Function Key	
DF	Dorsi Flexion
PF	Plantar Flexion
Irot	Internal Rotation
ExRot	External Rotation
Flx	Flexion
Ext	Extension
RRot	Right Rotation
LRot	Left Rotation
Ab	Abduction
Ad	Adduction
Ev	Eversion
In	Inversion
Atilt	Anterior Tilt
Ptilt	Posterior Tilt
LHike	Left Hip Hike
RHike	Right Hip Hike
LatRFlx	Lateral Flexion Right
LatLFlx	Lateral flexion Left

Movement Key	
RF	Right Foot
LF	Left Foot
RK	Right Knee
LK	Left Knee
RHip	Right Hip
LHip	Left Hip
RCage	Rib Cage
Shlders	Shoulders

MOVEMENT ANALYSIS

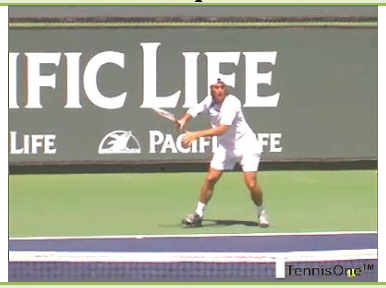
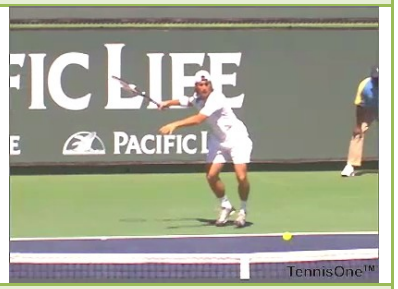
DAVID FERRER INSIDE OUT FOREHAND

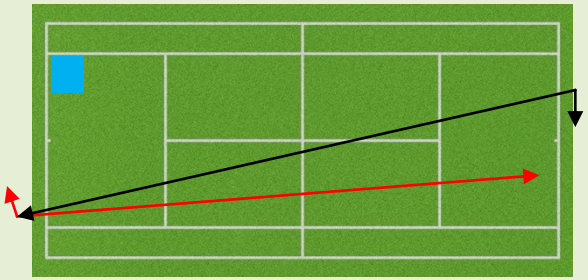
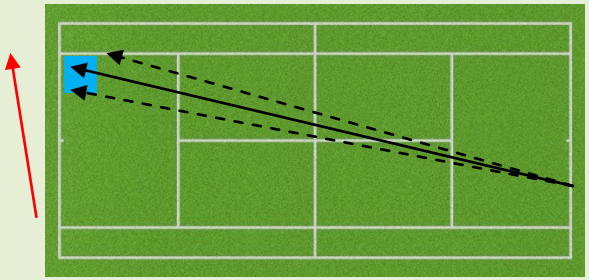
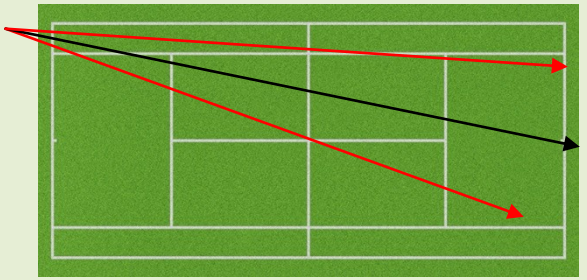
Mike Crooks

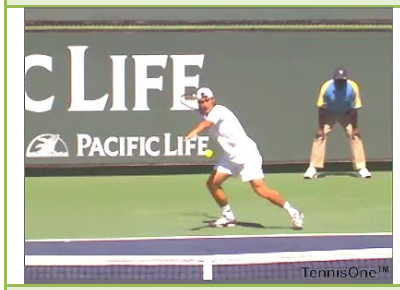
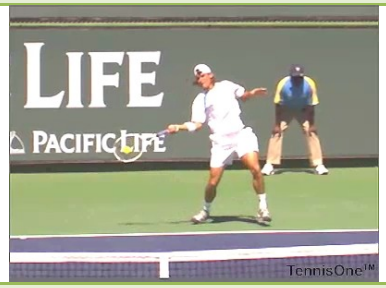
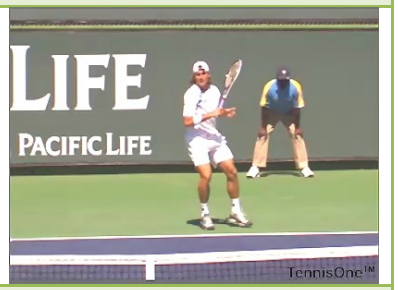
Latest Revision: 04/04/2013

A complete movement analysis of David Ferrer executing and inside out forehand. The analysis considers the tactical intention of the stroke, discussing possible reasoning and effects. Following this the analysis provides a biomechanical breakdown and a movement summary with key features. Finally the system provides suggested exercises and drills aid in the development of the movement cycle.

TACTICAL INTENTION: In considering the tactical possibilities it is important to consider the complete movement cycle and the effect on the opponent.

1. Initiation	2. 1st Shuffle	3. 1st Prep	4. 2nd Prep	5. Unit Turn
				

Opponent Position	Intended Shot	Recovery Position
		
Opponent is taken out of court and hits reply central. The optimum recovery for the opponent is on the other side of the court where space has been created. Ferrer has taken a recovery position just off to the right of the centre.	Depending on the urgency and the anticipated recovery there is a choice to play "inside out" or "inside in". Here Ferrer opts for "inside out" to exploit the space suggesting the opponent is struggling to manage the recovery. This causes the opponent to have to manage a lot of distance.	Having exploited the space of the opponent, dissecting the angles reveals that the optimum recovery position is on the opposite side of the ball and the same side as the stroke. This allows Ferrer to be efficient in his management of space and time.

6. Load	7. Forward Swing	8. Impact	9. Follow Through	10. Recover
				

Movement Analysis

1. Initiation

RF	Pf + ExRot
LF	Df + IRot
RK	Ext
LK	Flx
RHip	Ext + Ab + ExRot
LHIP	Flx + Ad + IRot
RCage	Atilt
Spine	In Flx throughout
Shlders	More Flx from neutral

2. 1st Shuffle

RF	DF + IRot
RHip	Flx + Ad + IRot
Pelvis	Rot right
	Adduction and abduction couple together to produce the shuffle

3. 1st Prep

RF	DF + IRot
RK	Flx
RHip	Flx + IRot + Ad
LF	ExRot + PF
LHip	ExRot + Ext + Ab
Pelvis	RRot + RHike + ShftR
RCage	Rot + Atilt

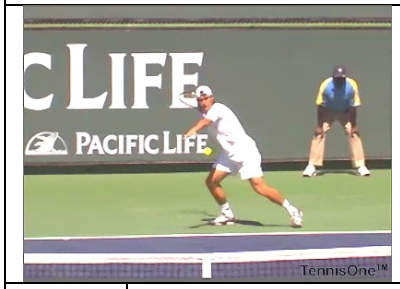
4. 2nd Prep

RF	Heel strike + Ext
RCage	Further RRot
LLeg	Flx
Pelvis	RRot (<RCage)
	Head position neutral

5. Unit Turn

RLeg	Further Ad
Plv	RRot
Rarm	ExRot at Rshlder
Larm	IRot at Lshlder
Shlders	RRot
Spine	RRot + still Flx
	Head position over right foot

6. Load



RF	DF + IRot
	load of the abdominal muscle via separation of pelvis and ribcage
	Head over right foot, C-spine rotated left
	Type 2 supination

7. Forward Swing

RLeg	Extended compared to previous image
RCage	Rotating back to left, pelvis leads
Pelvis	
Spine	LFlx L + RotL + Ext
Shldrs	RTilt (considerable)

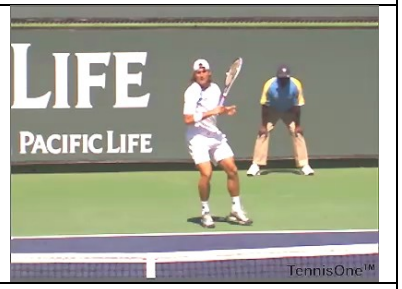
8. Impact

RLeg	Rot L
RCage	RotL + PosTilt
Spine	RotL + FlxL
Plevis	shifted left
	RCage nearly caught up with Pelvis, Lack of extension could cause the PosTilt in Rcage as compensation

9. Follow Through

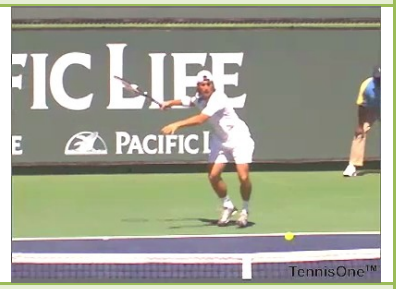
Legs	Flx throughout
Spine	RotL
	Shoulders pass pelvis again to load abs to decelerate speed and power of the swing.

10. Recover



Further decelerates the momentum of the swingin preparation to bring CofM back into alignment and prep for the next movement response.

MOVEMENT ANLSYSIS SUMMARY

1. Initiation	2. 1st Shuffle	3. 1st Prep	4. 2nd Prep	5. Unit Turn
				

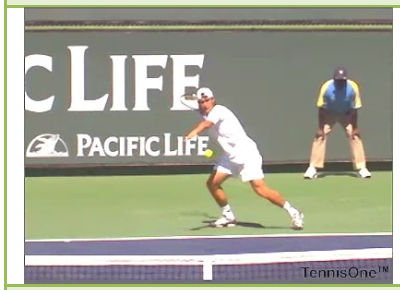
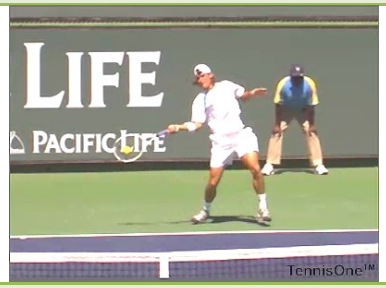
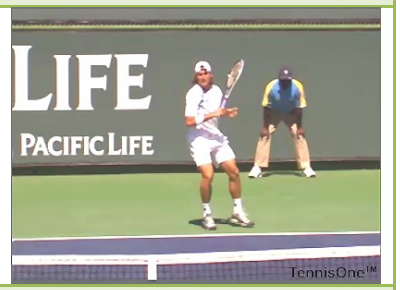
From the movement analysis it is evident that the entire body, including all the elements of the kinetic chain must be able to access all possible functions. It is clear that range is also important in carrying out tennis specific movements. The transfer of force from the ground through to impact is maximal if the joints involved can access the required movements and that the range of motion available is adequate. It is suggested that the range of motion should be greater at the joints than required for the body to be most comfortable and effective. Where there is not access or adequate range, the linkage will leak force and the body will be forced to compensate elsewhere, reducing the output, decreasing tactical opportunity and increasing injury risk (entering of emergency situations). The complete movement cycle has the potential to "leak force" from the beginning of the movement if space/time is not managed effectively and equally if the recovery is not sufficient.

From this it can be deduced that the tactical intention and the quality of the output has correlation with functionality of the body with in the required action.

Key Features

- This movement is primarily a rotational movement in the transverse plane.
- Ferrer generally has minimal extension in the lower body (this will cause compensation and it is suggested that the upper body posterior tilt at impact is where it is).
- The pelvis rotates approximately 90 degrees through the stroke allowing spinal structures to flex and rotate through wide range.
- There is cross loading patterns, right to left and left to right, which creates force and also used to decelerate the body post impact, (separation of pelvis and ribcage).
- Coupling of adduction/abduction allows the efficient shuffle action plus weight shifts too load.

Allowing Ferrer to access more extension in the lower body could limit the compensation in the upper body and enhance force transfer. In addition improving extension capabilities in the upper body would also allow more effective force transfer.

6. Load	7. Forward Swing	8. Impact	9. Follow Through	10. Recover
				

Functional Exercise	*These exercises promote joint/muscle actions that are prevalent in the output of the tactical intention and challenge the body in 3 dimensions in order to stimulate full potential.*	
SITUATION	**EXERCISE**	**DESCRIPTION**
Movement to the ball	Single Leg Squat w/Reach	With both feet together, flex at the knee & ankle whilst reaching out to the side with the free leg. Challenge the range & depth of the exercise. Aim to maintain a tall posture.
	Lateral Lunge	Lunge out to the side, keeping hands over the flexed knee and a vertical posture. Challenge the stretch by varying the lunge distance & direction and adding rotation & lateral flexion (to the left).
Movement through stroke	3D lunge (upper extension and lateral flexion)	Lunge in various directions whilst reaching vertically with the arms. Add a lateral flex and rotations with the reach.
	Full Stroke Move	Lunge into an exaggerated, full take back position with the "racket arm" reaching vertically whilst the other rotates. Rotate back through the stroke as far as possible.
Movement in recovery	Step & Return	Load hitting leg (right in this case) with full rotation and step onto left leg, complete full load and "bounce" back to neutral stance.
	Step and Flex	Step out to areas on the left/right side whilst using the left hand to reach back over the head to the right.

Movement Drills	*These drills integrate the functional exercises and should consider the complete movement cycle.*
Two Step Play, Two Step Recover	Start in a ready position, set the distance to cover and move with two side steps followed by exaggerated full stroke move. Finish stroke move and use two side steps to recover. Focus on quality, distances covered and full range of motion through stoke move.
Variations on above base drill	1. Add light medicine ball and incorporate throw 2. use racket to gain specificity 3. Change angles/distances of movement for full experience 4. Add in "speed" element (time pressures and/or actual hitting drill)