TO:1984 NA WAHINE O KE KAI CREW AND SUPPORT CREW

FROM: LAURA

SUBJECT: RE-CAP OF MOLO ARRANGEMENTS

Thanks for all of your info and imput. This is what it all comes out to -- pls. fill in blanks, make corrections, comments.

Friday, September 28 -

@ 9:40 a.m. to Molokai via Hawaiian Air
Pinky, Laura, Bob, Lana, 2 paddlers (Pls. give me names of those paddlers and any others who are going on Friday. Indicate if they want me to make air and Ke Nani Kai reservations, or will they do own?)
Pick up Annie's truck @ airport. Fetch blue truck. Shop. Check in at Ke Nani Kai. Snack lunch. To Lono and unload canoe. Bruce, Patrick and Terry will come up on radon. Dinner @ Ke Nani Kai (room #151) 7:00-ish.

Unit #151 Pinky, Laura, Bob,
#149 3 crew
(We have bed space for six more. Need names.)

Saturday, September 29

Breakfast about 8:00 in #151.
Meet RHAS plane @ 9:30. Pick up: Denise, Sue, Lindsey, Sharon, Pauahi, Sandy, Marion, Malia, Maril and Renee.
To Ke Nani Kai and Hale O Lono to rig, etc. Lunch wherever we are around noon. Return with Bruce, Patrick and Terry.
5:00 p.m. Coaches/officials meeting. Sheraton.
6:00 p.m. Hui Nalu dinner @ #151

Unit #151 Pinky, Laura, Bob, Terry, Bruce, Patrick
149 6 paddlers
146 6 paddlers
157 Myron, Sakura, 2 alternates, 2 extras

Sunday, September 30

4:30 a.m. Breakfast
5:30 a.m. Leave for Hale O Lono
Blue Truck: Pinky, Bruce, Terry, eight paddlers
Annie's Truck: Pat, Myron, Bob, Sakura, Maril, Renee, Patrick
Station Wagon: Laura, 6 paddlers

SEE YOU AT FORT DE RUSSY -- IN GOLD.

ESCORT BOAT SUPPLY PREPARATION

LOGISTICAL PLAN

NAME OF RACE___________________

DATE________________

I. Coordinator_________________________

II. Basic Information

A. No. of canoes_________

B. No. of paddlers__________

C. No. of escort boats_________

D. Total time for race__________

E. No. of changes per crew__________

F. No. of gallons of fluid required per crew__________

1. Formula - 8 oz. of fluid is required per paddler per change

____

Divide by 128 oz. per gallon = ___________________

Rounded__________________

2. Distribution

a. No. of gallons of water per crew__________________

b. No. of gallons of squincher per crew______________

c. Cases of apple juice_____________________

III. Equipment needed per _________________crews

A. Coolers

1. Medium__________

2. 48 qt. orange__________

B. Gallon bottles_________

C. Quart bottles_________

D. Squincher concentrate_________

E. Apple juice_________

F. Ice - as needed

IV. Process--By_________________________

A. Fill _________gals. of water

B. Fill__________qts. of water

C. Fill__________cups of water

D. Fill__________gals of squincher

E. Fill__________qts. of squincher

F. Fill__________cups of squincher

	Yellow Cooler	Orange Cooler
a. gals. of water		
b. qts. of water		
c. pts. of water		
d. gals. of squincher		
e. qts. of squincher		
f. pts. of squincher		
g. cs. of apple juice		

G. Place coolers on available escort boats ______________and ice down with drain open.

H. Race day repack ice at __________ a.m.

V. Additional remarks:

MOLOKAI RACE

ESCORT BOAT COMMITTEE

CHECK LIST

1. Attached is the sailing schedule for each of the two races, Women and Men.

2. Herman Clark will coordinate shipment of Canoes to Molokai. He will work with Bob Harbold. Herman to meet with Bob on September 19th.

3. Womens' Race Committee.

   Tommy Conners, Jim O'Hara, Art Messeran, Bob Harbold, etc. to meet at Hawaii Yacht Club at 1200 Tuesday, September 20th.

4. Mens' Race Committee.

   Kala, Jim O'Hara, Bob Harbold, etc. to meet on October 4 at 1200 hours Hawaii Yacht Club.

HUI NALU CANOE CLUB

MOLOKAI RACE ESCORT BOAT COMMITTEE

September ~~13, 1983~~ 1986

I. WAHINE RACE

A) Escort Boats — Skippers - HN Rep.

1) ~~Maálea~~ — ~~Jim O'Hara Art~~

2)

B) Catch Boats — Skippers - Deckhand

1) ~~Radon~~ — ~~Jim Shizuru Tommy Conners~~

2)

Sept. 28

C) Date of departure, Oahu, for Molokai:
Sept. 24 Saturday - Maalea departs Ala Wai 0700
Sept. 24 Saturday - Radon departs Ala Wai 0800
Starting times, Molokai:
0700 Sunday 25th Boats to be out of Harbor and on station by 0630.

D) Members on board:
1) Escort Boats
a. ~~1~~ ~~To Molokai~~ Escort 1
1. To molo Jonathan
Art
+ 2
2. From molo

b. ~~2~~ ~~From Molokai~~ Escort 2
1. To molo Jonathan
Bob Harbold
Diane
~~Plus 5~~
2. From molo Art

E) Special Instructions:

* Load 400 lbs of ice to Maalea on Friday - Jim O'Hara to coordinate.

I. Wahine Race (cont'd)

F) Sailing Route:

Tommy Conners will set course prior departure from Molokai

G) Clean-up of boats:

H) Costs:

II. MEN'S RACE

A) Escort Boats — Skippers - HN Rep.

1) Maalea — Jim O'Hara, Bob Harbold, Bob Rocheleau

2) Sisu

B) Catch Boats — Skippers - Deckhand

1) Radon — Jim Shizuru

2) Pinky and Kala to arrange

C) Date of departure, Oahu, for Molokai:
Maalea - 0700 October 8 from Ala Wai
Radon - 0800 October 8 from Hawaii-Kai
Starting times, Molokai:

0700 October 9 Sunday
Boats to be on station outside Harbor by 0630.

II. Men's Race (cont'd)

D) Members on board:

1) To Molokai

Jonathan
Rey Jonsson
+ 3 Hui Nalu

2) From Molokai

Jonathan	Diane
Rey Jonsson	+ 1 Hui Nalu
Kathy Raphael	
Bob Harbold	

E) Special Instructions:

400 lbs of Ice to be loaded to Maalea on Friday October 7.
Get a new Flag.

F) Sailing Route:

As set by Kala

G) Clean-up of boats:

H) Costs:

ARJ:rhk
09.13.83

HUI NALU

RACE EQUIPMENT

CHECK LIST - REGATTA

I. CANOE EQUIPMENT

		Koa		Fiber Glass
A.	Canoes	Koa ☐		Fiber Glass ☐
B.	Ama	☐		☐
C.	Iako (2)	☐	(2)	☐
D.	Buckets w/r (2)	☐	(2)	☐
E.	Tie Cords 2 @ 36'	☐	2 @ 36'	☐
	2 @ 60'	☐	2 @ 60'	☐
F.	Rubber Ties 2 @ 2"	☐	2 @ 2"	☐
	2 @ 1"	☐	2 @ 1"	☐
G.	Blocks	☐		☐
H.	Covers	Koa ☐		☐

II. TOOLS

A.	Hammer	☐	Paddle Rack	☐
B.	Hand Drill & Drills	☐		
C.	Screw Drivers	☐		
D.	Pliers	☐		
E.	Hack Saw	☐		
F.	Saw	☐		
G.	Tool Box	☐		

III. TENT

A.	Cover	☐
B.	Poles	☐
C.	Rubber Ties	☐
D.	Nails	☐
E.	Flag Pole	☐
F.	Flag	☐
G.	Tie Ropes	☐

Sample

ESCORT BOAT SUPPLY PREPARATION

LOGISTICAL PLAN

NAME OF RACE Womens Molokai

DATE ________________

I. Coordinator ________________

II. Basic Information

A. No. of canoes 1

B. No. of paddlers 12

C. No. of escort boats 2

D. Total time for race 6 1/2

E. No. of changes per crew 13

F. No. of gallons of fluid required per crew ______

1. Formula - 8 oz. of fluid is required per paddler per change

8 x 12 = 96 x 13 = 1248 oz

Divide by 128 oz. per gallon = 10

Rounded 10 of water — Take 12

2. Distribution

a. No. of gallons of water per crew 10 or 178 cups of Lifeguard

b. No. of gallons of squincher per crew ______ ~~90 water~~

c. Cases of apple juice 1 1/2 ~~90 juice~~.

III. Equipment needed per ______ crews

A. Coolers

1. Medium 2

2. 48 qt. orange _____

B. Gallon bottles ______

C. Quart bottles ______

D. Squincher concentrate 180 cups

E. Apple juice 1 1/2

F. Ice - as needed

IV. Process - By Day Before Race — put two gallons of extra water.

A. Fill 2 gals. of water

B. Fill _____ qts. of water

C. Fill 90 ~~pints~~ cups of water

1 hr 3 changes. 6 cups per ~~[illegible]~~
54 cups per [illegible] of 9

2 hrs	108
3 hrs	162
4 "	216
5	270
6	324

D. Fill_____gals. of squincher

E. Fill_____qts. of squincher

F. Fill 90 ~~pints~~ cus. of squincher

1. Yellow cooler

a. ______gallons of water

b. ______quarts of water

c. ______pints of water

d. ______gallons of squincher

e. ______ quarts of squincher

f. ______pints of squincher

g. ______cs. of apple juice

2. Orange cooler

a. ______gallons of water

b. ______quarts of water

c. ______pints of water

d. ______gallons of squincher

e. ______quarts of squincher

f. ______pints of squincher

g. ______cs. of apple juice

G. Place coolers on available escort boats Nite Before and ice down with drain open.

H. Race day repack ice at _______a.m.

V. Additional remarks.

TRANS-OCEAN PASSAGES ON-BOARD Hokuleʻa

1976

June 15 - July 1 - Sailing within Society Islands of French Polynesia

July 4 - July 26 - Tahiti to Hawaii

1980

March 15 - April 17 - Hawaii to Tahiti

May 14 - June 7 - Tahiti to Hawaii

1985

July 10 - Aug 12 - Hawaii to Tahiti

Aug 31 - Sept. 16 - Tahiti to Rarotonga

Nov. 21 - Dec. 8 - Rarotonga to New Zealand

1986

April 21 - May 24 - New Zealand to Samoa

Passages to be completed!

1986 (June - Sept.)

Samoa to Rarotonga

Rarotonga to Tahiti

1987 (April - June)

Tahiti - Marquesas

Marquesas - Hawaii

UNIT XIII Muscle Physiology
PART IV - Other Considerations: Muscle Soreness, Efficiency, Speed, Flexibility

I. Muscle Soreness -

A. Overexertion results in pain - which may develop several hours after the work and continue for several days.

B. Is thought to arise from the incomplete removal of metabolic wastes — that were toxic to the muscle and nerve endings.

C. Increased fluid accumulation causing swelling might sensitize the nerve endings.

D. Increased pressure would hamper blood flow thus prolong the pain.

E. Asmussen showed that negative work, the metabolism of which is 5 to 7 times less than that of positive work, caused the highest degree of soreness therefore soreness occurs most often as a result of negative work. The soreness evidently caused by a mechanical pull exerted by muscle fibers on intramuscular connective tissue.

Explanation - during negative work (eccentric contractions) muscle fibers lengthen and increase their tension and the number of participating fibers decrease. The result is a greater pull by each fiber on the connective tissue. It is postulated that this excessive pull traumatizes connective tissue, and local edema develops, causing pain.

Note: the issue is not settled.

II. Efficiency of Muscular Activity

A. Definition - Efficiency = $\frac{\text{work output}}{\text{work input}}$

B. Machine efficiencies
   1. Steam engine - 10-20%
   2. Gas engines - 20-30%
   3. Electric motors - 80-90%
   4. Man - 10% to 30 or even 40%

C. The longer the performance the greater need for efficiency.

D. Anaerobic is less than ½ as efficient as aerobic

E. Efficiency and Speed -

   1. Sargent showed - O_2 consumption increases as the 3.8 power of speed. i.e. when speed is doubled O_2 consumption increases almost 16 times. This means a tremendous loss of efficiency as speed doubles. Pace theories - efficient distribution of energy - have been built upon this data.

   2. Recent work shows - at rates of speed at which no O_2 debt occurs the rate of energy increase is only proportional to increases in speed. Thus for aerobic activities efficiency remains constant. Efficiency remains constant as long as the steady state can be maintained.

   3. Efficiency of Running is individualized - one person can perform the same work at the same rate with less energy expenditure. Probably associated with the energy lost from inefficient acceleration and deceleration of body parts

   4. Walking - most efficient at 2.4 m.p.h. or 4 Km. per Hr.

   5. Fatigue and Efficiency - as fatigue increases efficiency decreases. This results from increased motor unit recruitment to do the same work; greater recruitment should result in greater energy consumption.

   6. Diet and Efficiency of muscular work -
      a. Fat metabolism produces more energy at low work levels
      b. At higher work levels the energy source is predominantly carbohydrates

   7. Environment and Efficiency
      a. As temperature increases the metabolic rate increases - mild work done in 100° F temp. required 13.3% higher metabolic rate than at 85° F.
      b. Decreased efficiency is due to heat load demands on circulatory system to cool the body.

8. Obesity and Efficiency - The obese require considerable (30% +) more energy to perform the same task.

9. Acceleration - Deceleration versus smooth movement.
   a. Swimmers - the inexperienced swimmer and divers use 40% and more energy than the experienced did.

F. Pace and Efficiency -

1. The most efficient and least demanding pace appears to be the steady pace.

2. Fast-slow paces are effective psychologically but create greater physiological demands on the runner.

3. It seems wisest to run races which encounter high O_2 debts at a pace which delays the O_2 debt until late in the race.

4. This subject is still the center of some interesting research and hopefully further investigation will clarify it.

G. Efficiency of positive and negative work -

1. Positive work - contraction that provides force through a distance (concentric)

2. Negative work - muscle lengthens during contraction (eccentric)

3. Deception occurs when you compare lifting a 100# weight and lowering the same weight slowly or rapidly so gravity does all the work.

4. For more standardized work bouts it is clear that positive work requires three to 9 times as much energy as negative work.

H. Principles for improving efficiency -

1. Eliminate undesirable movements
2. Reduce or eliminate unnecessary muscle activity
3. Make movements in the proper direction
4. Use only the necessary power
5. Use muscles best suited for the activity - lifting as an example
6. Use optimum speed
7. Improve condition - thereby work at a reduced percentage of maximal decreases anaerobisis and delays fatigue.
8. Avoid costly acceleration - constant pace
9. Use high carbohydrate, low fat, normal protein diet. (60-35-15%)

III. Speed - an important factor in athletics

A. Speed - is the result of applying force to a mass.

B. Speed - implies movement at a constant rate.

C. Constant movement requires driving force to equal the resisting forces

D. Speed may be improved by increasing either the driving forces (positive factors) or decreasing the resisting factors (negative).

E. Positive factors -
1. Strength
2. Increase stride length
3. Increase frequency of stride
4. Warm-up muscle temp

Negative factors -
1. Gravity
2. Velocity changes
3. Acceleration of limibs
4. Deceleration of limibs
5. Wind
6. Running surface
7. Shoe type - friction
8. Joint range of motion - (flexibility)

F. Aspects of Speed
1. Acceleration - is the rate of change in velocity
   $\left(a = \frac{\text{Final Vel} - \text{original velocity}}{t}\right)$
   a. Accelertion is measured in units of velocity divided by units of time, i.e. ft/sec-sec.
2. Maximal Velocity - or the maximal movement rate -
   $\left(\text{Velocity} = \frac{\text{Distance}}{\text{Time}}\right)$ (velocity x Time = Distance)
3. These two factors are not highly related.
   Slow starter - fast 100
   Fast starter - slow 100 speed
4. Other aspects to consider for sprinting are - reaction time & movement time.

G. Specificity of Speed -
1. Is 87-88% specific to the limb
2. Within the limb speed is 88-90% specific to the direction
3. Individual may have fast arm movements and slow leg movements or vice versa.
4. Maximum velocity involves positive factors above as well as neuromuscular factors.
5. Improvement in the speed of movement probably lies in the nervous system. improve neural pathways

hypermax
increase
stride length
cadence

H. Methods to Improve Sprint Speed
1. Simulated sprint resistance training - horse running, running up grade, sprint sled, weighted jacket.
2. Sprint assisted training - running downgrade, supermaximal running velocities.
3. Improve running style - proper application of positive biomechanics.

IV. Flexibility - or suppleness is a desirable ability to facilitate muscle action with a minimum of resistance of the tissues. It is necessary to obtain perfection in movement. This process requires the stretching of tissues, especially connective tissue, beyond the normal limit and sometimes to the point of discomfort. Stretching should be done before and after hard exercise. Evidence favors slow controlled methods of stretching over the ballistic type. Controlled movements are less likely to go beyond extensibility limits because of pain limitations. After age 25 there is a general and steady loss of flexibility in principle joints in those who don't exercise and stretch, due mostly perhaps to the dehydration and disuse of the tissues.

Studies indicate that some individuals have too much flexibility while others have too little. A study by Nicholas (1970) indicates that, independent of many other factors responsible for injury in athletics, an increased likelihood of ligamentous rupture of the knee may be present in the loose jointed performer, and muscle tears more frequently accompanying tight jointed athletes.

Generally speaking we find very limited concern being given to maintaining flexibility or to detection and correction of those who have too much flexibility even though flexibility is recognized as important to general health, physical fitness, performance of certain skills and to the reduction of suceptibility to injuries by athletes.

A. Five basic tests of flexibility -
   1. Touch palms to floor with knees fully extended.
   2. A backward curve of the knee of 20° or more when in the prone position.
   3. Knees flexed 15° to 30° - external outward rotation of hips, knees and ankles to a straight 180° heel to heel toe out angle.
   4. Lie or sit on floor, knees and ankles parallel to floor in external or internal rotation of sufficient degree to permit legs and thighs to parallel the floor.
   5. Upper extremity laxity - elbow hyperertension, forearm hypersupination with elbows extended, exaggerated shoulder flexion.

Probably the most accurate tests of flexibility available are those that assess the actual range of motion of the various joints. These are accomplished by instruments such as the Leighton Flexometer and electrogoniometer. Simple field tests include the sit and reach test and the back hyperextension tests.

B. Definition of flexibility - the range of movement of a specific joint or group of joints, influenced by or limited by the bony and soft tissue. It is the ability to yield to passive stretch and relax.

C. Flexibility components -
   1. Static - the range of motion about the joint.
   2. Dynamic - the opposition or resistance of a joint to motion - the forces opposing the movement over the range.
      a. Inertia - negligible
      b. Friction - negligible
      c. Viscosity - accounts for 1/10 the torque
      d. Elasticity } are the major opposing factors - forces are
      e. Plasticity } wasted on stretching connective tissue.

D. Methods of Stretching - the best exercises for increasing flexibility are those involving controlled stretching movements. Stretching, however, can be performed two ways: passive or static and active or ballistic.

1. Static stretching - involves a controlled stretch without bouncing - Less dangerous, less energy and provides relief from or prevents muscle soreness. A firm static stretch invokes the inverse myotatic reflex, resulting in the inhibition of the antagonists, allowing them to relax, which enhances or increases the range of motion.
2. Active stretching - involves bobbing, bouncing, forcing ballistic type movemente. If a muscle contracts quickly or in a jerky motion it will stretch the antagonist muscles causing them to contract, thus limiting the range of motion.

E. Stretching Program - (static)

1. Before and after hard exercise
2. Alternative - 2 days per week - 30 min. per day
3. Hold stretched position for 30 seconds extending to 1 minute after improvement.

F. Common Flexibility exercises

1. Standing toe or palm to floor touch
2. Sitting toe touch
3. Swedish hurdle exercise
4. Alternate to touch - (cross over-or windmill)
5. Waist bend
6. Overhead toe touch
7. Chest stretch
8. Lower leg stretch - against wall
9. Head rotation
10. Trunk rotation
11. Side body bend
12. Side leg raise
13. Modified push-up
14. Head & Shoulder curl
15. Trunk lifter - back extension
16. Leg lifter - prone
17. Hip flexor stretch - supine
18. Hamstring stretch - sitting or Billig
19. Back arch in all forms
20. Bar Hang
21. Kneeling back bend
22. Sitting groin stretch
23. Others

UNIT XIII Muscle Physiology
PART III - Functional Adaptation of Muscle

I. General - Not much over 20 years ago training for strength, power, and muscle endurance was somewhat frowned upon by most coaches and athletes, except for competitive weight lifters, weight men and some football players, wrestlers and boxers. Quite obviously this has changed and we now realize and accept strength, power, and muscular endurance training as an integral part of nearly all sports training programs. Furthermore, during the last couple decades we have observed a sharp increase in physical fitness interest. For many years the primary fitness credo was cardiovascular respiratory endurance without complimentary programs in strength, power and muscular endurance. The all import thing was C-V respiratory fitness. Present day physical fitness advocates recognize that while C-V respiratory fitness is vitally important, so is the need for maintaining the strength and muscular endurance levels of all the large musculature in the body. In other words, to be physically fit means more than just cardiovascular respiratory fitness. Keep in mind, however, that when we refer to the combined use of C-V respiratory and strength, power and muscle endurance for more complete physical fitness we recognize the application of such a complete program is advocated only for those persons who have been found to be free of cardiovascular disorders.

II. Strength, Power and Muscular Endurance: The terms strength, power and muscular endurance are interrelated, but are not synonymous. Strength appears to be a pure component, independent of muscular power and endurance. Both power and muscular endurance, however, are dependent upon the level of strength.

A. Strength - is the ability of a muscle or group of muscles to apply or to resist force. Maximal strength would be the maximal force a muscle can exert along it longitudinal axis against a resistance in one maximal effort. It is the result of contractile force and angle of pull.

To the physiologist strength is directly related to the cross sectional area of the muscle which is about 3-4 kg. per cm^2. To increase strength, then, we want to engage in activities (learning practices) that will increase the mobilization (or disinhibition) of motor units activated and/or increase their firing frequency or we want to overload the muscle in ways that will bring about an increase in the amount of contractile proteins (the number of myofibrillar proteins — actin and myosin).

Strength can be measured as static or dynamic strength.

1. Static - (also isometric) - technically static or isometric is defined as strength that is applied against a fixed, nonmoving object. It allows no change in the muscle length. However, static measurements do allow some movement, such as the compression of a dynamometer.

47%

A normally active person would retain 52% of his original strength in a year of no strength work

Minimum of highest 47% strength lost in one week

2. Dynamic strength - is the maximum load that can be moved throughout a total range of motion. It involves movement by shortening or lengthening the muscle, also movement of the resistance. Furthermore, dynamic strength can be applied or assessed either isotonically or isokinetically. In isotonic movements the resistance remains constant throughout the full range. Because the maximum strength application varies according to the angle of pull and the length of the muscle throughout the entire range of movement, the contraction must be considered submaximal even if the resistance can be lifted only once.
Isokinetic movements are defined as the maximal contraction of the muscle group at a constant speed throughout the full range of motion, by varying or accommodating the resistance. In other words the muscle is maximally loaded at all angles of the movement. Resistance is controlled at a fixed speed and no matter how much strength is applied the resistance will not move faster.

a. Concentric and eccentric contractions - both static and dynamic movement can be accomplished by concentric or eccentric muscle contractions.

1. Concentric contractions - refer to muscle shortening

2. Eccentric contractions - refer to muscle lengthening

3. Strength summary: Strength can be either static (no movement) or dynamic (movement). Static strength can result from isometric contractions; dynamic strength from isotonic and isokinetic concontractions. Isometric, isotonic and isokinetic contractions can be either concentric or eccentric.

a. Static strength - fixed non-moving
Isometric - none or minimal muscle shortening
concentric - push or pull on immoveable object
eccentric - hold a weight in fixed position

b. Dynamic strength - involves movement
Isotonic - constant resistance through range
concentric - arm curl, chin up - lifting a weight
eccentric - lowering weight
Isokinetic - maximum resistance throughout range
concentric - maximal positive contraction against resistance
eccentric - maximal negative contraction against a resistance

4. Assessment of strength

a. Static strength - usually measured with a dynamometer, cable tensiometer, or strain gauges. Joint angles are fixed during maximal isometric contraction. The dynamometer is usually restricted to measuring grip strength and leg and back strength.

Cable tensiometers can be used to measure just about any muscle group in the body. Strain guages are limited mostly to grip and finger measurement.

b. Dynamic Strength - can be assessed with one repetition maximum or with the use of instruments using the isokinetic concepts.

1. One repetition maximum (1-RM) - is used to determine just how much weight can be lifted just one time. Example-arm curl-estimate starting with a 50 lb. barbell, if too light go to 65 lb. barbell, if too heavy try 60 lb. barbell, etc. The 1-RM would be the amount the individual could curl once.
   The disadvantage is that it only identifies the individuals strength at the weakest point in the total range of motion.
2. Isokinetic concept - apparatus are available that enable the individual to measure and usually record the full force applied throughout all points of both the extension and flexion phases of a movement. In addition to identifying peak strength it quantifies strength throughout the entire motion.

c. Strength per cross sectional area is almost the same in males and females regardless of age.

5. Training for strength - isometric, isotonic and isokinetic methods have been used to develop results in strength. Isometric training results in strength gains limited to the specific joint angle used during the exercise, because the involved motor units are specific to joint angle or stretch of the muscle. Isotonic techniques are also limited in a similar way, to the range of movement through which the exercise takes place.

a. Rates of Increase - improvements of 5 to 12% per week depending on the relative starting strength.

b. Isometric Training - best results are obtained by using maximal contractions, held for a period of 6 seconds, repeated 5 to 10 times per day. Muscle groups should be trained at three or more angles in the full range of movement using the repetitions at each of the angles.
   A common device in weight rooms for this type of training is the power rack which can be rigged for pure isometric or functional isometric exercises. Functional simply utilizes a short preceeding isotonic movement before confronting the isometric position.

c. Isotonic Training- traditionally this type of training has used iron in the form of barbells, dumbbells and various pulley type apparatus.
   Two important concepts are involved in this type of training: 1) the concept of overload-to gain strength muscles must be loaded beyond that point to which they are normally loaded and 2) progressive resistance exercises-as muscles become stronger they must work against proportionately greater resistance to increase strength further. In simple words this is the systematic application of overload.

1) Recommended procedures for weight training - based on research summaries a weight training program would include the following combinations of sets, repetitions, resistances, frequency and additional factors for maximizing strength gains:

a. Specificity - training programs must be relevant to the demands of the event being trained for.
b. Identify muscle structures involved in the movement pattern where strength gains are desired.
c. Select exercises that overload the indentified muscle structures imitating the desired movement as close as possible.
d. Perform 5-7 RM for 3 sets of each exercise, resting between leg, arms and trunk exercises. (RM-means repetitions maximum-the weight that can be lifted 5-7 times in one set.)
e. Training frequency 3 times per week on alternating days or up to 5 days per week if muscles are preconditioned.
f. Increases the resistance as rapidly as possible.
g. High speed contractions appear to be important.
h. The predominant energy system should be considered.
i. In spite of disagreement among strength training advocates concerning procedure and combinations there is agreement that to develop strength use progressive resistances in the overload zone.
j. Retention of strength-strength is less difficult to maintain than to develop. Maximal contractions once per week or once every two weeks will maintain strength levels fairly stable.

d. Isokinetic Training - traditionally strength training has been performed either at zero velocity (isometrically) or at very low velocities (isotonic 3 to 10 RM sets). Most athletic performances however, require high velocities. Seemingly then a high velocity strength training program that utilizes the advantages and eliminates the disadvantages of isometric and isotonic strength training would be much more effective in developing both the strength and velocity components of power.

Isokinetics is relatively new in both concept and practice. The potential for this concept, however, is particularly impressive. Although it has not yet been researched extensively the scientific studies that have been done suggest exciting new possibilities.

In studies so far it has been demonstrated that the isokinetic strength training program has increased overall strength dramatically and especially in the high speed ranges of strength application, substantially improved cardiovascular parameters, produced significant body composition changes, increase overall body flexibility and improved performance parameters such as two mile distance runs, 40 yard sprints and vertical jumping ability.

A study by Wilmore and Pipes (1976) showed that subjects trained isokinetically in a fast-speed or high velocity mode exhibited the greatest strength gains in nearly all movements. This suggests perhaps that athletes need to train at relatively high speeds of limb movements in order to achieve the greatest strength increases.

B. Power - is defined as the performance of work per unit of time, the rate of doing work. The classical physics formula is $P = \frac{W}{T}$. In physiology the formula used is P = Strength X Velocity. Simply put it is the product of strength and speed and is rated in terms of horsepower (1 Hp = 33,000 FT. LB./minute)

Strictly speaking, it should be determined by the speed at which a maximal load can be moved. Would this mean that a weight lifter successfully performing a maximal bench press of say 500 lbs. in a rather slow fashion is a powerful person? Or would we say that the person was strong? Let's look at another example: take two shot putters; one who has strength to bench press 600 lbs., another who can bench press 400 lbs. We might assume the 600 lb. bench presser would be able to put the shot farther than the 400 lb. presser. But in actual practice the 400 lb. shot putter throws 71 feet and the 600 lb. shot putter throws 50 feet. Who is the more powerful?

The term power is used a lot in athletics, and often incorrectly so. It is often confused with strength. But strength is only one component of power. The velocity of strength application also figures in the product. Focusing training entirely on the strength component of the formula will increase the power product somewhat because increases in strength should produce some increase in velocity or less than maximal efforts. But we know that to develop basic strength to high levels we must systematically, gradually and maximally overload the muscles. Furthermore, if strength gains are to be applicable to a specific sport movement the overloading must be done in a way that replicates the sport movement. If we continue to randomly assign lifting programs which are irrelevant to sport applications will we end up with a person who is basically stronger in performing a certain lifting maneuver but who is slower, because maximal lifts to build maximum strength cannot be performed at maximum velocity? Does it make more sense to attempt to increase basic strength in the musculature utilized in performing a specific sport movement by duplicating that movement as precisely as possible; then, when the basic strength component of the power formula is elevated focus our training toward increasing the velocity of the power component while periodically maintaining the strength level. How could this be done? By reducing the amount of resistance and increasing the velocity of the movement to the velocity nearer the actual sport movement. We would then be training with a relative maximal load that can be moved at maximum speed for either a low, medium or high level of repetitions. It would be easier, then, to discuss performances in terms of high power, power, and power endurance activities.

Earlier we discussed the measurement of aerobic power by way of the oxygen consumption per minute.

Margaria, et. al. (1966) has devised a power test that appears to be reliable and valid. We will do this test as one of our laboratory assignments. It involves running full speed up a set vertical distance using a flight of stairs and timing devices. Its main drawback is that it reflects only the power of the hip and knee extensors and not other parts of the body.

Several vertical and longitudinal jumping tests well as softball throws for distance have been used as field tests for power in the past. Even though they are repeatable and reliable their validity is questionable because the time element is not included.

The isokinetic testing device presents a way for estimating power from almost any muscle group because both the speed and resistance can be varied. The total power can be estimated from the area under the recorded curve.

2. Power training - the functional definition of power suggests the application of force at a great rate of speed. The number of times this must be done in an event is related to the type of power event. High power events include high strength components and velocity components (shot put) with a minimum endurance requirement. Power-endurance events are like the 200m to 800 meter distances which require an increasing endurance factor.

Power training can be done by way of weight lifting and isokinetic apparatus, if these apparatuses can be set at very high speeds. Weight lifting should include weights that can be lifted 50 to 100 times at a rate as fast as and as identical with the performance movement as possible. It obviously is strenuous and likely cannot be maintained for prolonged periods without proper resting-recovery periods.

Muscle Endurance - is the ability of a muscle or group of muscles to repeat a given movement or to continue a fixed or static contraction for an extended period of time. It can be thought of simply as the ability to repeat a given movement, persist in physical activity or to resist fatigue.

The concept of endurance is not simple. For purposes of analysis the component parts of endurance is sometimes separated into discrete parts: (1) local or muscular endurance and (2) cardiovascular respiratory endurance. We must keep in mind that endurance essentially is not a discrete set of elements but rather is a group of interrelated, and basically inseperable components.

Local muscle endurance is concerned with the strength, the energy stores and the peripheral circulation of a single muscle group, or several localized groups. The term cardiovascular-respiratory endurance is used to define over-all body endurance (whole body activity or stamina). In this unit we will focus on local muscle enduranee and will look into cardiovascular respiratory endurance in later units.

1. Measurement of muscle endurance - we can measure muscle endurance by means of:

   a. Field tests - the number of pullups, push-ups, situps, etc. Performance is evaluated on the basis of how long the movement can continue or by determining how many movements can be repeated for a set period of time with an increased load. The latter is critical in athletic performance in many instances the person who completes a predetermined task in the fastest time is the winner. In athletics also the magnitude of the work decreases as the time of the event decreases and as the participant approaches better performances.

   b. Laboratory tests - muscle endurance is measured by several devices:

      1. the ergograph - is a weight or spring loaded device which provides a means for continuously lifting or lowering a constant weight through a fixed distance at a constant rate. The device is usually connected to special recording instruments so continuous quantitative and qualitative records can be obtained. Some laboratories are equipped with strain guages or force tranducers connected to recorders. The resulting recordings are called ergograms.
      2. Fixed weights - as in weight training - endurance is evaluated on the basis of the number of repetitions completed. Is not as satisfactory because body segment lengths (arms, etc) influences the distance the weight has to be lifted.
      3. Isokinetic testing devices - this device measures maximal force application throughout the full range of motions, contractions continue until no further movement is possible. After the first few contractions peak performance declines. Summing the recorded peak strengths or summing the area under the curve accurately assesses muscular endurance.
      4. Electromyographic - demonstrates that as fatigue progresses more motor units are called upon consequently the electrical activity increases in the muscle.

2. Strength and Endurance - at a load of 60% of maximum voluntary contraction (MVC) blood vessels supplying the working muscle are completely occluded. Therefore, under these conditions the muscle must use only the ATP-PC immediate energy sources, and energy from glycolysis, which, of course, are finite. The duration of contraction is determined by the stored energy and its rate of depletion as well as the accompanying drop in ph which decreases muscle contractability.

   MVC is isometric and demonstrates clearly the relationship between muscular endurance and the load on the muscle. Load is considered in terms of the percentage of MVC, therefore strength becomes a major factor in local muscle endurance.

a. MVC (maximal voluntary contraction) is isometric and represents 100% of the load.
b. Relative endurance - is measured by using a percentage of each individuals maximal voluntary contraction.
c. Absolute endurance - is measured by using the same load for everyone.
d. A high correlation exists between strength and absolute endurance. As an example, if we used 30kg as a load in the grip dynamometer the person with the highest grip strength could likely endure longer because they would be using a smaller percentage of their maximal strength.
e. We can demonstrate and observe muscular endurance by observing the fatigue curves by performing maximal contractions on a grip dynometer or a cable tensiometer or most of the other laboratory devices. The observed strength loss (percentage of loss from pre-exercise levels) is referred to as the Strength-Decrement Index (Clark, 1955). This exercise will be performed in laboratory experiments.

3. Factors affecting muscle endurance -
   a. age - older fatigue more rapidly than young, but not much.
   b. Sex - no significant difference
   c. Temperature - cold reduces fatigue to 80°F muscle temperature. Lower temperatures produce poorer performances.
   d. Cross-education Effect - endurance training of one limb produces increased endurance in the untrained contralaeral limb. By increasing trained limb endurance 966%, the untrained limb improved 275%.
   e. Circulation - peripheral circulation is significantly improved as a result of an endurance training regimen-by improved vascularization.

4. Ways to Improve Muscular Endurance -
   a. must overload - use high reps-low resistance for endurance. Research evidence indicates that muscle training at 20 to 30 RM is the most efficient way to develop muscular endurance.
   b. Optimize muscular strength in order to work at smaller percentage of maximal effort.

D. Biological long term training effects for Strength and Endurance.

1. Effects of long term strength training -
   a. Hypertrophy - an increase in muscle mass by enlargement of the already existing fibers. There is an increase in myofibrillar protein, therefore increased contractile machinery. (While true hypertrophy of existing fibers appears to be the most important factor in the volume change of muscle in man, published animal studies indicate that prolonged excessive muscle training may create new fibers.)

The total amount of myofibrillar protein in muscle increases with strength training and decreases with inactivity. Disuse atrophy brings about a selective reduction in myofibrils and an increase in fat content of the muscle.

Hypertrophy appears to be independent of growth hormone, insulin, testosterone orthyroid hormone. Protein synthesis and DNA-RNA synthesis increases. Hypertrophy occurs in the fast twitch fibers.

b. Bones, ligaments and joint cartilages are affected by use and disuse. Stressed bone structures become more sturdy, articular cartilage thickens, connective tissue volume increases, ligament attachments become stronger.

c. Recruitment - training results in less inhibitions and greater recruitment of motor units (i.e. inhibition of the inhibitions). (Motivation is very important-Hollman, 1967.)

d. Maximal strength depends on neuromuscular functions and especially on ATP-PC system.

e. The loss of strength after a period of training is relatively slow; a significant loss is observed after one month; it may take several months to return to pretraining levels. Less effort is required to maintain an established level of strength than to develop it.

f. Strength gains are best achieved by using low-reps of maximal resistance. Underloading does not increase strength.

g. The effect of strength training programs on the endurance capability of muscle is negligible, ie. the oxidative capacities are not appreciably altered.

h. Glycolytic pathways also seem unresponsive to muscular strength training. Evidence does show however, that high intensity training does increase the glycolytic enzymes.

i. Reaction time and maximal speed of contraction does not seem to be affected by chronic overload strength training-If anything it appears that muscular speed is decreased as a result of chronic overload strength training.

j. Changes in body composition - there is little change in weight accounted for by significant gains in lean body weight accompanying losses in body fat.

k. Drug supplements - anabolic steroids have been found to cause great increases in weight and strength when taken in extremely high doses and supplemented with additional protein intake. Such practices present moral, ethical and health considerations.

l. Electrical Stimulation - indirectly or directly applied on the motor nerves increases maximum voluntary contraction. It's drawback: coordination is not properly trained.--

2. Effects of long term Endurance training - muscular endurance is related to the exerted force in relation to the maximal muscle strength.
   a. Biochemical changes - There is an increased capacity for aerobic metabolism which increased the capacity to oxidize pyruvates and long-chain fatty acids. This is due to an increase in the size and number of mitochondria and increase in the mitochondrial enzymes.
   b. Vascular changes - increased vascularization
   c. Increased aerobic capacity - oxygen transport.
   d. Body composition - reduction of fat
   e. Little change in muscle strength and bulk
   f. Increased anaerobic thresholds and the ability to tolerate high pain levels. The endurance trained has lower blood lactate levels at both the same absolute and relative work loads.
   g. Increased amounts of intracellular glycogen and fat and slower rates of glycogen depletion at the same absolute work load - the glycogen sparing effect.

3. Strength training Effects for women - it is well recognized that the average male is considerably stronger (30 to 40%) than the average female. Such statistical results are misleading because when individual values for specific body areas such as leg strength are considered or when strength is expressed in relation to body size or lean body weight the values are quite similar. Leg strength expressed relative to body size is identical between men and women. When expressed relative to lean body weight females are slightly stronger. Upper body strength however shows that females are only 30 to 50% as strong as males. From the similarity in leg strength between the two sexes it appears the quality of muscle is the same.

   Gains in strength, as we have stated before, are not always accompanied by hypertrophy. It is not always a necessary consequence of weight training. Weight training of males, but not females, is usually associated with hypertrophy. This has suggested that testosterone determines the amount of hypertrophy that will occur. Individuals with high testosterone levels should experience greater muscle hypertrophy. Females generally have low levels of testosterone while males have higher levels. Because of this testosterone level the male will continue to have a greater muscle mass. If muscle mass is the major determinant of strength the male will always have a distinct advantage. If levels of strength are independent of muscle mass, then both sexes have the same potential for absolute strength.

   It has been observed that the size of muscles in some females tend to increase with weight training. It is believed to be due to higher, naturally occurring levels of testosterone. New measurements will soon make it possible to confirm this theory.

   Females can benefit from strength training. This was shown by Brown and Wilmore (1974) with college age women. Wilmore (1974) demonstrated that young nonathletic women can improve their mean strength by as much as 30% by a ten week weight training program. From the above it appears the female has the potential for substantially higher levels of strength without concomitant gains in bulk.