The Functional Continuum (are we weight training to fail?)
Orr, Rob Marc

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**THE FUNCTIONAL CONTINUUM**  
(Are we weight training to fail?)

**INTRODUCTION**

The *Functional Continuum* explores how functional an exercise is by determining the amount of movement required to complete the action. As all sports and most activities in life (functional) require multiple joint movements, the more functional an exercise, the more transferable it is to sport and everyday life. The functional continuum also allows exercise prescriptors to understand whether the exercise selected has a high movement focus or a high muscle focus and explains how to increase or decrease this focus. However before we move into discussing the functional continuum, here are a few reminders as to the role of skeletal muscle.

**Role of Skeletal Muscle**

Voluntary movement; locomotion; manipulation of the environment; facial expression. Voluntary control. (Marieb 1998)

....skeletal muscle is responsible for activities such as walking and manipulating objects in the external environment. (Spence 1990)

Through contractions, muscles perform three important functions: Motion, Maintenance of posture and heat production. (Tortora & Anagnostakos 1987)

Note: None of these references have the function of skeletal muscle as either hypertrophy or aesthetics. All of them do however mention its importance in movement and motion.

During the analysis of an action or exercise the joints involved and their movements are identified. It is the number of joints employed and the number of planes across which the force is development that determines the movement classification.

<table>
<thead>
<tr>
<th>Isolation</th>
<th>Compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation movements involve actions that cover only one joint.</td>
<td>A Compound movement involves actions that take place over more than one joint.</td>
</tr>
<tr>
<td>Eg. <strong>Action</strong></td>
<td>Eg. <strong>Action</strong></td>
</tr>
<tr>
<td>Lateral Raise</td>
<td>Upright Row</td>
</tr>
<tr>
<td>Shoulder Abduction</td>
<td>Shoulder Abduction</td>
</tr>
<tr>
<td>Leg Extension</td>
<td>Elbow Flexion</td>
</tr>
<tr>
<td>Knee Extension</td>
<td>Hip Extension</td>
</tr>
<tr>
<td>Knee Extension</td>
<td>Knee Extension</td>
</tr>
</tbody>
</table>

**Kinetic Link**

• Complex

A complex movement is one in which more than one compound movement is linked together to complete an action.

<table>
<thead>
<tr>
<th>Eg.</th>
<th><strong>Action</strong></th>
<th><strong>Joint and Movement</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean &amp; Press.</td>
<td>1. Deadlift</td>
<td>Knee Extension</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hip Extension</td>
</tr>
<tr>
<td></td>
<td>2. High Pull</td>
<td>Shoulder Abduction</td>
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<td></td>
<td></td>
<td>Elbow Flexion</td>
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<tr>
<td></td>
<td>3. Push Press</td>
<td>Shoulder Flexion</td>
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<tr>
<td></td>
<td></td>
<td>Elbow Extension</td>
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<tr>
<td></td>
<td></td>
<td>Scapula Abduction</td>
</tr>
</tbody>
</table>
• **Multiplane**
Multiplane exercises are those that would involve movement across more than one plane, Eg. plyometrics. Not only are plyometric activities complex but they also have movement across more than one plane, hence allowing greater sports specificity.

**PLOTTING**
The more motion involved in the action the greater the number of joints required to perform the action. With this in mind, and other factors withstanding, the generic plotting of the functional continuum would be as shown in Figure 1.

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**Movement Focus**

Isolation  Compound  Kinetic Link

Complex  Multi-Plane

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Figure 1. The generic plotting of the functional continuum.

**INCREASING THE MOVEMENT VALUE**

**Stabilisation**
Activities that require the body to stabilise other body parts through increased synergy, increase the functional value of an exercise, two qualities vital to sports performance and everyday function.

- **Dumbbell Exercises** — Dumbbells due their independent nature have a higher synergy requirement than bar or fixed machine work. They also allow greater versatility in movement and mimicking of specific actions.
- **Fitball Exercises** — Fitballs decreases the stability of the body by amplifying weaknesses in balance. Therefore exercising on a Fitball increases the need for effective stabilisation, hence increasing synergy between muscles and core stabilisers. (Eg. Try performing a push up with each hand and foot on separate basketballs. You are so busy utilising energy to balance, your push up strength / endurance is usually poor.).

**Potential For Movement**
The greatest potential for movement is one that allows full range of motion (ROM) across all planes of movement in unilateral independence. Dumbbells for example, allow greater movement (hence require greater stabilisation) than a barbell. Medicine balls, with their droppable - throwable nature, can provide even greater potential for movement than a dumbbell.

**RE-PLOTTING**
So as can be understood, plotting on the functional continuum is not quite so black and white. For example; a Squat performed on a Universal machine (a fixed - machine) would have a lower synergy and stabilisation requirement than a squat performed on a smith machine, which would in turn have a lower synergy and stabilisation requirement than a barbell free squat. Although all these are compound exercises, they have a different plotting on the continuum. As shown in Figure 2, the continuum is more complex than it first appears.

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**Movement Focus**

Universal  Smith  Barbell  Dumbbell  Plyometric

Squat  Machine  Free  Free  Squat

Squat  Squat  Squat

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Figure 2. Plotting a compound movement classification accounting for the increased stabilisation requirements and potential for movement.
COMPARING THE FUNCTIONAL VALUES
Isolation vs Compound

The technology of the fitness boom with its muscle isolating machines and focus on parts of the body produces the body as an object of increasingly isolated and fragmented parts. (Costa 1995).

One must ask how functional isolated exercises are. Not only is the cross over to function of single joint exercise poor (Chek 1998a) but when in life are isolated movements performed? Name any sport that utilises a purely isolated action? When in life does the knee perform extension alone, as in the Leg Extension, whilst the back and upper thighs are supported?

There are few benefits of an isolated action for the general fitness trainer or even advanced athletes. Some of the common reasons (or excuses) given by resistance training (RT) instructors for the implementation of isolated exercises include:

♦ Rehabilitation:
Even though an isolated exercise may be prescribed by a physiotherapist, (Eg. The Leg Extension, prescribed to strengthen the Vastus Medialis Obliques (VMO).), it is done so in conjunction with functional movement and mobility work. You will find that for most physiotherapists, it is the return to function that is of primary concern and the restrengthening exercises are so directed.

In regards to the greater activation of the VMO by utilising the Leg Extension with toes out, Ostrowski (1998) states that

"EMG research has demonstrated that during the leg extension, external rotation of the foot (toes out) leads to greater activation of all the quadriceps muscles. The old belief that a toe out posture will more highly activate the Vastus Medialis and a toe in posture the Vastus lateralis would appear misleading."

♦ Muscle Balance:
Would not a compound exercise provide the same muscle strengthening benefits whilst providing a greater functional movement and co-ordination aspect. For unilateral actions like Javelin throwing or bowling, where one side is trained more than the other, the same gross action can be performed on the weaker side utilising weighted balls like medicine balls.

♦ Pre-fatiguing:
The means of isolating a muscle to ensure it is the limiting factor in an exercise, is utilised by body builders to target a specific muscle requiring growth. However this value is almost purely aesthetic and of little use for athletes. For example, if an Olympic lifter always fatigues in the glutes when dead lifting, what good would pre-fatiguing the quadriceps be (to ensure the quads are the limiting factor in his/her dead lift) to performance.

Machine vs Free Weights

80% of injuries in the US are from machines like a Pec Deck. (Chek 1998a).

♦ Safety:
For many years it has been commonly advised that beginners utilise machine weights rather than free weights. The predominant reason being safety, as less synergy and balance is required. However what happens in real life when the client is required to utilise the muscles in a functional capacity requiring synergy and balance. For example: Many novices Squat utilising machine weights, what happens then when they get home in the afternoon and attempt to lift a box. The muscles may be further developed but how has the synergy, proprioception and balance improved to aid in the movement. The same applies to the body builder when they attempt to lift heavier weights in order to stimulate greater neural drive, the prime movers may have increased strength capabilities during isolated exercises, but what about the synergists and fixators?
McEvoy, Rawson & Ridley (1993) state that ‘Since pin weight machines consist of preset lines, it is often argued that the stabilisers are neglected. It is often these stabilisers that are prone to injury.’

By fixing lines and planes of movement the chance of injury may actually increase as opposed to decreasing. Poliquin (1997 as cited by Ostrowski 1998), in regards to the Smith - machine bench press, states that

Because of the mechanics of the human shoulder joint, the body will alter the natural pathway during a free - weight bench press to accommodate efficient movement at the shoulder. A fixed - bar pathway does not allow variation for efficient movement at the joint, thereby predisposing the shoulder to harmful overload from the lack of accommodation.

The Injury Cycle:
Machine training, when the sole form of resistance training, may lead to what I call the injury cycle.

1. The client sees a doctor who informs them to perform squatting exercises to improve strength, coordination and balance in order to lift correctly with the legs and protect their back.
2. The client goes to the gym and asks to be taught to squat.
3. The RT instructor prescribes a machine squat.
4. The muscles required for a squat are strengthened, yet coordination and synergy are still neglected.
5. The client attempts to use the correct squatting action picking up an object and the likelihood of acute or progressive injury increases until the point of injury.
6. The client gets injured and goes to see the doctor.

Scenario 2.
1. The recreational sports person sees a doctor for a shoulder injury and is informed to perform resistance training exercises to strengthen the muscles around the joint.
2. The client goes to the gym and asks to be given exercises to strengthen the shoulder.
3. The RT instructor prescribes a machine shoulder press.
4. The muscles are strengthened, yet coordination and synergy are still neglected.
5. The client returns to sport but the increased strength, which is not transferred to the functional setting, does not help them to catch or throw the ball and the likelihood of acute or progressive injury increases until the point of injury.
6. The client gets injured and goes to see the doctor or physiotherapy.
The question must then be asked why then are fixed - machine weights still so commonly prescribed. I have determined three major reasons after consulting resistance trainers and gymnasium instructors.

1. The gym owners are safe, the injuries occur outside of their facility or instruction,
2. The RT instructors are either lazy or under time constraints and short cuts are taken with technique coaching which becomes easier and quicker on a machine, and
3. Overload is introduced to soon. Why are free squats performed in aerobic classes and pump classes without an uproar? The most common answer is...because the weights are lighter in an aerobic class.

**PUTTING FUNCTION TO WORK**

♦ Stabilisation

The transferability of gains made on machines are questionable. Chek (1997) explains that motor patterns are centrally generated and if the body is not satisfied that the core is stable it will decrease the activation of the larger muscle groups.

*If the stabilising muscles of the shoulder joint are weak then innervation of the prime movers will decrease during the performance of a movement.* (Ostrowski 1998, on developing the stabilisers for the Bench Press.)

*You can only pull what you can stabilise.* (Chek 1998b, on Bent Over Rowing.)

**TRY THIS**.....Perform a single leg Leg - Extension on a Leg Extension machine with a weight that will allow only ten to fifteen repetitions. Now stand on one leg and perform a single leg extension with the same weight for the same amount of repetitions, can you do it? Probably not. Even though your legs can still produce the same amount of force, it is not able to as the rest of the body is unstable. The body is also accustomed to producing this force with your core supported, the way you trained it in the gym on the leg extension machine. Yet which position are you in on the sports field when kicking a ball, are you standing on one leg whilst moving and rotating, or sitting down with a back support? As Ellison (1995) states it is ‘Important to develop active, internal stabilisation as opposed to passive external stabilisation.’

The more you stabilise a movement the stronger the movement becomes, transferability from functional to stable exercises is therefore high, yet these gains are low in the reverse situation. Ostrowski (1998) uses the example of the Lat Pulldown and the Chin Up. Increases in the Chin Up are transferable to the more stable Lat Pulldown, yet not the other way around.

♦ Synergy

One of the most notable factors in strength gains for beginners comes from an increase in muscle synergy (Sharkey 1990; Shields 1994; Wilmore & Costill 1994; Fleck & Kraemer 1997). This is because the motor pathways develop to make the action more efficient by not sending neural impulses to the antagonists and non essential muscles. Synergy develops to allow a coordinated activation of the agonists, synergists and fixators in their correct roles, without interference from the antagonists. (See Figure 3.)

The body adapts to the level of performance required. If the level required is below the current level developed, then detraining will take place (Eg. When you take time off, your body detrains to your current sedentary levels). For the sedentary person who takes up resistance training, there is a positive adaptation to the new level of synergy and stabilisation required, (the inter muscular adaptations that bring strength gains.). However for the general resistance trained individual, who performs the generic isolated, machine or supported exercises, the stabilisation / synergy requirement is still below that required for functional activity and sport. With this in mind, strength for function needs to be developed in a functional setting, (remembering that strength is transferable from an unstable environment to a stable environment but not the other way around.)
The means is which stabilisation is increased is also important. In the upright position humans use their abdominals as a stabilisers as opposed to just movers. How many functional activities and sports require their strength in the upright position, almost all of them. As Ellison (1995) states ‘A muscle’s function in the upright position is a priority in training.’

PROGRAMMING FOR FUNCTION

The first and most simple thing to do to each exercise is add more movement, rather than moving only one joint, move more. The more you move the more functional your exercise. Compare the amount of joint movement in a leg extension as opposed to a Deadlift or even a run.

Progression is the most important aspect of programming. It is hard, due to ego, but vital that we start at the beginning. The method of progression should be from techniques and stabilisation to strength then if required power. ‘We should never break the stability - strength - power rule of progression or we break the client/athlete’ (Chek 1998a). I know .... You want the muscles of your legs to look good, so you want to do Leg Extensions and Leg Pressing............Ever seen a sprinters legs ? Pec Decs and Flyes for the Upper Body? - Seen a gymnast?  Yes they do perform weight training exercises, but their dominant training is kinetic link and they do their weight training after functional training.

The next thing to do is to decrease your support and increase the requirement to balance. This can be done by moving off the machines and onto free weight. Once barbells have been mastered move onto dumbbells. From there the choices are endless. Use medicine balls, body weight, ropes, throw away the bench and use a Fitball.

Easy is it not? However there is a catch. By decreasing your stability and increasing your balance requirement, the weights you can normally lift need to be decreased. Once you can control your ego, here are a few variations you can try. The exercises are shown in order of functional / stabilisation regression, as training protocols dictate, the athlete / client should move from an unstable environment to a stable one.

- **Legs**
  1. 80 to 100m sprints
  2. Deadlifts or Lunges
  3. Free Weight Barbell Squats
  4. Machine Squats
  5. Machine Leg Press

- **Back**
  1. Rope Climbing.
  2. One hand per rope, Rope Heaves
  3. Rope Heaves
  4. Chin Ups
  5. Assisted Chin Ups
  6. Pulldowns

   1. Tug Of War / Ring Tug
   2. Dumbbell Bent Over Row
   3. Barbell Bent Over Row
   4. Bent Over T-Bar Row
   5. Supported Bent Over Row
   6. Seated Row

Rob Orr
• **Chest**
  1. Dumbbell Bench Pressing on a Fitball.
  2. Barbell Bench Pressing on a Fitball
  3. Free Weight Dumbbell Bench Pressing – feet crossed above the bench (crunch position)
  4. Free Weight Dumbbell Bench Pressing
  5. Free Weight Barbell Bench Pressing
  6. Machine Bench Pressing

  1. Push Ups with your hands (one each) and feet on a Basketball.
  2. Push Ups with your hands (one each) and feet on a medicine ball.
  3. Push Ups with your feet OR hands on a medicine ball
  4. Push Ups

• **Shoulders**
  1. Dumbbell Shoulder Press seated on a Fitball.
  2. Barbell Shoulder Press seated on a Fitball
  3. Free Weight Dumbbell Shoulder Pressing standing on one leg (make sure you change legs).
  4. Free Weight Dumbbell Shoulder Pressing
  5. Free Weight Barbell Shoulder Pressing
  6. Machine Shoulder Pressing

To get even more functional perform Kinetic Link exercises, those that require two or more compound actions (eg. Running and swimming.). Try Rope climbing for Legs, Back, Biceps, Forearms and Abdominal training all in one. You can either climb up and down the length of rope or perform reps, one bite - lower = 1 Rep. How about a ‘Clean and Press’ (a combination of a ‘deadlift’, ‘upright row’ and ‘shoulder press’) for training Legs, Shoulders, Upper Back and Arms.

For burning fat, developing cardio vascular endurance, improving muscle balance and coordination increase the functional requirement of your aerobic training by utilising more muscle groups, rather than utilise the stepper in the cardio theatre try the rowing machine or versa climber (Like climbing a ladder). If you don’t have a versa climber, try rock climbing, or climbing the gymnasium wall bars (up and down) for twenty minutes.

**Safety**

1. Follow the guide of developing technique and core stabilisation **FIRST** then Strength then Power.
2. Move from exercises with the higher stabilisation requirement to those more stable during a training session.
3. Progression - DO NOT increase weight too rapidly -------Remember first rule.
References


