring curls
- Sit-ups
- Back extensors

1 or 2 Light upper body workouts per week (Max 30 minutes)

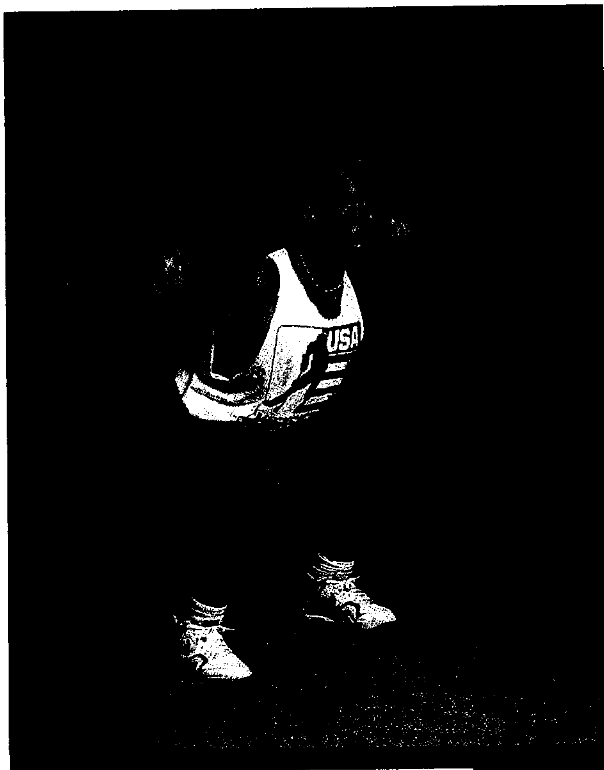
➤ GOOD NUTRITION (IF YOU WERE LESS THAN PERFECT DURING THE SEASON)

Start immediately:
- replacing skim milk for pop;
- reducing fat in your diet, especially saturated fat;
- fat meats;
- egg yolks;
- pizza and other cheese;
- Big macs, cheesburgers,
  hot dogs, sausage;
- ice cream;

increasing high carbohydrate foods:
- fruit, vegetables, cereals, and bread;

increasing high protein foods:
- tuna, egg whites, non-fat yogurt or cottage cheese.

Keep this up for life ... not just during these intense training months!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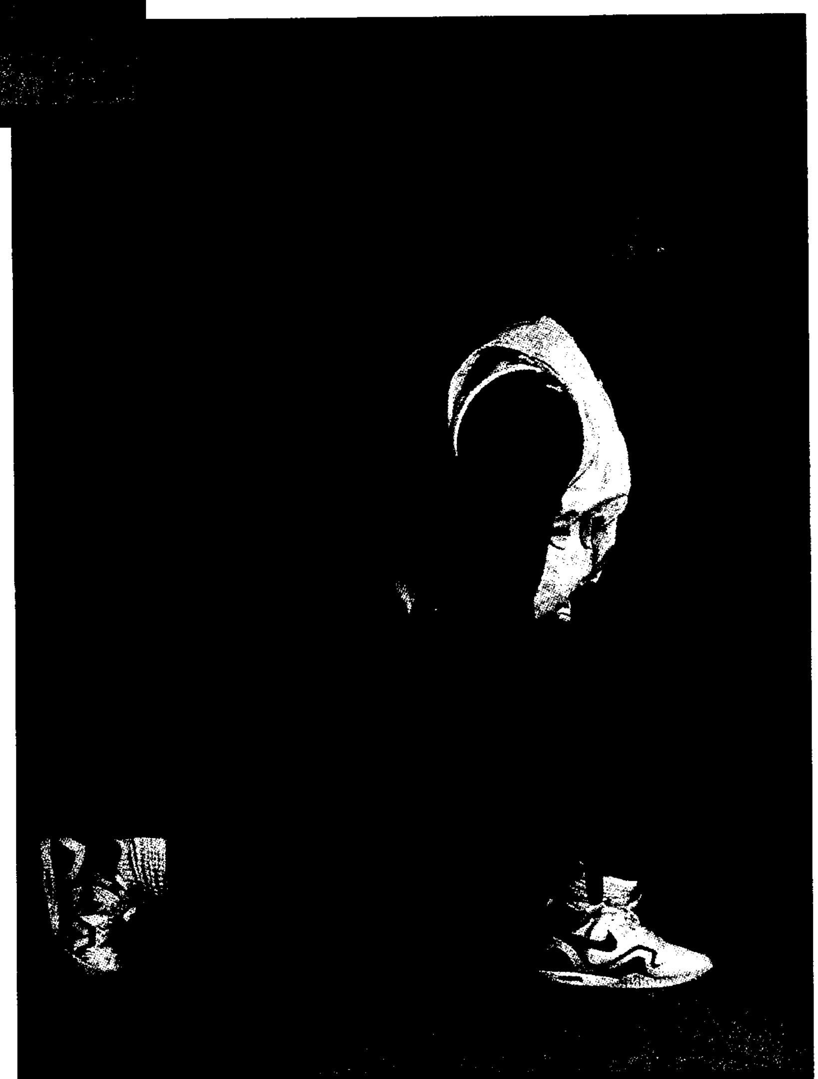


Conditioning and muscular hypertrophy April-May

SPRING CONDITIONING

SPRING GOALS:

Aerobic endurance base.
Muscular endurance in weightroom: High volume / minimum rest.
Muscular hypertrophy: High volume lower body workouts.
Reduction of body fat.
Begin sprint workouts with gradual build-up sprints.

Building the conditioning base is the toughest phase of the year.
During the summer there will be more rest/recovery ... a promise!!!

➤ AEROBIC CONDITIONING 3-7 TIMES PER WEEK (40-60 MINUTES)

Options: Jog (walk at times), bike, tennis, basketball, soccer, hills, stadium steps.

7 times per week if your body fat is over 11% .... distance work with the the fat club!
Include more distance work, rather than intense workouts like hills.
Alternate workouts every other day (bike; jog; bike; jog)

3 times per week if your body fat is under 8% ... emphasize interval training.
Avoid a lot of jogging (some is fine) — the opposite of the fat club.
Include more intense workouts like hills, bike, sprints, basketball, games.

➤ SPRINTS 2-3 TIMES PER WEEK (20-30 MINUTES).

➤ LOWER BODY WEIGHTS 2-3 TIMES PER WEEK AFTER SPRINTS (20-90 MINUTES).

High volume workouts: 20-30 reps and many sets for muscular endurance.
Minimum rest between sets (start a new set every 2-3 minutes).

➤ UPPER BODY WEIGHTS 2-3 TIMES PER WEEK: HIGH VOLUME WORKOUTS AS ABOVE).
After the season and recovery phase, stagger the starting dates for hard workouts:
Start the tough upper body workouts a week after starting in hard on lower body.

➤ MIDLINE MUSCLES: SIT-UPS, BACK EXTENSORS, HIP FLEXORS, ADDUCTORS.

➤ ➤ **No skating! Get away from the rink for a couple months.**

➤ ➤ **OPTIONAL SLIDE BOARD OR ROLLER BLADES FOR BENT-KNEE ENDURANCE.**
These can substitute for some (but not all) aerobic workouts.
Use 40:80 intervals (Work 40 seconds : Rest 80 seconds).

Sample weekly schedule

Spring: Conditioning phase

Work up gradually to this schedule in 2-3 weeks
Remember, you'll have more days off during June and July.

MONDAY:
Medium sprint day (Warmup + 20 minutes of sprints)
Optional slide board
Midline muscles
Medium lower body strength day (40 minutes)

TUESDAY:
Aerobic distance workout
(40-60 minutes)
Medium upper body weights
(40 minutes)

WEDNESDAY:
Hardest sprint day of the week
Optional slide board
Midline muscles
No lower body weights or optional 20 minute workout

THURSDAY:
Light aerobic workout
Hard upper body weights
(40-90 minutes)

FRIDAY:
No sprints or optional easy workout
No slide board or optional short workout
Midline muscles
Hardest lower body strength day of the week (up to 90 minutes)

SATURDAY:
Aerobic distance workout
(40-60 minutes)
Optional light upper body workout

SUNDAY:
Aerobic workout if you are trying to lose body fat

Medium sprint / Medium lower body workout

Spring: Conditioning phase

Adjust for a harder workout by adding more sets; don't change the rest intervals.

SPRINT WORKOUT **EXTRA MINUTE STRETCH AFTER EACH GROUP**

Warmup run	Stretch after warmup	5 minutes
Build-up sprints	4 x 40 yards : rest and stretch	Start every minute
Walking split squats slowly	2 x 40 yards : rest and stretch	Start every minute
Acceleration sprints	4 x 60 yards	Start every 1-2 minutes
Acceleration sprints	2 x 120 yards	Start every 3 minutes

LOWER BODY STRENGTH WORKOUT **MUSCULAR ENDURANCE, HYPERTROPHY**

Keep moving: start a new set every 2-3 minutes.
Extra 2 minute rest between lifts.
Warmup sets are not shown below.
Superset the lifts within each marked group.

Squats	Bar alone: for stretch	1 x 20
	Light weight	2 x 30
	Medium weight	2 x 20
Sit-ups between sets of squats		
Hip sled or squat sled	Major lift of the spring!	3 x 20
Hamstring curls		3 x 15
Hip flexor leg raises on dip bar or chin-up bar		3 x 20
Back extensors		3 sets

Short aerobic / Hard upper body workout

Spring: Conditioning phase

AEROBIC WORKOUT **30-40 MINUTES**

.... jog or bike before or after upper body weights.

UPPER BODY STRENGTH WORKOUT **MUSCULAR ENDURANCE, HYPERTROPHY**

Keep moving: start a new set every 2-3 minutes.
Extra 2 minute rest between lifts.

Adjust for a harder workout by adding more sets; or add other lifts, such as dips, chin-ups.
Bench and incline are both done on the hard day.

Warmup sets are not shown below.
Superset the lifts within each marked group.

Bench press or Incline bench		3 x 15
Lat pull-downs or Wide arm pull-ups		3 x 15
Dumb-bell shoulder press		3 x 15
Rowing or Narrow grip pull-downs		3 x 15
Shoulder shrugs or Upright rowing		3 x 15
Dips	Optional	2 max sets
Underhand chin-ups	Optional	2 max sets

Skating, sprinting and muscular strength June – July

GOALS:

Skating interval workouts, including high speed skills.
Muscular strength in weightroom: High weight / low reps.
Increased muscle mass: greater rest between sets and days.
Continue sprint workouts — explosive starts.

➤ SKATING INTERVALS THREE TIMES PER WEEK FOR 60-90 MINUTES.

➤ LOWER BODY WEIGHTS 2-3 TIMES PER WEEK (20-90 MINUTES) AFTER SKATING.

Heavier weight: 8-15 reps ... but, squats with sets of 15-20 in your first 2 years!!
Allow plenty of rest between sets (start a new set every 3-6 minutes).

➤ UPPER BODY WEIGHTS 2 TIMES PER WEEK (SETS OF 6-8 REPETITIONS).

➤ MIDLINE MUSCLES: SIT-UPS, BACK EXTENSORS, HIP FLEXORS, ADDUCTORS

➤ AEROBIC CONDITIONING IF YOU'RE NOT SKATING.

Options: Skate, jog, bike, tennis, basketball, soccer, hills, stadium steps.
Skating interval workouts but not games can substitute for aerobic workouts.

3 times per week plus skating if your body fat is over 11%
    Include more distance work, rather than intense workouts like hills.
    Alternate workouts every other day (bike; jog; bike; jog)

Skating intervals replace distance work if your body fat is under 8%

➤ ➤ Sprints 2 times per week (20-30 minutes) if you're not skating.

➤ ➤ Slide board or roller blades for bent knees if you're not skating.
These can substitute for some (but not all) aerobic workouts.
Use 40:80 intervals (Work 40 seconds : Rest 80 seconds).

Sample weekly schedule

Summer: Skating / Strength Phase

Work up gradually to this schedule in 2-3 weeks
You can take off an occasional strength workout in June and July

MONDAY:
Skating intervals for 60-90 minutes
Slide board and sprints if you are not skating
Midline muscles
Medium lower body strength day (40 minutes)

TUESDAY:
Aerobic distance workout or sprints if you are not skating
Upper body weights (40-90 minutes)

WEDNESDAY:
Skating intervals for 60-90 minutes
Slide board and sprints if you are not skating
Midline muscles
Short 20 minute lower body strength workout

THURSDAY:
Light aerobic workout
Upper body weights (40-90 minutes)

FRIDAY:
Skating intervals for 60-90 minutes
Optional, easy sprint workout
Midline muscles
Hardest lower body strength day of the week (up to 90 minutes)

SATURDAY
Optional light upper body workout

SUNDAY:
Aerobic workout if you are trying to lose body fat)

Lower body workout

Summer: Skating / Strength phase

SKATING WORKOUT — **60-90 MINUTES OF HIGH SPEED INTERVALS**

Shown in a later section.
Adjust for a harder workout with more total time; don't change the rest intervals.

LOWER BODY STRENGTH WORKOUT — **STRENGTH PHASE**

Allow as much rest as you want;
3-6 minutes for each set.
Warmup sets are not shown below.
Superset the lifts within each marked group.

Squats	Bar alone: for stretch	1 x 20
	Light weight	2 x 20
	Medium weight	3 x 15
Sit-ups between sets of squats		

Hip sled or Squat sled	Add weight each day! Add several sets on a hard day. This station is the place to really improve!	2-10 sets x 8

Hamstring curls		3 x 8-10
Hip flexor leg raises on dip bar or chin-up bar		3 x 20
Back extensors		3 sets

Heavy upper body workout
Summer: Skating / Strength phase

AEROBIC WORKOUT... IF YOUR BODY FAT IS HIGH

UPPER BODY STRENGTH WORKOUT **STRENGTH PHASE**

Rest as much as you want (3-6 minutes) between sets.

Use a spotter and lift heavier weights.

Avoid isolation lifts during this phase.

Adjust for a harder workout with more sets; or add other lifts, such as dips, chin-ups.
Bench and incline are both done on the hard day.

Warmup sets are not shown below.
Superset the lifts within each marked group.

Bench press		3 x 6
Lat pull-downs or Wide arm pull-ups		3 x 8
Incline bench		3 x 6
Rowing or Narrow grip pull-downs		3 x 8
Shoulder shrugs or Upright rowing		3 x 8
Underhand chin-ups		2 max sets
Dips	Optional	2 max sets
Dumb-bell shoulder press	Optional	2 x 8

Early fall: Speed / Strength phase

GOALS:

Fall sport if available.
Sprints, and gradually begin anaerobic endurance intervals.
Leg power from sprints, plyometrics, and heavier weights.
Upper body strength.

➤ SPRINTS , PLYOMETRICS, AND HILLS 1-2 TIMES PER WEEK

See the next phase for these workouts, but start gradually with a reduced load.

➤ LOWER BODY STRENGTH 2 TIMES PER WEEK.

Heavy weight: 8-15 reps.
Squats with sets of 15-20 in your first 2 years!!
Allow plenty of rest between sets (start a new set every 3-6 minutes).
Explosive, weighted jumps using a plyometric leg machine or a weight vest.

➤ Upper body strength 2 times per week .

➤ Midline muscles: sit-ups, back extensors, hip flexors, adductors

➤ ➤ **Fun scrimmage games instead of skating intervals.**
Since the season is going to have plenty of structured skating, play some pickup hockey in these last weeks before training camp, but avoid intense intervals.

➤ ➤ **Aerobic conditioning is replaced by anaerobic sprints ...**
... unless you are trying to reduce body fat.

➤ ➤ **Slide board or roller blades for bent knees if you're not skating.**
Use 40:80 intervals (Work 40 seconds : Rest 80 seconds).

Sample weekly schedule

Early fall: Speed /Strength phase if you are not in a fall sport

Work up gradually to this schedule in 2 weeks

MONDAY:
Sprint workout; no plyos or hills (20 minutes)
Slide board optional
Midline muscles
Heavy lower body strength day (45 minutes)

TUESDAY:
Upper body strength training

WEDNESDAY:
Sprint/Plyometrics/Hills (60 minutes)
Midline muscles
No lower body strength workout

THURSDAY:
Upper body strength training

FRIDAY:
Sprint/Plyometric workout (30 minutes)
Slide board optional
Midline muscles
Medium lower body strength day (35 minutes)

SATURDAY:
Active recovery

SUNDAY:
Aerobic workout if you are trying to lose body fat

Heavy lower body workout

Early fall: Speed / Strength phase

Adjust for a harder workout with more sets.

Include a month somewhere in the off-season with no weights if you've been lifting all summer (see next section).

SPRINTS, PLYOMETRICS, HILLS **20-40 MINUTES**

See the next section for sprints/plyometrics/hills workout.
Reduce the sprint/plyo/hill workout on heavier weight training days.

LOWER BODY WEIGHT WORKOUT **AFTER LIGHT SPRINTS/PLYOS**

Allow as much rest as you want;
3- 6 minutes per set.
Warmup sets are not shown below.
Superset the lifts within each marked group.

Squats	Bar alone: for stretch	1 x 20
	Light weight	2 x 20
	Medium weight	3 x 15
Sit-ups between sets of squats		
Plyometric sled or weight vest	Explosive, weighted jumps Quality jumps — not done to failure!	3 x 6
Hip sled	Heavy sets!	3 x 8
Hamstring curls		3 x 8
Hip flexor leg raises on dip bar or chin-up bar		3 x 20
Back extensors		3 sets

Heavy upper body workout

Early fall: Speed / Strength phase

Adjust for a harder workout with more sets.

Include a month somewhere in the off-season with no weights if you've been lifting all summer (see next section).

UPPER BODY STRENGTH WORKOUT **EARLY FALL PHASE**

Rest as much as you want (3-6 minutes) between sets.

Use a spotter, adding weight each day.

Pyramid sets (8,6,4,2,4), adding weight up to near max.

Warmup sets are not shown below.
Superset the lifts within each marked group.

Bench press		2 x 8,6,4,2,4
Lat pull-downs or Wide arm pull-ups		3 x 8
Incline bench		2 x 8,6,4,2,4
Rowing or Narrow grip pull-downs		3 x 8
Shoulder shrugs or Upright rowing		3 x 8
Dips	Optional	2 max sets
Dumb-bell shoulder press	Optional	2 x 8
Underhand chin-ups	Optional	2 max sets

Pre-season: Anaerobic Interval Phase

... or any period of the year where you aren't in the weight room.

GOALS:

Fall sport if available.
Sprints and anaerobic endurance.
Muscular strength handling your own body weight.
Leg power (speed/strength).
Fun, relaxed skating to avoid groin injuries in camp.

Get away from the weight room for a month!
Upper body strength without weights.
Lower body power through sprints and plyometrics.

➤ SPRINTS, PLYOMETRICS, AND HILLS 3 TIMES PER WEEK.

This improves speed, increases endurance, builds leg power, and helps avoid hip flexor and adductor muscle pulls in training camp.

➤ UPPER BODY STRENGTH 3 TIMES PER WEEK WITH YOUR OWN BODY WEIGHT.

➤ MIDLINE MUSCLES: SIT-UPS, BACK STRENGTH, HIP FLEXORS, ADDUCTORS

➤ ➤ **Fun scrimmage games instead of skating intervals.**
If you skated this summer, skate now only to avoid groin injuries in training camp.

Play some pickup hockey in these last weeks before training camp, but avoid intense intervals, since the season is going to have plenty of structured skating.

➤ ➤ **Aerobic conditioning is replaced by anaerobic sprints.**
... unless you are still trying to reduce body fat!

➤ ➤ **Optional slide board or roller blades for bent knees and groins.**
Use 40:80 intervals (Work 40 seconds : Rest 80 seconds).

Sprints / Plyometrics / Hills

Pre-Season phase: No weight training

Sample of hardest day (60 minutes)
Work up to this schedule gradually

Warmup jog	Stretch after warmup	10 minutes
Build-up sprints	4 x 40 yards : rest and stretch	Start every minute
Walking split squats slowly	1 x 40 yards : rest and stretch	Start every minute
Squats (knee bends) without bar	2 x 20 for stretch	Start every minute
Explosive starts	2 x 40 yards : rest	Start every 2 minutes
Downhill sprints (5% grade)	2 x 40 yards : rest	Start every 2 minutes
Sprints	2 x 80 yards : rest	Start every 3 minutes
Acceleration sprints	2 x 120 yards : rest	Start every 3 minutes
	Rest	Extra 2 minutes

PLYOMETRICS		**START EVERY 90 SECONDS**
Side-to-side jumps, gathering your weight, bending the knees		2 sets of 12
One-legged squat jump with good knee bend		1 set of 12 each leg
One-legged squats (with or w/o weight vest)		1 set of 20 each leg
Two legged jumps (with or w/o weight vest)		2 sets of 12
	Rest	Extra 2 minutes

ANAEROBIC ENDURANCE:	**CHOOSE FROM EITHER HILLS OR SPRINT INTERVALS BELOW:**	
Sprints up hill	6 x 20 seconds	Start every 2 minutes
Anaerobic sprint intervals	6 x 30 seconds	Start every 2 minutes

Upper body strength without weights

Take a month break from the weight room

SUGGESTED STRENGTH TRAINING:

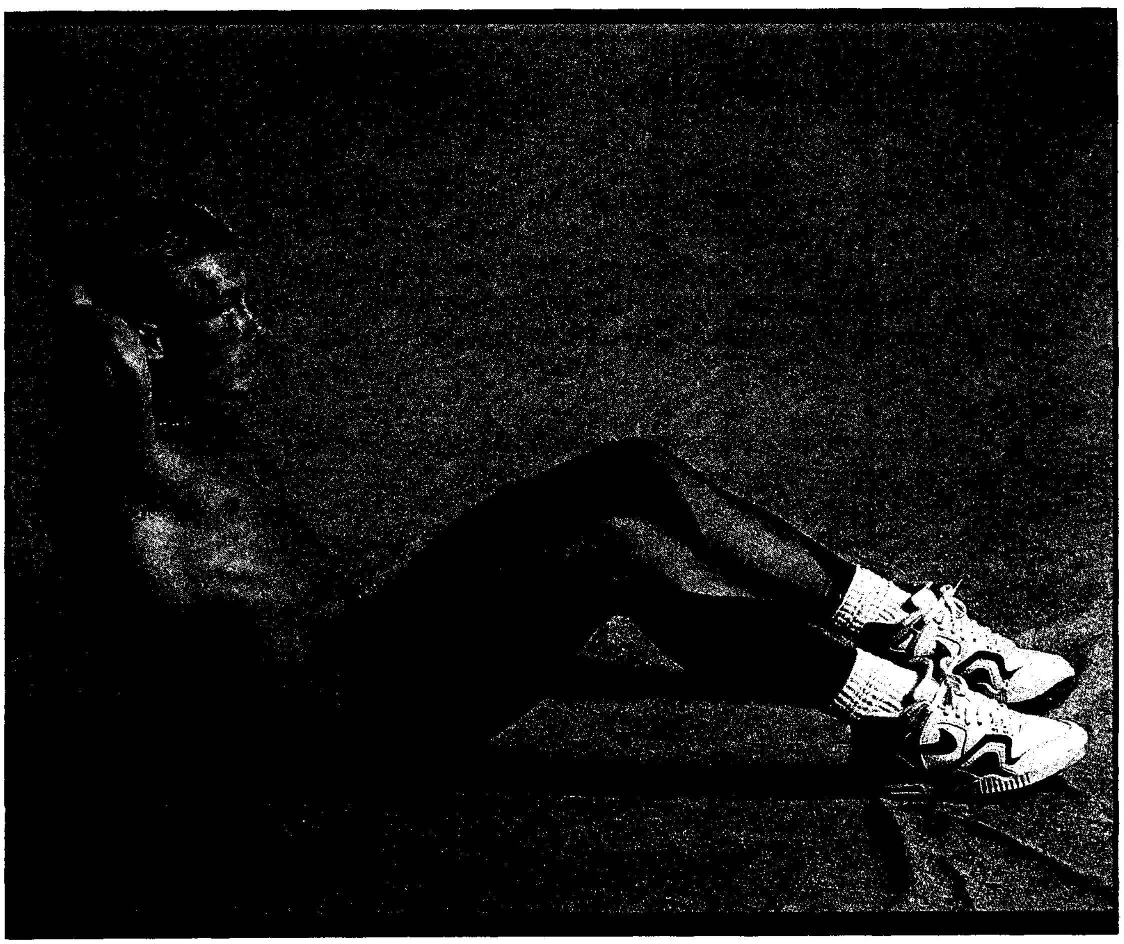
Alternate:
a pushing exercise
and then a pulling one

Push-ups with handle bars or dumb-bells	3 sets
Wide arm pull-ups	3 sets
Push-ups with feet up on a chair or higher	3 sets
Underhand chin-ups	3 sets
Dips	3 sets

➤ **Try wrestling, rope climbing, rowing, or even some yard work!**

CHAPTER FOURTEEN

Summary of training drills: their purpose and age specifity



Summary of training drills: their purpose and age specificity

A brief outline follows which summarizes the training drills referenced in this book. Their purpose is prioritized along with the ages for which they are appropriate.

The drills will be listed alphabetically in the following categories:

- Aerobic distance workouts
- Anaerobic/aerobic interval workouts
- Plyometrics (jumping, hopping exercises)
- Running Sprints (hills, flat surfaces)
- Skating drills (with or without weight vests or pucks)
- Skating-specific off-ice drills
- Weight training

AEROBIC DISTANCE WORKOUTS

BICYCLING
If bicycling is done as an aerobic endurance workout, it can be done in distances (45 minutes or more). Quadriceps, hamstring, and gluteal muscles are used, and some physiologists think bicycle workouts are more specific to skating muscles than jogging. Leg power is not improved much with distance work of any kind. Distance training is a low priority for young hockey players in comparison to activities designed to improve coordination, speed, agility, and skill.

JOGGING
45 minutes or more. Excellent for increasing aerobic endurance and reducing body fat. Does not improve power. Very low priority for young players; in fact, might be contraindicated because of potential cartillage damage to knee joints.

ROLLERS
Roller-blades (ultrawheels), slide boards should never be done for distances. Poor skating technique will be repeated enough to become permanent. See skating-specific off-ice drills.

SKATING
Never done for distance. Poor skating technique is being practiced after a few seconds.

Swimming
45 minutes or more. Increases aerobic endurance and reduces body fat.

➤ ANAEROBIC/AEROBIC INTERVAL WORKOUTS

HILLS

150-200 meter sprints, starting every two minutes (30:90 seconds). Improves leg power, anaerobic endurance, and if combined with a 45-60 minute workout will improve aerobic endurance. For faster, more intense intervals, start every three minutes, and the priority shifts toward power and anaerobic, rather than aerobic endurance. Tough anaerobic intervals are a very low priority for young players.

STEPS

Same as for hills. Low priority for younger players.

RUNNING

150-200 meters and start every two minutes (30:90 seconds) should improve leg power, anaerobic endurance, and if combined with a longer workout will improve aerobic endurance. For faster, more intense intervals, start every three minutes, and the priority shifts toward power and anaerobic, rather than aerobic endurance.

300-400 meters and start every three minutes (60:120) are more for endurance (combination of aerobic and anaerobic endurance) than for running speed or power. These intervals would be about as tough a workout as you could have, because there will be significant lactic acid. Not for younger players.

ROLLERS

See skating-specific workouts.

➤ PLYOMETRICS (JUMPING, HOPPING EXERCISES)

HOPPING

Exercises like the triple jump or other ballistic plyometrics done by track athletes for very quick, explosive recoil. Might be dangerous for young hockey players who haven't developed leg strength yet. For older players choose a soft surface like grass or a wrestling mat, but these might be a low priority for hockey players.

JUMPING

With or without vests, these jumping exercises will help develop powerful legs, the key to combining strength with speed. Emphasize knee bend well past 90° and maximum effort on the jump. Choose a soft surface like grass or a wrestling mat. Great way to develop leg power at any age; one of the highest priorities in developmental training.

➤ RUNNING SPRINTS (HILLS, FLAT SURFACES)

SPRINTING
The importance of sprinting has been grossly underestimated as a training tool for hockey. In combination with jumping and lower body strength training, this is by far the most important aspect of your off-ice program.

DOWNHILL
Down a slight decline (no more than 5%) sould be done for distances up to 40 meters for improving quick feet. This should be attempted only after weeks of sprinting on flat surfaces.

STARTS
Short (20-40 meter) sprints are done for explosive starts and quick feet.

ACCELERATIONS
40-100 meters are done for speed, and relaxing and lengthening strides.

UPHILL
Short (20-80 meters) are done for explosive strides and strengthening the muscles used in the recovery phase of sprinting and skating (hip flexors and groin muscles). High priority at every age.

Longer intervals on hills (20:100) or (20:160) develop great muscular endurance, challenging aerobic and anaerobic systems. Low priority for players under 16 or 17 years old.

PORT-A-PIT
Running in place on a mat (like a port-a-pit) is excellent for developing quicker feet, strengthening quadricep muscles, and strengthening the hip flexors (recovery phase of the skating and running stride). Low priority for players under 16 or 17 years old.

➤ SKATING-SPECIFIC OFF-ICE DRILLS (ROLLER SKATES, SLIDE BOARDS, SKATING MACHINES)

These are done to develop muscular endurance and habit in a range of motion with the knees bent well past 90°. Never done in distances, but should use intervals of about 40:80 seconds. Use a mirror or video tape to reinforce the intent of the drill. The object is to exaggerate the knee bend. These exercises are not used to develop strength (like weight training) or power (like jumping). A high priority for any player who can use more knee bend.

➤ SKATING DRILLS (WITH OR WITHOUT WEIGHT VESTS OR PUCKS)

SPRINTS
Without pucks, these intervals should emphasize over-speed effort around corners, especially. Use intervals of about 5-12 seconds, and start a new sprint every 60-75 seconds. Time the inter-

vals, so that players know there is a planned rest period. This is the highest training priority at every age. It is rare to find a group so skilled and so motivated that skating speed is improved while carrying pucks.

OVERLOAD
As the season progresses, and endurance is improved by the number and total time of workouts, you can add some overload sprints. These can be stops and starts or cornering drills as above, but the intervals will last up to 15-20 seconds, starting every 75 seconds. Endurance training on the ice is not important for players under high school age in comparison to developing skill, speed, and agility.

PUCKS
Carrying pucks and shooting at top speed, with passes and creativity added as long as the pace remains over-speed. Highest priority at every age, and the objective toward which all other training should focus.

VESTS
Exaggerate the knee bend around corners for intervals of 15:75 seconds up to 30:90 or 40:80 seconds. Not intended as much for endurance as to teach habit of greater knee bend by creating muscular endurance. These can be done without the vests. Don't worry about moving the feet quickly, just keep the knees bent. Use shorter intervals for younger players. Can be done at younger ages, but keep the weight at about 10-15% of body weight.

➤ WEIGHT TRAINING

In comparison to other methods of training for hockey, like sprinting, jumping, running hills, and playing other sports, weight training may have become over-rated in the past ten years. Improving skating and using strength on the ice are critical factors for every player, but we should never lose the perspective we are lifting to improve hockey skills. Lift with a purpose, and remember that purpose is different from body builders, Olympic lifters, and very often different from football players.

LOWER BODY
Strengthening the legs, stomach, back, and groin muscles is the most important of all activities in the weight room. I believe this is true for most sports, even though football coaches might disagree.

Before 14 years old, squats can be learned with a hockey stick. After puberty, and during the high school years, the weight is kept light, and lifts are done for technique, for stretch, muscular endurance, and developing a low center of gravity. At around 17 or 18 years old, players can use the hip sled or other machines to really overload fast-twitch fibers and develop great strength, but squats should not be done for this purpose until the athlete is over 20 years old, and has done them successfully for many years. Never compete with peers during lower body weight training.

For anyone trying to gain weight, the legs and gluteal muscles should be the target. Gains in upper body mass (even muscle mass) will raise your center of gravity and make it more difficult to skate with agility, so make sure that most of the weight gain is in your legs.

MIDLINE

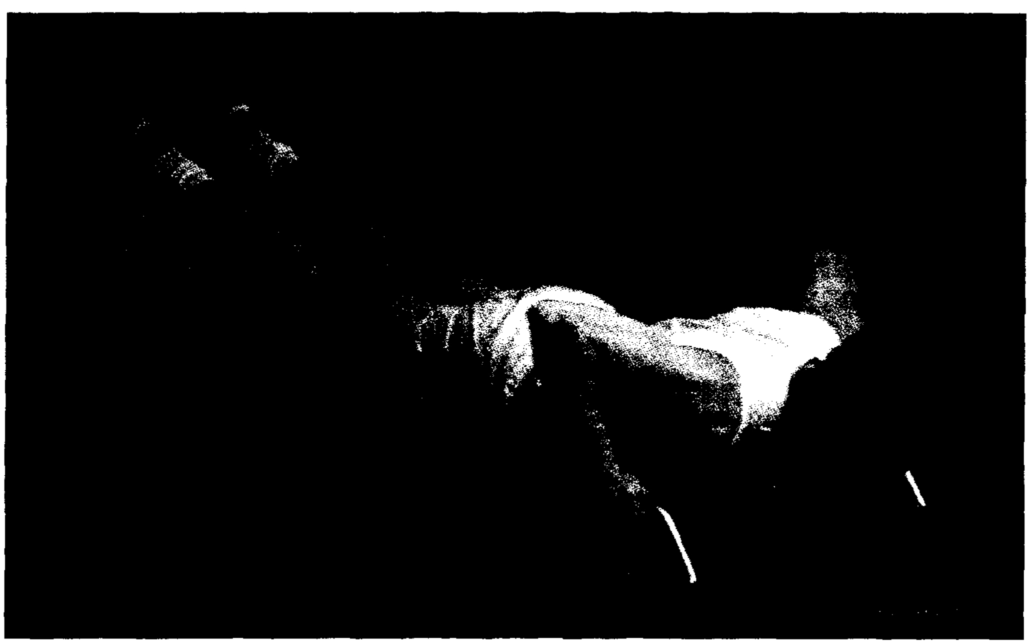
Many exercises using body weight or light weights are excellent for lower body strength. Sit-ups, hanging leg raisers and twisters, back extensors, jumping, one-legged squats, and split squats or lunges with light weight should be done with instruction and supervision at all ages.

UPPER BODY

This is an area that has grown out of perspective in many sports. The term 'workout' has become almost synonymous with the bench press and other upper body exercises. The bench press is a great lift, but hockey is played with the legs and the head. Upper body strength is valuable for building confidence, reducing injuries, and is involved in some aspects of play. Choose structural lifts (involving two or more joints) rather than isolating on one joint (like curls). For players who haven't reached puberty, strength training should be limited to handling your own body weight. At ages 13-15 upper body weight lifting should be done with light weights to learn proper technique.

Lift for functional strength, not for bulk, unless you are college age and have decided this is the way you want to make your living. For some players, adding weight is a priority, for most others it may be counter-productive. If college and pro scouts think you should be bigger, tell them you are.

For many, the value of training for upper body muscle mass has been grossly exaggerated in comparison to running, jumping, skating, and strengthening the legs. However, upper body strength without excessive mass is an asset to any player.



PROPER ◀ TECHNIQUE

Weights should be distributed over the arches of feet.

Chin and chest are straight ahead.

Back is locked in the same position as when standing, so there is a slight arch.

SQUATS

COMMON MISTAKES ▶

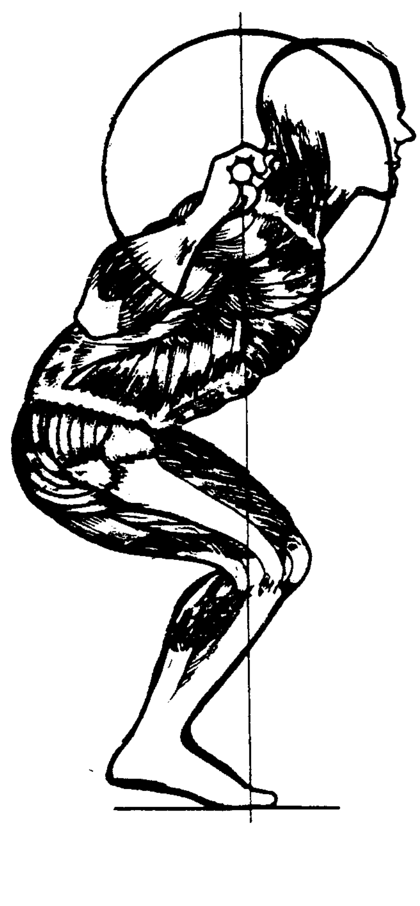
Bar resting too high on the neck.

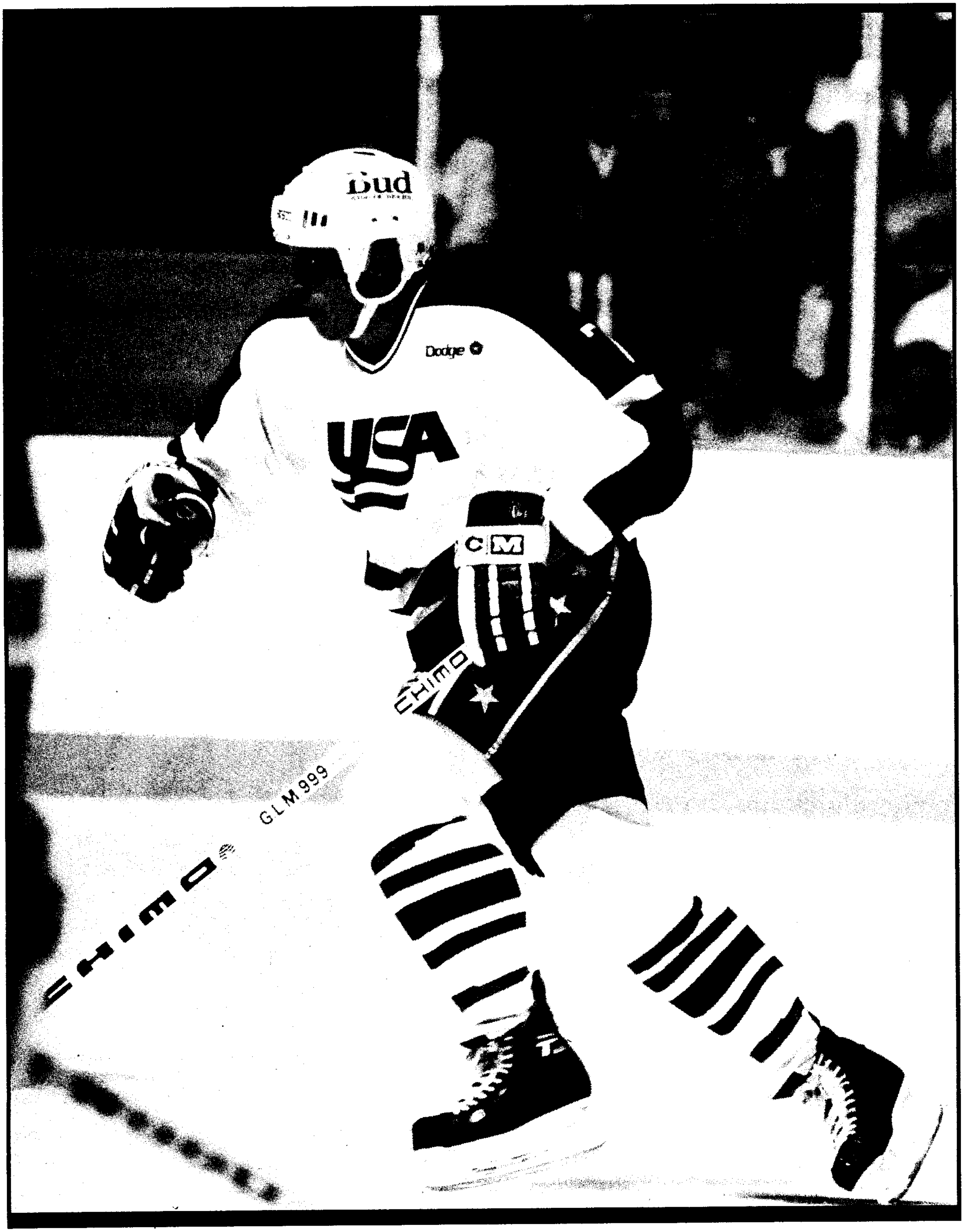
Weight too far forward over the balls and toes of the feet.

Heels are raised.

Back is *rounded,* rather than straight.

Buttocks remain higher than knees at bottom.

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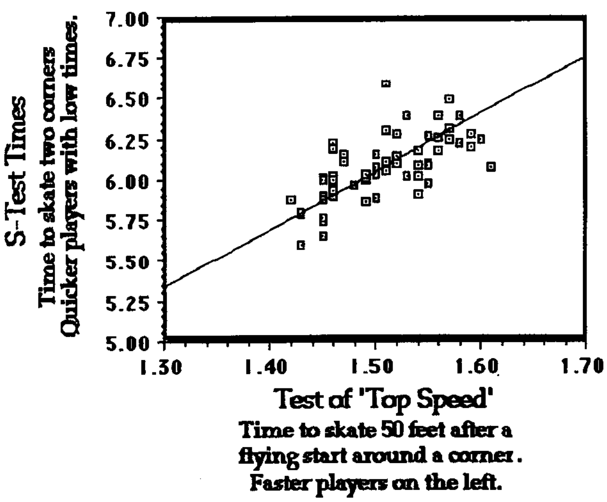
Elevating the comfort zone; a mathematical model.

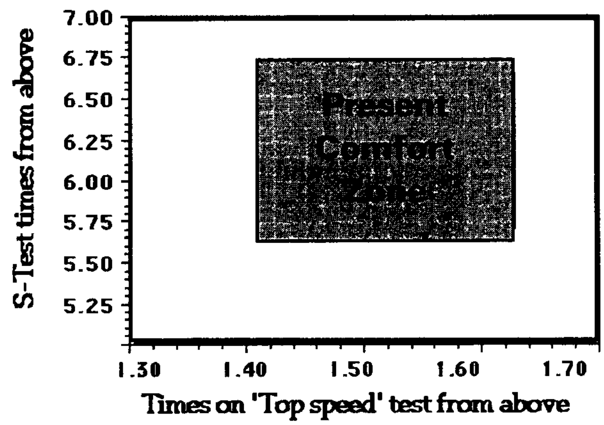
Elevating the comfort zone – a mathematical model.

The graph below shows results on two cornering tests for 75 players who tried out for the 1991-92 U.S. Olympic Team. The test of 'Top speed' requires one high speed corner prior to timing in the neutral zone for 50 feet, and the S-test includes two corners.

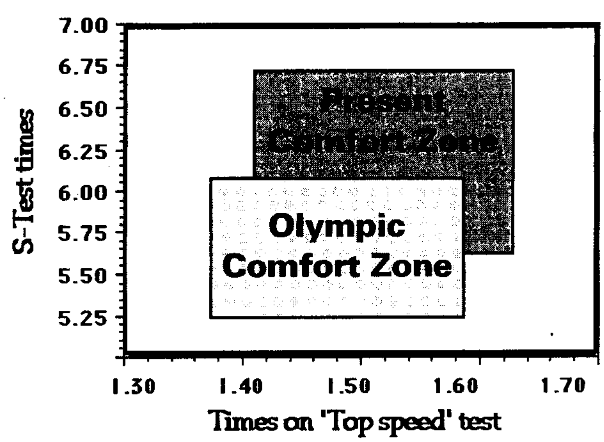
A rectangle drawn around the data points could be called: **'the present comfort zone of cornering skill.'**

By the end of the training season, previous Olympic teams skated corners at faster speed. Their results define the target comfort zone.





There are similar goals (but different numbers) for every team at every level.



How do we elevate the comfort zone for skating corners?

These are the BUILDING BLOCKS.

a. Off-ice sprint training for quick feet;

b. Sprints uphill for power, downhill for quicker strides;

c. Plyometrics for deeper knee bend and explosive power;

d. Slide board and roller skating intervals for muscular endurance with exaggerated knee bend — training for a low center of gravity;

e. Squats and hip sled to strengthen the legs, challenging fast-twitch fibers;

f. Reduction of excess weight (body fat) to reduce centrifugal force on corners;

g. Distance work and interval training off-ice for general (non-specific) endurance;

h. On-ice instruction and repetition of skills at a comfortable speed;

i. On-ice over-speed intervals around corners with and without pucks;

j. On-ice intervals with weight vests to exaggerate knee bend (form new habits);

k. Over-speed practices for the length of a game, twice a week, over the entire season. This builds 'hockey-specific endurance.'

The incorporation of these building blocks throughout a well planned year prepares a team to play in the 'Olympic Comfort Zone' every shift of an entire game.

Alphabetical Glossary

Alphabetical glossary of terms

Aerobic literally means 'with oxygen.' Aerobic metabolism is the supply of energy for long, submaximal work by chemical reactions between oxygen and fuels like glucose and fats that are carried by the blood. When a person walks, jogs, bikes, or swims for many minutes (or even hours) the heart, lungs, and blood vessels supply oxygen fast enough to keep up with the pace. Dissipation of heat and removal of waste products like CO_2 and water are also functions of the heart, lungs, blood, and sweat glands.

A high **aerobic capacity** helps a hockey player compete or practice at a higher intensity without relying heavily on anaerobic metabolism. Aerobic capacity can be raised by distance work or by interval training, but interval training is too stressful to maintain over the entire twelve months.

Aerobic capacity is highly related to endurance for distance events. In the laboratory, this can be measured in several ways:

VO_2 Max is the maximum volume of oxygen a person is capable of using in one minute of exercise. Usually, during a progressive treadmill or bicycle test, a subject will reach this maximum before having to stop. Often the subject continues to higher levels of work while oxygen consumption levels off. For this reason, VO_2 max is easily identified as the peak point and is a reliable (and somewhat valid) indicator of a person's endurance capacity.

Anaerobic threshold is the point during progressive work where lactic acid starts to build up disproportionately fast in the muscles. Another way to describe it is the level of work above which lactic acid accumulates rapidly, and below which lactic acid does not accumulate substantially in the blood. It is often associated with increased blood lactate, hyperventillation, and perceived discomfort.

Oxygen uptake kinetics is the exponential rate at which oxygen uptake adjusts to a sudden workload. Note: at the beginning of exercise (and often in anticipation) the heart and breathing rates increase immediately, because of input from the nervous system. However, the metabolic machinery is not as responsive, because these chemical reactions are driven by the heat from exercise, by concentrations of accumulating end products (like CO_2, ADP, lactic acid, or many other intermediates), or by deficits in chemicals like ATP or oxygen. Furthermore, enzymes are 'turned on' by these same factors and by other circulating hormones released during exercise. Therefore, the utilization of oxygen at the tissue level (measured by the amount of oxygen taken out of the air as you breathe) rises gradually (in 40-80 seconds) to equal the demand of the given workload.

Oxygen deficit: Since the metabolic adjustment at the beginning of work is not immediate, but the energy demand is, there is an energy deficit being built up which must be repaid later as an oxygen debt. Like any debt, the cost at a later time is greater than the actual expenditure.

Oxygen debt is the repayment (after exercise ends) of the energy deficit built up during exercise. From the discussion on anaerobic metabolism, it is observed, that the workload is met only partially by aerobic processes, but also by the breakdown of **ATP, CP,** and **glycogen** and results in the buildup of creatine and lactic acid. These fuels must be returned to pre-exercise levels, and this process requires energy, usually keeping the oxygen uptake levels above the basal rate for 10-30 minutes.

Anaerobic literally means 'without oxygen.' When a player exercises nearly all out (above his anaerobic threshold), the heart lungs, and blood vessels can no longer supply oxygen or remove waste products fast enough for the energy demands. The energy (over and above that supplied aerobically) comes from chemical conversion (without oxygen) of fuels stored in the muscle.

Alactic anaerobic metabolism is the conversion of **high energy phosphates** for a very brief, explosive workload, such as a 5-10 second sprint or strength effort. **ATP** (adenosine triphosphate) supplies the energy for muscular contraction and all other cell activities by splitting off one of its phosphates in a chemical reaction which liberates a great deal of energy. Since ATP levels must be (and generally are) kept constant, creatine phosphate (**CP**) will donate its phosphate to adenosine **di**phosphate. The measurement of this ability is sometimes called **anaerobic power** and is determined by how explosively an athlete can perform for a short effort.

Glycolytic metabolism (glycolysis) is the conversion of muscle glycogen (glucose) to **lactic acid** in the absence of oxygen. This releases energy to re-supply the ATP stores. However, the increased acidity eventually prevents effective muscle contraction, limiting all-out effort to 20-40 seconds. After that point, coordination, speed, and strength are adversely effected. Interval training (eg: 40:80 seconds) would allow players to eventually function better and longer with acid buildup during a very intense shift. The measurement of this ability is called **anaerobic endurance**. Continuing these anaerobic intervals for the length of a game or practice leads to more and more lactic acid buildup and eventually depletes muscle glycogen stores.

ATP (adenosine triphosphate) is the body's energy currency. In its chemical bonds, it stores energy for all of the processes of life like muscle contraction and relaxation, and supporting cell growth, integrity, and duplication, maintaining electrical potentials, and pumping certain molecules in and out of cells. For any reaction requiring energy, one phosphate is split off from ATP. If an athlete has trained for power, his muscles will have more enzymes to make the muscle contract and use ATP faster. They should also have more enzymes to re-supply the ATP either by aerobic or anaerobic metabolism.

CP (creatine phosphate) is the most immediate source of replacement of the phosphate to ADP (adenosine diphosphate) to convert it back to ATP. Powerful sprinters or weightlifters, whose performance lasts only a few seconds, have more of the enzymes (creatine phosphokinase) that aid in this reaction.

Capillaries are the smallest blood vessels, whose diameter allows red blood cells through in single file. Capillaries are intermediate between arteries and veins, and are the place for exchange of water, oxygen, fuels, waste products, and any other molecules from the blood to other tissue (such as muscle tissue).

From training (for as little as a few days) the microscope can detect an increase in capillary density around those muscle fibers that have been working aerobically.

Cardiovascular refers to the heart and vessels. Very often this term is over-used to describe aerobic training and its benefits, but this term does not acknowledge the beneficial changes in the lungs, blood, and muscle.

Cholesterol is a ring shaped molecule manufactured in the body for vital purposes such as in the composition of cell membranes and as a building block for physiological hormones. It is also manufactured by the body to line the arteries in areas where they have been damaged by nicotine, high blood pressure, or other trauma. This is where cholesterol gets its bad reputation, because it is part of the plaque which builds up and narrows the arteries over time. Don't be fooled by advertisements which claim that a food product has no cholesterol. If the food is rich in saturated fats, it leads to an increase in blood cholesterol, and this is one of the potent risk factors for future vascular disease.

Enzymes are the large proteins which facilitate chemical reactions within the body. Enzymes are not 'used up' or 'broken down' in the process, and are therefore, not part of the chemical reaction as either a product or reactant. However, they speed up the reaction by bringing the reactants (fuels) together, repositioning them, even changing their shape, so the chemicals will react more readily.

Fat as a fuel in the body is in the form of **tri-glyceride**, a molecule that contains glycerin and three long carbon chains called fatty acids.

Glucose is the six carbon sugar of the blood. It is used for energy supply to the brain, to muscles, and to other active organs.

Glycogen is the storage form of glucose within cells (like the liver and muscles). Many molecules of glucose are chemically bonded together to form glycogen, and when the cell needs energy, the first step is to split each glucose molecule away from glycogen.

Metabolism is the conversion of chemicals within the body to supply energy. See also **aerobic** and **anaerobic** metabolism.

Mitochondria are small bodies (organelles) within a cell. These are often called the 'powerhouse' of the cell, because this is where aerobic energy metabolism takes place. Mitochondria contain all the enzymes of the Krebs citric acid cycle and of the electron transport chain. After several weeks of aerobic training, the slow twitch (and fast twitch intermediate) fibers contain more mitochondria, giving the muscle fiber greater capacity to exchange oxygen and fuels for energy.

Muscle fibers are long, thin muscle cells which have the ability to contract and relax when they are electrically stimulated by nerve impulses or when they are stretched. Energy for contraction is stored in several chemical forms (each one is discussed in this glossary): ATP, CP, fat, protein, glucose, and glycogen.

Any muscle is composed of several fibers, up to thousands of fibers in the large muscles of the leg. Fibers contract all-out when stimulated by the nerve. That is, no fiber is capable of making progressively stronger contractions. The two ways a muscle can contract with varying strength is to either fire more of these fibers or have each one contract more often.

There are two distinct types of muscle fibers, categorized by the speed at which they can contract and relax.

Fast twitch fibers contract very rapidly and powerfully when stimulated. They have a high concentration of enzymes to split ATP for contraction and replace the ATP quickly through anaerobic metabolism. Because they contain fewer mitochondria, fewer enzymes of aerobic metabolism, and are surrounded by fewer capillaries, fast twitch fibers are more easily fatigued.

Fast twitch glycolytic fibers are the powerful fibers of sprinters and weight lifters. These fibers appear more pale than slow twitch fibers. In some animals, certain muscles are composed almost entirely of fast twitch fibers, like the white meat of turkeys or chickens. These are powerful muscles with little endurance, like domestic chicken breasts which are not used for long flight. Wild ducks or geese, on the other hand, have darker red breasts, because they are the muscles of endurance flights. In humans most muscles are heterogeneous, having a combination of fast and slow twitch fibers. Most physiologists think the overall percentage of each type in a human is determined genetically. However, there is evidence that different training regimes might change the relative makeup.

Fast twitch intermediate fibers have some of the best characteristics of fast and slow fibers. Probably as a result of rigorous training, these fast twitch fibers are large, powerful, and quick, but have great endurance as well. Intermediate fibers appear more reddish because they are surrounded by many capillaries and because they have more **myoglobin**, the chemical which binds or stores oxygen in the muscle and appears red (because of the combination of iron and oxygen).

Slow twitch fibers are smaller in diameter and contract more slowly and with less force than fast twitch. Long distance runners usually have a greater percentage of these than power athletes. Hockey players, and the average person have about 50% of each type. The endurance of a slow twitch fiber results from greater blood supply, more mitochondria, along with an enzyme profile opposite to fast twitch fibers. Any one nerve axon supplies several fibers, all of the same type. A nerve together with all its fibers is called a **motor unit**.

Neuromuscular refers to all the interractions between nerves and muscles.

Plyometrics are jumping or hopping exercises, whose purpose is to train with great force in an explosive manner. There are two components to train. When any muscle is stretched, it actively contracts against the stretch because of a neuromuscular reflex. This is the same stretch reflex that is observed when the doctor taps your patellar tendon, stretching the quadriceps muscle, causing it to contract quickly. The second component is the strengthening of tendons and connective tissue surrounding muscles. These function like a rubber band or spring during jumping. The more training the stronger the spring.

Sports sciences mentioned in this book:

Biomechanics deals with the physics of motion of the entire body or the relative motion of individual limbs. Two branches of physics (mechanics and kinetics) describe these motions in terms of distance-time relationships like velocity and acceleration or force-time relationships like force, torque, work, and power.

Physiology is the study of how the body works on the cellular level. On a larger scale, physiology describes the function of various organs and how they work together to support life and react to stress, such as exercise. Biochemistry includes the description of all the chemical reactions within the body, such as those dealing with energy metabolism, electro-chemical signals, or the breakdown or construction of substances involved in cell structure or regulation. Biophysics, unlike biomechanics, deals with other areas of physics such as electricity, hydrostatic and osmotic pressure, and the flow of water and particles through vessels and leaky membranes.

Statistics and abbreviations used in this text:

Correlation (Pearson product-moment correlation in this text) is simply a number, r, which expresses the degree to which two variables are related, the extent to which one could be predicted from the other variable. The value of **r is zero** if there is no relationship at all. On the other hand, **r is 1 or -1** if the value of one variable is predictable, simply by knowing the value of the other variable. In this case, the x,y graph of these two variables is a straight line.

Regression equation for two variables is the equation of the straight line which best fits the data or best describes the relationship between the two variables.

T-test (Student's t-test) in this text is an expression for the probability, p, that two group means (A and B) are truly different. For example: to say that research results showed that A was greater than B and **p<.01**, means that if we continued to randomly compare groups from A against groups from B, the probability is greater than 99% that we would continue to get the same result, that A>B.

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To the coach and youth program... the cost of development:

If we want a skillful game for the future of ice hockey, — and if we are genuinely interested in the development of players, for whom we work:

➤ Like the Soviet youth program, we must emphasize development of skills and athleticism, even if it costs us some early wins. Soviet hockey offers the best development model in all of sport, but we aren't listening. Their national teams have dominated the international game more decisively, and for a longer time than any team in any sport in history.

They play a style of game we only dream of: passing, skating, and making creative plays; long breakouts, regrouping, and keeping the puck from opponents. Furthermore, they've done it by the rule book.

Like Japanese business, the Soviets have planned their development many years in advance. When they first started playing hockey, they were not interested in a 'quick fix approach.' Nor were they interested in the occasional 'miracle win.' They wanted their national teams to dominate consistently, so they prepared their youth.

The Soviets have stuck with long-term values rather than short-term wins. They develop skills and athleticism rather than winning records of their youth coaches.

Because no athletic program in our continent has ever approached development in this way, no one has ever dominated a sport for as long as the Soviets. We seem to be driven by the immediate needs of parents, coaches, and spectators, rather than the long-range interests of our young players.

➤ If we want a skillful game, we must protect the rule book.

There is no question a pee wee, bantam, or high school team could find early success by employing the illegal defensive styles of our North American college and professional role models. We could insist that 12 year-olds interfere with their check and we could call it, "good, sound defense." But the only 'winner' in this situation is the coach — not the player and not the game of hockey.

We must encourage officials to interpret the rules as they are written. We also have to oppose those coaches who bend the rules to fit team weaknesses. If they want the rules to be interpreted differently, they should state so publicly and work to have them changed.

➤ If we want skillful hockey we must have patience with mistakes in practices and games. We have to encourage players to try anything and allow them to fail.

➤ If we want creative hockey we must give the game back to the players. They may just come up with something we hadn't thought of. Overly-structured hockey will not develop another Wayne Gretzky. For the sake of the game, let's hope there is a coach somewhere whose ego allows the growth of the next young genius.

➤ The goal of the greatest educators is to help students get to the point where they no longer need the teacher.

To the aspiring player... the cost of development:

If you dream of the Olympics, of playing college or even pro hockey, — or if your immediate focus is to improve skills and help your team:

➤ Eric Heiden's workouts consisted of speed-skating, weight lifting, plyometrics, weighted jumps, bicycling, isometric wall sits, slideboard intervals, sprinting, running hills, and skate-walking an entire golf course with bent knees while carrying a weight vest on his back. Winning every event from short sprints to long distances seems like a physiological impossibility, except, perhaps to those who watched him train.

➤ A gold medalist, record breaking heptathlete gets up at 5 AM to run hills and lift weights, returns in the afternoon for a 2 hour workout of sprints and plyometrics.

➤ A wrestler runs and lifts in the morning, comes back for a two hour workout in the afternoon, and goes home to a strict diet in order to make weight.

➤ A gymnast works out twice a day for five hours, six to seven days a week, twelve months of the year. When you see him or her perform, the routine has probably been practiced 2500 times — and failed 1000 times.

➤ A marathoner runs 150 miles a week; a bicyclist pedals 25,000 miles a year.

➤ Eighteen years after winning seven gold medals, 41 year-old Mark Spitz is making a comeback by swimming five hours a day, followed by weight training and the most intense dry land workouts of his life.

➤ A German figure skater works out for hours on ice, lifts weights, and practices ballet. In competition she doesn't need a superhuman effort to win a gold medal. She's performing within the comfort zone she established over countless hours.

➤ The hockey player whose leg workouts were photographed for this book, dedicated two off-seasons to gaining weight, sprinting, and skating quicker. In that time he gained 26 pounds of muscle (mostly in the legs), reduced body fat to 3%, and improved his skating from average college speed to the top 10% of all players tested. His time on the forty yard dash went from 4.95 seconds to 4.56. Five hour leg workouts included sets of 15 squats with 400 pounds, hip sled with 800 pounds. Some, who didn't know him asked if these gains might have been aided by steroids. Anyone who watched him sprint hills, do plyometrics, and lift for five hours knew the answer was hard work and a good diet — cutting corners was never considered.

➤ One hockey player trained for weeks in the mountains just to prepare for the U.S. hockey team tryouts at altitude. He and others with similar commitment won the gold medal in 1980, an event journalists refer to as 'a miracle.' The players and coach call it the result of work ethic and team spirit. After a three year retirement to coaching, John Harrington decided to dust off the skates and work ethic and try out for the 1984 team. He became a leader on that team as well.