

Scott Pingel

Technical Fundamentals

Technical Fundamentals

Supplemental Mini-Studies

Scott Pingel

The exercises contained herein are intended to be targeted supplemental mini-studies that introduce various technical concepts to bassists. Some of the exercises are my own and some of them I've picked up from various people over the years, including former teachers, clinicians, authors, and former students. Among the sources are Francois Rabbath, Franco Petracchi, Simon Fischer, George Vance, Jeff Bradetich, Gary Karr, Louis Feuillard, Paul Ellison, Max Dimoff, David Moore, and Thomas Martin.

1. Fingerboard Geography

String playing is a matter of hearing and measuring. The ear is the ultimate guide, but your body must know where the sounds exist on the instrument and how to efficiently produce them.

Understanding the layout of the fingerboard and training your body to be intimately familiar with it will enable great freedom in playing. Much like learning the geography of an area, you may look at a map, but you cannot truly know the environment until you've explored it for yourself.

The geography begins with the entire playable range of the instrument, which is primarily the notes on the fingerboard, plus the natural harmonics off the end of it. The playable range is divided into natural reference points, or "nodes", which relate to the natural harmonic divisions of the string. This concept was first formalized by Francois Rabbath, but is to one degree or another one of the primary ways that string players have intuitively found their way around vibrating strings for centuries.

Training your geographical understanding begins with relating, respectively, your posture, arm position, thumb location, hand frame, and finger placement to the instrument, fingerboard, nodes, and individual notes, as well as the processes of moving efficiently between them. This involves the concepts of proprioception, kinesthesia, exteroception, and interoception.

Proprioception: unconscious awareness of body positioning

Kinesthesia: unconscious awareness of body motion

Exteroception: sensitivity to external stimuli and perception of the environment (sound, touch, sight, smell, taste)

Interoception: sensitivity to internal stimuli (muscle tension, breath, headaches, hunger, etc.)

Proprioceptive and kinesthetic systems are intimately related and operate via internal sensory receptors of the nervous system. They are what fundamentally comprise "muscle memory", which can be trained and refined like any motor activity through the practice of proper efficient motion and repetition. Training such abilities to become automatic enables you to concentrate on other aspects of your performance, such as expression and phrasing. Hence, it is imperative to build a solid foundation of technical abilities.

Reference "Nodes"

Tuning Harmonics

0 4-2-1 4-2-1 4-2-1+ 3-2-1+ 3-2-1+ 3-2-1+ 3-2-1+

Rabbath Positions: 1st Pos. 2nd Pos. 3rd Pos. 4th Pos. 5th Pos. 6th Pos.

0 4-2-1 4-2-1 4-2-1+ 3-2-1+ 3-2-1+ 3-2-1+ 3-2-1+

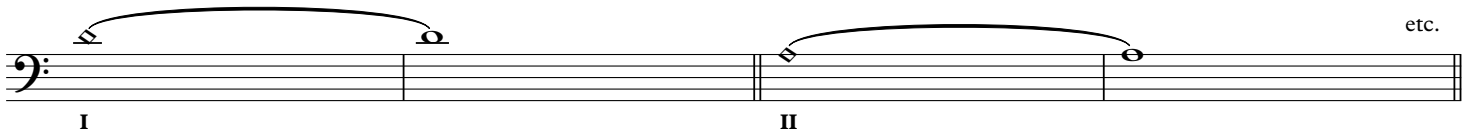
0 4-2-1 4-2-1 4-2-1+ 3-2-1+ 3-2-1+ 3-2-1+ 3-2-1+

0 4-2-1 4-2-1 4-2-1+ 3-2-1+ 3-2-1+ 3-2-1+ 3-2-1+

2. Engaging the String

Engaging the string to change its vibrating length is principally a matter of using torque and gravity, rather than any kind of clapping motion with the hand. Squeezing the neck inhibits the free motion of the fingers and inhibits shifting. The thumb should be primarily used as a guide and a pivot point for the free weight of the arm. To the degree that the thumb is engaged, it contacts the neck on the inner side of the thumb and *not* the pad. Attempting to use the pad of the thumb will dangerously contort the hand.

To see what degree of engagement is necessary to trap the string, sustain the D harmonic on the G-string with the 1st finger. Slowly close the string until it is fully trapped and a resonant tone is achieved.



Play the following repeated notes with a strong pizzicato, with your left hand finger only lightly on the string. You should only hear a dead "thud" sound. Gradually engage the string down to the fingerboard until the pitch comes into focus in a ringing tone. Any more pressure than this is wasted energy. Repeat the same process again, but with the bow, and notice how the bow is much more forgiving of inadequate trapping. Therefore, it is a good practice technique to play arco passages pizzicato, because it helps keep things honest!



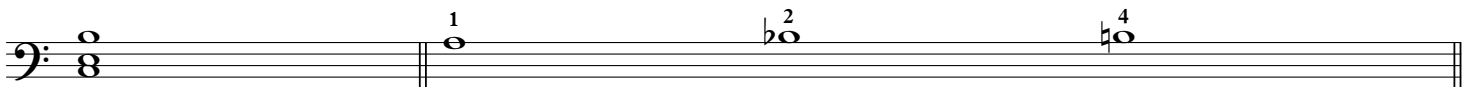
3. Natural Hand Shapes

When you use your body to engage the instrument, it is imperative that everything looks and feels as natural and effortless as possible. For something to be natural, there should be as little deviation from the neutral state of the body. The effortlessness comes from exploiting the forces of gravity and training smooth and efficient movement.

Lightly drape your fingers on the neck in the first position (first finger loosely on E on the D-string) with your elbow out in such a way as to feel both comfortable and engaged (neither sagging low, or elevated above the shoulder) and your wrist neutral (not contorted in any way). See how your hand is naturally shaped without any activation.

The natural width of your hand from first to fourth finger will form approximately a 5th: 1st finger on E on the D-string, and 4th finger on B on the G-string. The second finger will be sitting somewhere between, laying around C on the A-string (it is the longest finger and naturally reaches further across the strings), and the 3rd finger will be somewhere between 2nd and 4th fingers.

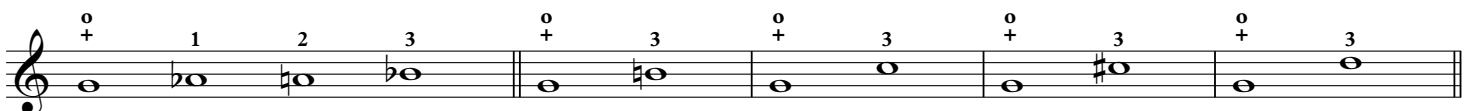
If you move all the fingers onto the G-string, the frame should naturally form about a whole step, with 1st finger on A, 2nd finger on B-flat, and 3rd and 4th finger working together on B-natural. In order to expand the frame fully to the whole step, widen from the base joints like opening a fan. As you do so, the base joints will also move closer to the neck to accommodate the increased reach. The fingers should remain curved and sitting on the string just back from the finger tip. To ensure that you are not sitting too low or flat-fingered, you should be able to see the upper part of your palm between your fingers. Practice expanding and contracting the frame of the hand from the base joints, primarily between 1st and 2nd fingers.



Likewise, loosely lay your hand on the fingerboard with thumb on the octave harmonic on the G-string. With the fingers neutrally draped, naturally curved, and relaxed, they will be spaced vertically about a half-step apart, and when placed all on one string, the frame will naturally form approximately a minor 3rd, or for some people, closer to a major 3rd. The contact point with the fingers will be more on the tip than the pad, relative to the neck positions.

To expand the frame, widen at the base joints like a fan, dropping them closer to the fingerboard as you widen. This will help to keep your arm weight centered, low, transferable to the needed finger, and not falling over toward the bridge.

It is important to note that the base joint of the thumb is located near the bottom of the palm of the hand. This joint has the largest range of motion and enables the hand to reach comfortably to a 5th or more in this position. We will address the spacing of the fingers within the frame in subsequent exercises.



4. Left Hand Articulation

The fingers are manipulated primarily by the muscles in the forearm: the flexors, which bring the fingers down, and the extensors, which raise them up. However, it is important that these muscles do not work against one another and cause tension and strain. I had problems with tendonitis because of the way my forearm muscles were working against one another, and had to spend months in physical therapy to remedy the problem. During that process, I learned how integrated the arm, forearm, and hand need to be. It isn't necessarily the pressing of the fingers that traps the string, but rather the fingers integrated with the free weight of the arm and rotational torque around the thumb.

When you engage the string, you should feel the sense of your arm hanging from the finger being used. As you place different fingers down, or use different shapes in the hand, the weight of the arm has to be free to redistribute its weight as needed. For instance, when playing 1st finger, your elbow will tend to be a slightly lower, and when playing 4th finger, your elbow will tend to be slightly higher.

Releasing the string should feel more passive than active. As the flexor muscles release, the extensors raise the fingers naturally unimpeded, aided by a slight lifting of the arm weight.

Practice the following exercises first pizzicato to study efficient trapping of the string. Pluck once at the beginning of the bar and then engage the following note so that it resonates freely. I like to describe the action as being like the suction cup of an octopus tentacle rapidly attaching to the fingerboard, or a cat stepping with its paw.

When lifting on the descent, slightly curl the finger toward the palm as you release to "pull" the string to efficiently activate it at the longer vibrating length. This helps to minimize the time between the string being fully engaged and fully released.

Feel the integration of your whole arm as you engage and release the different fingers. You should notice the weight of your arm shifting slightly into each finger as needed.

As the rate increases when playing the rhythmic variations, the motions will be smaller, but still integrated with the arm. If your arm gets tired or tense, stop, shake it out and relax. Tension only breeds more tension.

1. Pizz.

2. Arco

The musical notation consists of four staves. The first two staves are in bass clef, and the last two are in treble clef. Each staff contains six measures of music. The first staff shows exercises with fingerings 0-1, 1-0, 0-2, 2-0, 0-4, and 4-0. The second staff shows exercises with fingerings 1-2, 2-1, 1-4, 4-1, 2-4, and 4-2. The third staff shows exercises with fingerings 0+, 1, 1, 0+, 0+, 2, 2, 0+, 0+, 3, 3, 0+. The fourth staff shows exercises with fingerings 1-2, 2-1, 1-3, 3-1, 2-3, 3-2.

Variations: Also practice with separate bows (up to 16th-notes) for the study of coordination.

The musical notation consists of two staves in bass clef. The first staff shows exercises with triplets of 16th notes, with the number '3' written below each triplet. The second staff shows exercises with sextuplets of 16th notes, with the number '6' written below each sextuplet. The final note of the second staff is marked with a trill symbol (tr) and a flat sign (b).

5. Framing the Hand in the Neck Positions

The following exercises seek to develop the frame and strength of the hand in the neck positions. Unfortunately for our instrument, such exercises are not as musically interesting as those possible on smaller-scale string instruments that have more notes under the hand. Practicing various diatonic double-stops in your scale practice is another great way to train the frames of the hand. Training your hand to automatically know these physical distances will vastly improve your intonation consistency.

Focus on using the free weight of your arm to engage the string. Achieving a centered intonation and a resonant tone are essential as it will indicate that the fingers are in the correct position and properly engaged.

As the hand shapes change, notice how your elbow moves to accommodate the slight shifting of the arm weight in the hand. For example, when playing a perfect 5th the elbow will naturally be in a different position than when playing a minor third because of the way the weight will need to distribute in the hand.

Keep the fingers curved and either down or low to the string and ready act. If you feel cramped or tired, stop and shake it out.

Practice in various positions and on the other strings.

Two musical exercises for framing the hand in neck positions. The first exercise shows a sequence of double-stops on the bass staff with fingerings: 4/1, 4/2, 1/2, 1/4, 2/4, 2/1, 4/1, 4/1, 4/2, 1/2, 1/4, 2/4, 2/1, 4/1, etc. The second exercise shows a sequence of double-stops with fingerings: 4/1, 2/1, 2/4, 1/4, 1/2, 4/2, 4/1, 4/1, 2/1, 2/4, 1/4, 1/2, 4/2, 4/1, etc.

This exercise combines left hand articulation with the above framing exercises. This will help train your fingers to stay low and ready to engage.

Two musical exercises for left hand articulation with the frame of the hand. The first exercise shows a sequence of notes with fingerings: 4/1, 2/1, 2/4, 1/4, 1/2, 4/2, 4/1, 4/1, 2/1, 2/4, 1/4, 1/2, 4/2, 4/1, etc. The second exercise shows a sequence of notes with fingerings: 4/1, 2/1, 2/4, 1/4, 1/2, 4/2, 4/1, 4/1, 2/1, 2/4, 1/4, 1/2, 4/2, 4/1, etc.

Left hand articulation in the frame of the hand with open strings.

Two musical exercises for left hand articulation in the frame of the hand with open strings. The first exercise shows a sequence of notes with fingerings: 4/0, 2/0, 1/0, 4/0, 2/0, 1/0, 4/0, 2/0, 1/0, 4/0, 2/0, 1/0, 4/0, 2/0, 1/0, 4/0, etc. The second exercise shows a sequence of notes with fingerings: 4/0, 2/0, 1/0, 4/0, 2/0, 1/0, 4/0, 2/0, 1/0, 4/0, 2/0, 1/0, 4/0, 2/0, 1/0, 4/0, etc.

6. Chromatic fingering exercise for speed and dexterity.

Begin quite slowly, paying attention to integrating your entire arm as you engage each finger. Gradually increase the speed, with the actions always feeling effortless, fluid, and tension-free. Continue up the neck positions and back, and repeat on the other strings. Also, practice these patterns mixed with legato and separate bows in order to develop coordination between the hands.

Two staves of musical notation for a chromatic fingering exercise. The first staff shows a sequence of notes with fingerings: 1 2 4 2 1 4 2 4 1 2 4 2 1 4 2 1, followed by a repeat with fingerings: -1 2 4 2 1 4 2 4 1 2 4 2 1 4 2 1 etc. The second staff shows a sequence of notes with fingerings: 3 2 1 2 3 1 2 1 3 2 1 2 3 1 2 3, followed by a repeat with fingerings: -4 2 1 2 4 1 2 1 4 2 1 2 4 1 2 4 etc. Both staves include the word *détaché* under the notes.

7. Small Shift Exercises

These exercises seek to study the mechanics of smooth shifting using small intervals. Understanding these motions will improve many aspects of your technique, from executing shifts in scales to passage work in repertoire. Additionally, it is important to study carefully the motion of the arm, for it is the arm that locates positions, not the fingers. The fingers follow the arm in either direction.

As you play the first exercise, the notes should all sound equal in tone and intonation, regardless of which finger is being used. Practice both with a ringing pizzicato and arco to ensure proper engagement of the string. When changing fingers, feel the rotational torquing motion in the hand as the weight shifts between them.

Three staves of musical notation for small shift exercises. Each staff contains a sequence of notes with fingerings, repeated three times. The first staff has fingerings: 1 1 2 4 4 2 1 1, 1 2 2 4 4 2 2 1, 1 2 4 4 4 4 2 1. The second staff has fingerings: 1 2 1 2 2 1 2 1, 1 2 4 2 2 4 2 1, 1 2 4 1 1 4 2 1. The third staff has fingerings: 1 2 4 4 4 4 2 1, 1 2 4 2 2 4 2 1, 1 2 4 1 1 4 2 1.

Tetrachord Exercise: This exercise is a common warm-up. It uses five different tetrachords to study shifting between adjacent positions. Continue up the neck chromatically, and play on different strings.

Two staves of musical notation for a tetrachord exercise. Each staff shows a sequence of four-note tetrachords with fingerings: 1 4 2 4, 1 4 1 4, 1 2 1 4, 1 2 2 4, 1 4 1 4. The second staff includes the word *etc.* at the end.

8. Scale Study on One String

The following exercises build on the small shifting exercises, as well as examine using the frame of the hand to measure the distance between the arm positions.

The first scale uses "replacement fingerings" to feel and measure the distance between the positions with the frame of the hand. The second scale uses the same pattern, only with "ghosting" or "miming" the x-notes without playing them. The third scale focuses on the action of shifting between the positions, and then finally the fourth scale is to be played normally. Additionally, try practicing this with the thumb off of the neck at all times to neutralize any attempt at squeezing.

One staff of musical notation for a scale study exercise. It shows a sequence of notes with fingerings: 1 4 1 4 2 4 1 4 1 4 1 3 2 3 3 2 3 1 4 1 4 1 4 2 4 1 4 1.

9. Large Shift Exercise

This exercise is affectionately known as the "vomit" exercise, because it can sound a bit like that rather unpleasant action. It is intended to develop the action of shifting over the entire range of the fingerboard. Practicing this exercise up to two octaves will help train your ear to hear intervals over an octave. It is also a very good exercise to sing the pitches before playing them so that your ear is guiding your hand.

Play these quite slowly, thinking about how you use your arm to track up and down the fingerboard. Always be aware of your arm position relative to the reference nodes, as shifting and positioning are more about the arm than the fingers. 3rd finger replaces the 4th finger above the octave harmonic.

Practice on all strings in all fingering combinations using scales in any major or minor key, diatonic modes, or other scales such as chromatic, whole-tone, and diminished. You will likely use this exercise much of your career and will get out of it what you put into it.

Bowing tips: Play both legato and détaché (starting both down-bow and up-bow) in order to practice timing the shift with the change of bow. For the purposes of this exercise, use "classical shifts" when playing separate bows. A "classical shift" is a shift that occurs *before* the bow change, and arrives at the new note at the moment the bow changes direction.

As you shift, *the bow should move at the speed of the lowest note*. Additionally, as you change the vibrating length of the string, you have to proportionately change the bow contact point in order to maintain a consistent tone. For example, if you shift up one octave from 1st position A on the G-string, you've shortened the vibrating string length by half. To maintain a consistent tone on the higher A, you would have to proportionally move your bow half the distance to the bridge from its contact point for the lower A.

Fingering patters: 1-1, 1-2, 1-4(3); 2-1, 2-2, 2-4(3); 4-1, 4-2, 4-4(3). -In this key, begin the 4th finger pattern on the note B.

Variation: To practice shifting with string crossings, begin the first note on a higher or lower string. Generally, the bow will cross strings when the left arm has arrived at the new position.

8 10. Pivot Technique

The pivot technique involves leaving the thumb in one location while pivoting the hand frame around it to expand the range of notes. Most players use this technique, whether they realize it or not, when playing in the traditional 4th position (Rabath 3rd position), where the thumb rests at the heel of the neck. In that position, the thumb remains essentially in the same position as the hand reaches toward the higher pitches, up to the octave harmonic. I personally use this technique only intermittently and not exclusively, but do find it quite useful in many instances, such as passage work.

While playing these exercises, pay attention to the location of your thumb relative to the reference nodes, how your arm and hand move around the thumb, and what notes are under your fingers in the frame of your hand. Release the finger preceding the pivot motion, moving rotationally around the thumb. Avoid dragging your finger or stretching your hand out of a relaxed shape.

Practice these both pizzicato and arco in different positions on all the strings, and experiment with some of your own fingering patterns. (From *Vade Mecum* by George Vance, an excellent book for beginning bass players.)

Five staves of musical notation for pivot exercises. Each staff shows a sequence of notes with fingerings (1, -2, 4, 0, -3, 0, 3, -4, 2, -1) and corresponding bowing patterns with slurs and accents.

Pivot versions of the chromatic fingering exercise (#6 above). Practice in different positions with a variety of rhythms.

A single staff of musical notation for pivot chromatic fingering exercises. It shows two groups of notes with fingerings (1, -2, 4, 2, -1, -4, 2, 4) and (-1, 4) and (-1, 4) above them, and corresponding bowing patterns.

11. One Octave Scales in Position Across Three Strings Using the Pivot Technique

Practice these universal fingering patterns in different positions and keys beginning on both the A and E strings.

A complex block of musical notation for one-octave scales in position across three strings. It includes six staves for E Major, E Minor, D Major, D Minor, C Major, and C Minor, each with specific fingerings and bowing patterns.

13. Diatonic Frames and Pivots Across Four Strings in the Neck Positions

This exercise is a bit more advanced, but really develops stamina and strength (especially if you go up and then back down to where you started). If your hand gets tired, stop and shake it out. Also, try playing the entire exercise up a half-step in G \flat Major.

The exercise is written in bass clef and consists of ten staves. The first two staves are in 3/4 time, and the remaining eight staves are in 4/4 time. The key signature has one flat (B \flat Major). The notation includes various fingerings (1-4) and techniques such as pivots (indicated by -1) and frames (indicated by 4). The exercise is designed to develop stamina and strength by moving up and then back down across four strings.

Staff 1: 3/4 time. Fingerings: 4 1, 2 4, 4 2, 2 4, 4 1, 1 4. Notes: G \flat 2, B \flat 2, C3, D3, E3, F3, G \flat 3, A3, B \flat 3, C4, D4, E4, F4, G \flat 4, A4, B \flat 4, C5, D5, E5, F5, G \flat 5, A5, B \flat 5, C6, D6, E6, F6, G \flat 6, A6, B \flat 6, C7, D7, E7, F7, G \flat 7, A7, B \flat 7, C8, D8, E8, F8, G \flat 8, A8, B \flat 8, C9, D9, E9, F9, G \flat 9, A9, B \flat 9, C10, D10, E10, F10, G \flat 10, A10, B \flat 10, C11, D11, E11, F11, G \flat 11, A11, B \flat 11, C12, D12, E12, F12, G \flat 12, A12, B \flat 12, C13, D13, E13, F13, G \flat 13, A13, B \flat 13, C14, D14, E14, F14, G \flat 14, A14, B \flat 14, C15, D15, E15, F15, G \flat 15, A15, B \flat 15, C16, D16, E16, F16, G \flat 16, A16, B \flat 16, C17, D17, E17, F17, G \flat 17, A17, B \flat 17, C18, D18, E18, F18, G \flat 18, A18, B \flat 18, C19, D19, E19, F19, G \flat 19, A19, B \flat 19, C20, D20, E20, F20, G \flat 20, A20, B \flat 20, C21, D21, E21, F21, G \flat 21, A21, B \flat 21, C22, D22, E22, F22, G \flat 22, A22, B \flat 22, C23, D23, E23, F23, G \flat 23, A23, B \flat 23, C24, D24, E24, F24, G \flat 24, A24, B \flat 24, C25, D25, E25, F25, G \flat 25, A25, B \flat 25, C26, D26, E26, F26, G \flat 26, A26, B \flat 26, C27, D27, E27, F27, G \flat 27, A27, B \flat 27, C28, D28, E28, F28, G \flat 28, A28, B \flat 28, C29, D29, E29, F29, G \flat 29, A29, B \flat 29, C30, D30, E30, F30, G \flat 30, A30, B \flat 30, C31, D31, E31, F31, G \flat 31, A31, B \flat 31, C32, D32, E32, F32, G \flat 32, A32, B \flat 32, C33, D33, E33, F33, G \flat 33, A33, B \flat 33, C34, D34, E34, F34, G \flat 34, A34, B \flat 34, C35, D35, E35, F35, G \flat 35, A35, B \flat 35, C36, D36, E36, F36, G \flat 36, A36, B \flat 36, C37, D37, E37, F37, G \flat 37, A37, B \flat 37, C38, D38, E38, F38, G \flat 38, A38, B \flat 38, C39, D39, E39, F39, G \flat 39, A39, B \flat 39, C40, D40, E40, F40, G \flat 40, A40, B \flat 40, C41, D41, E41, F41, G \flat 41, A41, B \flat 41, C42, D42, E42, F42, G \flat 42, A42, B \flat 42, C43, D43, E43, F43, G \flat 43, A43, B \flat 43, C44, D44, E44, F44, G \flat 44, A44, B \flat 44, C45, D45, E45, F45, G \flat 45, A45, B \flat 45, C46, D46, E46, F46, G \flat 46, A46, B \flat 46, C47, D47, E47, F47, G \flat 47, A47, B \flat 47, C48, D48, E48, F48, G \flat 48, A48, B \flat 48, C49, D49, E49, F49, G \flat 49, A49, B \flat 49, C50, D50, E50, F50, G \flat 50, A50, B \flat 50, C51, D51, E51, F51, G \flat 51, A51, B \flat 51, C52, D52, E52, F52, G \flat 52, A52, B \flat 52, C53, D53, E53, F53, G \flat 53, A53, B \flat 53, C54, D54, E54, F54, G \flat 54, A54, B \flat 54, C55, D55, E55, F55, G \flat 55, A55, B \flat 55, C56, D56, E56, F56, G \flat 56, A56, B \flat 56, C57, D57, E57, F57, G \flat 57, A57, B \flat 57, C58, D58, E58, F58, G \flat 58, A58, B \flat 58, C59, D59, E59, F59, G \flat 59, A59, B \flat 59, C60, D60, E60, F60, G \flat 60, A60, B \flat 60, C61, D61, E61, F61, G \flat 61, A61, B \flat 61, C62, D62, E62, F62, G \flat 62, A62, B \flat 62, C63, D63, E63, F63, G \flat 63, A63, B \flat 63, C64, D64, E64, F64, G \flat 64, A64, B \flat 64, C65, D65, E65, F65, G \flat 65, A65, B \flat 65, C66, D66, E66, F66, G \flat 66, A66, B \flat 66, C67, D67, E67, F67, G \flat 67, A67, B \flat 67, C68, D68, E68, F68, G \flat 68, A68, B \flat 68, C69, D69, E69, F69, G \flat 69, A69, B \flat 69, C70, D70, E70, F70, G \flat 70, A70, B \flat 70, C71, D71, E71, F71, G \flat 71, A71, B \flat 71, C72, D72, E72, F72, G \flat 72, A72, B \flat 72, C73, D73, E73, F73, G \flat 73, A73, B \flat 73, C74, D74, E74, F74, G \flat 74, A74, B \flat 74, C75, D75, E75, F75, G \flat 75, A75, B \flat 75, C76, D76, E76, F76, G \flat 76, A76, B \flat 76, C77, D77, E77, F77, G \flat 77, A77, B \flat 77, C78, D78, E78, F78, G \flat 78, A78, B \flat 78, C79, D79, E79, F79, G \flat 79, A79, B \flat 79, C80, D80, E80, F80, G \flat 80, A80, B \flat 80, C81, D81, E81, F81, G \flat 81, A81, B \flat 81, C82, D82, E82, F82, G \flat 82, A82, B \flat 82, C83, D83, E83, F83, G \flat 83, A83, B \flat 83, C84, D84, E84, F84, G \flat 84, A84, B \flat 84, C85, D85, E85, F85, G \flat 85, A85, B \flat 85, C86, D86, E86, F86, G \flat 86, A86, B \flat 86, C87, D87, E87, F87, G \flat 87, A87, B \flat 87, C88, D88, E88, F88, G \flat 88, A88, B \flat 88, C89, D89, E89, F89, G \flat 89, A89, B \flat 89, C90, D90, E90, F90, G \flat 90, A90, B \flat 90, C91, D91, E91, F91, G \flat 91, A91, B \flat 91, C92, D92, E92, F92, G \flat 92, A92, B \flat 92, C93, D93, E93, F93, G \flat 93, A93, B \flat 93, C94, D94, E94, F94, G \flat 94, A94, B \flat 94, C95, D95, E95, F95, G \flat 95, A95, B \flat 95, C96, D96, E96, F96, G \flat 96, A96, B \flat 96, C97, D97, E97, F97, G \flat 97, A97, B \flat 97, C98, D98, E98, F98, G \flat 98, A98, B \flat 98, C99, D99, E99, F99, G \flat 99, A99, B \flat 99, C100, D100, E100, F100, G \flat 100, A100, B \flat 100, C101, D101, E101, F101, G \flat 101, A101, B \flat 101, C102, D102, E102, F102, G \flat 102, A102, B \flat 102, C103, D103, E103, F103, G \flat 103, A103, B \flat 103, C104, D104, E104, F104, G \flat 104, A104, B \flat 104, C105, D105, E105, F105, G \flat 105, A105, B \flat 105, C106, D106, E106, F106, G \flat 106, A106, B \flat 106, C107, D107, E107, F107, G \flat 107, A107, B \flat 107, C108, D108, E108, F108, G \flat 108, A108, B \flat 108, C109, D109, E109, F109, G \flat 109, A109, B \flat 109, C110, D110, E110, F110, G \flat 110, A110, B \flat 110, C111, D111, E111, F111, G \flat 111, A111, B \flat 111, C112, D112, E112, F112, G \flat 112, A112, B \flat 112, C113, D113, E113, F113, G \flat 113, A113, B \flat 113, C114, D114, E114, F114, G \flat 114, A114, B \flat 114, C115, D115, E115, F115, G \flat 115, A115, B \flat 115, C116, D116, E116, F116, G \flat 116, A116, B \flat 116, C117, D117, E117, F117, G \flat 117, A117, B \flat 117, C118, D118, E118, F118, G \flat 118, A118, B \flat 118, C119, D119, E119, F119, G \flat 119, A119, B \flat 119, C120, D120, E120, F120, G \flat 120, A120, B \flat 120, C121, D121, E121, F121, G \flat 121, A121, B \flat 121, C122, D122, E122, F122, G \flat 122, A122, B \flat 122, C123, D123, E123, F123, G \flat 123, A123, B \flat 123, C124, D124, E124, F124, G \flat 124, A124, B \flat 124, C125, D125, E125, F125, G \flat 125, A125, B \flat 125, C126, D126, E126, F126, G \flat 126, A126, B \flat 126, C127, D127, E127, F127, G \flat 127, A127, B \flat 127, C128, D128, E128, F128, G \flat 128, A128, B \flat 128, C129, D129, E129, F129, G \flat 129, A129, B \flat 129, C130, D130, E130, F130, G \flat 130, A130, B \flat 130, C131, D131, E131, F131, G \flat 131, A131, B \flat 131, C132, D132, E132, F132, G \flat 132, A132, B \flat 132, C133, D133, E133, F133, G \flat 133, A133, B \flat 133, C134, D134, E134, F134, G \flat 134, A134, B \flat 134, C135, D135, E135, F135, G \flat 135, A135, B \flat 135, C136, D136, E136, F136, G \flat 136, A136, B \flat 136, C137, D137, E137, F137, G \flat 137, A137, B \flat 137, C138, D138, E138, F138, G \flat 138, A138, B \flat 138, C139, D139, E139, F139, G \flat 139, A139, B \flat 139, C140, D140, E140, F140, G \flat 140, A140, B \flat 140, C141, D141, E141, F141, G \flat 141, A141, B \flat 141, C142, D142, E142, F142, G \flat 142, A142, B \flat 142, C143, D143, E143, F143, G \flat 143, A143, B \flat 143, C144, D144, E144, F144, G \flat 144, A144, B \flat 144, C145, D145, E145, F145, G \flat 145, A145, B \flat 145, C146, D146, E146, F146, G \flat 146, A146, B \flat 146, C147, D147, E147, F147, G \flat 147, A147, B \flat 147, C148, D148, E148, F148, G \flat 148, A148, B \flat 148, C149, D149, E149, F149, G \flat 149, A149, B \flat 149, C150, D150, E150, F150, G \flat 150, A150, B \flat 150, C151, D151, E151, F151, G \flat 151, A151, B \flat 151, C152, D152, E152, F152, G \flat 152, A152, B \flat 152, C153, D153, E153, F153, G \flat 153, A153, B \flat 153, C154, D154, E154, F154, G \flat 154, A154, B \flat 154, C155, D155, E155, F155, G \flat 155, A155, B \flat 155, C156, D156, E156, F156, G \flat 156, A156, B \flat 156, C157, D157, E157, F157, G \flat 157, A157, B \flat 157, C158, D158, E158, F158, G \flat 158, A158, B \flat 158, C159, D159, E159, F159, G \flat 159, A159, B \flat 159, C160, D160, E160, F160, G \flat 160, A160, B \flat 160, C161, D161, E161, F161, G \flat 161, A161, B \flat 161, C162, D162, E162, F162, G \flat 162, A162, B \flat 162, C163, D163, E163, F163, G \flat 163, A163, B \flat 163, C164, D164, E164, F164, G \flat 164, A164, B \flat 164, C165, D165, E165, F165, G \flat 165, A165, B \flat 165, C166, D166, E166, F166, G \flat 166, A166, B \flat 166, C167, D167, E167, F167, G \flat 167, A167, B \flat 167, C168, D168, E168, F168, G \flat 168, A168, B \flat 168, C169, D169, E169, F169, G \flat 169, A169, B \flat 169, C170, D170, E170, F170, G \flat 170, A170, B \flat 170, C171, D171, E171, F171, G \flat 171, A171, B \flat 171, C172, D172, E172, F172, G \flat 172, A172, B \flat 172, C173, D173, E173, F173, G \flat 173, A173, B \flat 173, C174, D174, E174, F174, G \flat 174, A174, B \flat 174, C175, D175, E175, F175, G \flat 175, A175, B \flat 175, C176, D176, E176, F176, G \flat 176, A176, B \flat 176, C177, D177, E177, F177, G \flat 177, A177, B \flat 177, C178, D178, E178, F178, G \flat 178, A178, B \flat 178, C179, D179, E179, F179, G \flat 179, A179, B \flat 179, C180, D180, E180, F180, G \flat 180, A180, B \flat 180, C181, D181, E181, F181, G \flat 181, A181, B \flat 181, C182, D182, E182, F182, G \flat 182, A182, B \flat 182, C183, D183, E183, F183, G \flat 183, A183, B \flat 183, C184, D184, E184, F184, G \flat 184, A184, B \flat 184, C185, D185, E185, F185, G \flat 185, A185, B \flat 185, C186, D186, E186, F186, G \flat 186, A186, B \flat 186, C187, D187, E187, F187, G \flat 187, A187, B \flat 187, C188, D188, E188, F188, G \flat 188, A188, B \flat 188, C189, D189, E189, F189, G \flat 189, A189, B \flat 189, C190, D190, E190, F190, G \flat 190, A190, B \flat 190, C191, D191, E191, F191, G \flat 191, A191, B \flat 191, C192, D192, E192, F192, G \flat 192, A192, B \flat 192, C193, D193, E193, F193, G \flat 193, A193, B \flat 193, C194, D194, E194, F194, G \flat 194, A194, B \flat 194, C195, D195, E195, F195, G \flat 195, A195, B \flat 195, C196, D196, E196, F196, G \flat 196, A196, B \flat 196, C197, D197, E197, F197, G \flat 197, A197, B \flat 197, C198, D198, E198, F198, G \flat 198, A198, B \flat 198, C199, D199, E199, F199, G \flat 199, A199, B \flat 199, C200, D200, E200, F200, G \flat 200, A200, B \flat 200, C201, D201, E201, F201, G \flat 201, A201, B \flat 201, C202, D202, E202, F202, G \flat 202, A202, B \flat 202, C203, D203, E203, F203, G \flat 203, A203, B \flat 203, C204, D204, E204, F204, G \flat 204, A204, B \flat 204, C205, D205, E205, F205, G \flat 205, A205, B \flat 205, C206, D206, E206, F206, G \flat 206, A206, B \flat 206, C207, D207, E207, F207, G \flat 207, A207, B \flat 207, C208, D208, E208, F208, G \flat 208, A208, B \flat 208, C209, D209, E209, F209, G \flat 209, A209, B \flat 209, C210, D210, E210, F210, G \flat 210, A210, B \flat 210, C211, D211, E211, F211, G \flat 211, A211, B \flat 211, C212, D212, E212, F212, G \flat 212, A212, B \flat 212, C213, D213, E213, F213, G \flat 213, A213, B \flat 213, C214, D214, E214, F214, G \flat 214, A214, B \flat 214, C215, D215, E215, F215, G \flat 215, A215, B \flat 215, C216, D216, E216, F216, G \flat 216, A216, B \flat 216, C217, D217, E217, F217, G \flat 217, A217, B \flat 217, C218, D218, E218, F218, G \flat 218, A218, B \flat 218, C219, D219, E219, F219, G \flat 219, A219, B \flat 219, C220, D220, E220, F220, G \flat 220, A220, B \flat 220, C221, D221, E221, F221, G \flat 221, A221, B \flat 221, C222, D222, E222, F222, G \flat 222, A222, B \flat 222, C223, D223, E223, F223, G \flat 223, A223, B \flat 223, C224, D224, E224, F224, G \flat 224, A224, B \flat 224, C225, D225, E225, F225, G \flat 225, A225, B \flat 225, C226, D226, E226, F226, G \flat 226, A226, B \flat 226, C227, D227, E227, F227, G \flat 227, A227, B \flat 227, C228, D228, E228, F228, G \flat 228, A228, B \flat 228, C229, D229, E229, F229, G \flat 229, A229, B \flat 229, C230, D230, E230, F230, G \flat 230, A230, B \flat 230, C231, D231, E231, F231, G \flat 231, A231, B \flat 231, C232, D232, E232, F232, G \flat 232, A232, B \flat 232, C233, D233, E233, F233, G \flat 233, A233, B \flat 233, C234, D234, E234, F234, G \flat 234, A234, B \flat 234, C235, D235, E235, F235, G \flat 235, A235, B \flat 235, C236, D236, E236, F236, G \flat 236, A236, B \flat 236, C237, D237, E237, F237, G \flat 237, A237, B \flat 237, C238, D238, E238, F238, G \flat 238, A238, B \flat 238, C239, D239, E239, F239, G \flat 239, A239, B \flat 239, C240, D240, E240, F240, G \flat 240, A240, B \flat 240, C241, D241, E241, F241, G \flat 241, A241, B \flat 241, C242, D242, E242, F242, G \flat 242, A242, B \flat 242, C243, D243, E243, F243, G \flat 243, A243, B \flat 243, C244, D244, E244, F244, G \flat 244, A244, B \flat 244, C245, D245, E245, F245, G \flat 245, A245, B \flat 245, C246, D246, E246, F246, G \flat 246, A246, B \flat 246, C247, D247, E247, F247, G \flat 247, A247, B \flat 247, C248, D248, E248, F248, G \flat 248, A248, B \flat 248, C249, D249, E249, F249, G \flat 249, A249, B \flat 249, C250, D250, E250, F250, G \flat 250, A250, B \flat 250, C251, D251, E251, F251, G \flat 251, A251, B \flat 251, C252, D252, E252, F252, G \flat 252, A252, B \flat 252, C253, D253, E253, F253, G \flat 253, A253, B \flat 253, C254, D254, E254, F254, G \flat 254, A254, B \flat 254, C255, D255, E255, F255, G \flat 255, A255, B \flat 255, C256, D256, E256, F256, G \flat 256, A256, B \flat 256, C257, D257, E257, F257, G \flat 257, A257, B \flat 257, C258, D258, E258, F258, G \flat 258, A258, B \flat 258, C259, D259, E259, F259, G \flat 259, A259, B \flat 259, C260, D260, E260, F260, G \flat 260, A260, B \flat 260, C261, D261

14. Pivot and Extension

Sometimes extended fingerings are the appropriate technical solution to a musical problem, such as minor 6th double stops in the neck positions when using the thumb is not practical, or minor 3rd intervals where a shift or pivot won't suffice in context. The range of extended fingerings is of course contingent on the relative size of the hand to the overall string length. If you have large hands and a short string length, you may be able to reach as far as a major 6th double stop from 1st to 4th finger around the traditional 4th position (A on the D-string and F# on the G-string).

The challenge with extended fingerings is keeping the hand relaxed and free of tension. Extensions are an opening of the hand from the base joints in order to reach beyond the normal frame of the hand.

15. Bar and Fork Techniques

Playing perfect 4ths and minor 7ths across the strings on a bass presents a unique problem from the other intervals because of the tuning of the strings. In some musical contexts, hopping to the next string with the same finger may be mechanically too complicated and therefore disruptive to the flow and connection in the music, especially in the case of a legato string crossing. Bar and fork techniques can serve to make things smoother and more resonant.

The bar technique uses the same finger to trap notes directly across from one another on different strings, and is only used in the neck positions. The position of the hand is perpendicular to the string.

The fork technique uses different fingers for similar purposes, yet can be used anywhere on the fingerboard in a few different shapes of the hand (almost always involving a higher finger on a higher string). The position of the hand will be angled to the string.

Each has advantages and disadvantages in different musical contexts. In the neck positions, the bar technique is easier to set up, whereas the fork technique has better resonance because of the more secure trapping of the string. Because of the angle of the arm in the higher positions, the bar technique become largely impractical. Whichever technique you use, accommodating the music with ease and efficiency should be the primary determining factor.

Bar Technique

In the first exercise, notice how the arm rotates slightly around the neck to transfer weight into the part of the finger that is needed. In the following example, the elbow will be slightly higher for notes on lower strings, and will rotate lower around the neck notes on the higher strings. In some cases when the speed is fast, or playing double-stops, you need to "mash" down the weight equally into both notes.

Exercise combining the various hand shapes with barring technique. Practice chromatically in different positions.

Fork Technique Exercise

This exercise utilizes different "forked" shapes on the perfect fourths and tritones. Keep the hand ready during the major 3rds.

Continue up the neck chromatically, and practice on other strings.

16. Vibrato

Vibrato is an expressive effect consisting of a pulsating change in pitch from the pitch center and below (vibrating above the center of the pitch makes the note sound sharp, as the human ear is naturally drawn to the higher pitch).

The variety of expressive effects in vibrato arise from the amplitude (width) and speed (rate), which should ultimately be intuitive and not calculated and mechanical. However, I have seen a number of students struggle to liberate their vibrato from technical limitations, so some exercises can be helpful toward this end.

The mechanics of vibrato are a combination of active and passive movements in the arm to effect a rocking motion around the fingertip. The action becomes a matter of "drop-rebound", rather than two separate active motions of "forward-back". It is not a twisting motion in the forearm, but a rocking motion, as the base knuckles of the hand should describe an arc from the center of the pitch and back.

The genesis of the motion comes from different parts of the arm, depending on the position on the fingerboard. In the lower positions, the motion comes primarily from rotation in the shoulder, and as the arm moves to the higher positions, the motion comes more and more from an opening and closing of the elbow joint.

Vibrato Motion and Speed

In the exercise below (adapted from Simon Fischer), the x-note is where the hand rocks back before the weight of the arm falls forward to the pitch center. As the rate gets faster, the backward rocking will feel more like a rebound. (F = forward to center of pitch, B = rock back below center of pitch)

Practice with fingers 1, 2, and 4(3) in all positions, one finger at a time. As you are rocking on each finger, keep the other fingers relaxed together like a closed fan, and positioned so as to allow for a free rocking motion. For example, it is easier to rock on 4 if 1 and 2 are slightly lifted off the string.

Notice how the source of the motion changes from shoulder to elbow as you go to higher positions. The thumb should always be relaxed. Try practicing with the thumb off of the neck, feeling the arm hanging from the finger.

The bow speed should remain constant throughout, unaffected by the rate of the vibrato, and drawn parallel to the bridge.

Vibrato Width

In this exercise, the rate of vibrato will remain constant (pulses per beat) as the width changes.

♩ = 60

very narrow... ...moderate width... ...very wide... ...moderate width... ...very narrow

very narrow... ...moderate width... ...very wide... ...moderate width... ...very narrow

Vibrato Accents

Generally, you want to have a degree of independence between the hands; however, sometimes the left hand can enhance what the right hand is doing. Here the rate of vibrato will be used to enhance the effect of the accents, matching the energy in the right hand with the left hand.

The bow speed on "sforzando" accents is fast-slow. When the bow speed is faster, so will be the vibrato speed, and as the bow speed slows, the vibrato rate slows.

Try it without any vibrato, then add the vibrato to match the right hand and see how it changes the effect. Repeat with different fingers in different positions.

sf *sf* *sf* *sf*

Timing the Change of Finger During Continuous Vibrato

Using the pulsing subdivisions from before, this exercise seeks to aid in the timing and coordination of transferring weight during vibration.

Ascending: as the arm rocks forward, the higher finger will drop into position in the center of the pitch.

Descending: the lower finger has to be prepared before the higher finger lifts. This can be done by leaving the lower finger down loosely on the string, or putting it down as the hand rocks back, just before the higher finger lifts (at faster speeds, this will feel almost simultaneous).

2 drops onto the fingerboard as the hand rolls forward.

Prepare 1 before 2 lifts.

Continue with other subdivisions.

Two pulses per beat.

Three pulses per beat.

3 3 3 3

Four pulses per beat.

etc.

3 3 3 3

Continuous Vibrato During Shifts and Shifts with Finger Changes

Practice these shifts and shifts with finger changes with the subdivisions above.

Two staves of musical notation in bass clef. The first staff contains six measures of eighth-note patterns with fingerings 1, 2, and 4. The second staff contains six measures with fingerings 1, 2, 4, and 1. Each measure includes a slur and a vibrato symbol over the notes.

One Finger Vibrato Scale

One-finger scale with each finger for the study of smooth shifting and continuous vibrato. This also makes a wonderful warm-up exercise. Also practice with the fingering from exercise #8 for continuous vibrato during the change of fingers

Two staves of musical notation in bass clef. The first staff shows a scale with fingerings 1, 2, 2, 2, 2, 2, 2 and finger numbers 1, 4, 4, 4, 4, 3, 3 below. The second staff shows a scale with fingerings 1, 1, 1, 1, 1, 1, 1 and finger numbers 3, 3, 4, 4, 4, 4, 1 below. Each measure includes a slur and a vibrato symbol over the notes.

17. Frames of the Hand with the Thumb

The frame of the hand has a much broader range of possibilities when using the thumb, especially in the higher positions where the spacing between the notes becomes smaller. Everyone's physiology is slightly different, but there are a number of frames and finger spacings that can be made quite practical for most players.

In his book, *Simplified Higher Technique*, Franco Petracchi identifies the most common hand shapes (frame of the hand and finger spacing) as the "chromatic, semi-chromatic, and diatonic". These span, respectively, a minor 3rd, major 3rd, and a perfect 4th, with the common denominator being a half-step between the 2nd and 3rd fingers. For most people, a spacing of a whole step or more between 2nd and 3rd finger is very unstable and weak. This is because 3rd finger is shorter than the 2nd finger, and as the hand moves to higher positions, the base joint of the 3rd finger moves further away from the string because of the angle of the arm (assuming the wrist remains neutrally straight and not contorted).

Chromatic (minor 3rd) Semi-Chromatic (major 3rd) Diatonic (perfect 4th)

H H H W H H W W H

The above frames across two strings:

Chromatic (minor 7th/major 2nd) Semi-Chromatic (major 6th/minor 2nd) Diatonic (minor 7th/unison)

Other hand shapes:

H H W H W H H W W W H W W W W

The frame of the hand can be both contracted and expanded beyond the above, primarily through the distances between the fingers and the thumb. This is enabled by the unique location of the base joint of the thumb at bottom of the palm, as well as its wider range of motion. The following exercise explores some of the possibilities.

18. Hand Frame Expansion and Finger Spacing Exercise

This exercise is related to those in Franco Petracchi's book, but supplementally incorporates other hand frames and finger spacings from the shapes above. Though some are more practical than others, the intent is to explore various possibilities, as well as develop strength, agility, and versatility.

There are essentially two ways of executing these patterns: leave the lower fingers down on the string as you ascend, or allow them to release. Generally, it is better to leave them down so that the movement is more economical. However, as the frame widens and the intervals increase, you will likely have to release the lower fingers so that weight can be properly transferred through the forearm and wrist into the higher finger(s).

Practice on other strings as well, and try shifting the entire exercise up by half-steps, similar to how Petracchi does in his book. Make everything feel as easy and tension-free as possible. If your hand feels tired or cramped, stop and recover.

The image displays ten staves of musical notation in 4/4 time. Each staff contains a sequence of eighth-note patterns, often grouped with slurs. The patterns vary in their intervallic structure and the use of accidentals (sharps, flats, naturals). The first few staves show relatively simple intervals, while the later staves introduce wider intervals and more complex chromatic or diatonic sequences, demonstrating the concept of hand frame expansion and finger spacing.

Pattern Variations:

This section shows two variations of the eighth-note patterns. The first variation is a direct continuation of the patterns from the previous section. The second variation, separated by a double bar line, shows a different intervallic structure, possibly a chromatic or diatonic sequence, illustrating how the exercise can be adapted or shifted.