Advanced Reed Design
&
Testing Procedure for Bassoon

by Mark G. Eubanks

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Acknowledgments

The late reed researcher, Frank Schwartz, once said that it only takes a few years to learn to play the bassoon, but at least 25 years to learn to make a reed. I will be forever indebted to Frank for filling in the missing pieces of my technique. Now in my 25th year of reedmaking, I feel secure. Along the way, I had a lot of help from the following individuals who have influenced my work: Raymond Wheeler who made the first beautiful reed I ever experienced; Don Christlieb for his writings and scientific approach; Chris Weait for his excellent book that gave me clues about the reed tip; Richard Plaster for his insights; Hugh Cooper for his many contributions; Bob Richards for his quick test; Sherman Walt and Ken Pasmanick for the important elements their reeds showed me; and, to my colleagues around the country who have allowed me to measure their reeds. Also, special thanks to my staff, students and the Oregon Symphony Bassoon Section for their participation in this work and to my beautiful wife for her excellent typing skills and infinite patience.

Drawings Mark G. Eubanks

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Published by **Arundo Research Company**
P.O. Box 4952
Portland, OR 97208
(503) 245-3231

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INTRODUCTION

The following reed design information and test note sequence gives an objective approach to fine tuning bassoon reeds. In 1982 ARC published a brochure that focused on correction of reed failure, Reed Testing Procedures, a sequence of seven tests and wire adjustment information. The new testing sequence offered here is directed to the exact tuning of the reed through comparison of certain standard, harmonic, alternate and false fingerings. For best results, these new tests should be used in conjunction with the earlier tests to produce greater refinement through double checks. The advanced reed testing procedures are specifically designed for use with ARC shaped and profiled bassoon cane and for reeds assembled with the techniques outlined in ARC publication Secrets to a Better Bassoon Reed. However, the test note sequence will work for all forming techniques and reed styles where the initial blade profile is close to finished dimensions.

* * *

DESIGNING YOUR REED

Most bassoonists who teach reedmaking to their students insist that the student copy the teacher's reed. They are instructed to use his shape, cane type, scrape, warping process, etc. This is fine for the beginner, but due to the many inconsistencies between instrument types, bocal bores and lengths, embouchures and breath support practices, physiogomy and performance requirements, reeds must vary considerably from player to player. You must experiment to find a suitable reed shape and profile, and adjust each reed you make to fit the cane and the demands of the music.

Three Basic Reed Blade Profiles

The graphs in Figure 1 show three common blade profile centerlines taken along the spine of the reed. Type A is a straight taper (heavy back/light tip), which is easily produced from a "single" profiling machine. This type offers the least resistance to blowing. (When designing a reed, the thickness near the tip is a critical element influencing resistance). Type B, a double taper (medium back/medium tip) is the most common "scrape" used. Note that the hypothetical "point of resistance" indicated by X (a point of equal thickness) in Figure 1 is closer to the tip, offering greater resistance or "back pressure". Type C is the "plateau scrape" (light back/heavy tip). This style of scrape is gaining popularity and offers the greatest resistance. Note that a "parallel scrape" is also possible, but not in common usage. Obviously, many variations are possible within the curves of these basic profiles.

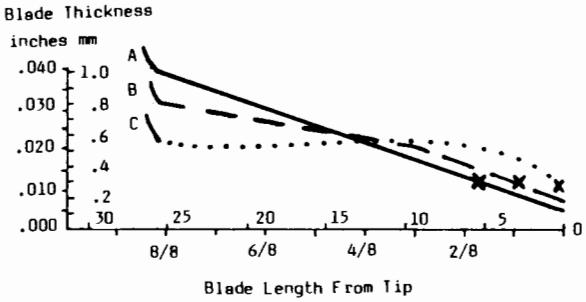


Figure 1

If you require a finished reed with a profile Type C but are starting with profiled cane similar to Type A, you will have to cut the blade back 20% to achieve the same thickness in the heart of the reed. Major adjustments to compensate for the initial profile, distort the reed shape and waste time due to extra scraping at the back and usually work against the desired result.

An initial profile close to the desired type not only saves time, but also affects the type of tip opening that is possible. It is important to note that the back of the initial profile must not be too thin or the blades will pucker in the channels during forming.

The Tip Opening

The relationship of the edges to the centerline in the initial profile and the degree of warping in the reed forming process immeasuably affect the outcome of the reed. What is "set" in the initial warp cannot be undone through scraping. Reeds formed with a profile where the edges and the centerline are of equal thickness, will produce an eliptical tip opening that "yawns" when clipped open. See Figure 2. This type of tip opening has a tendency to close "all at once" or center first when squeezed shut with the fingers.

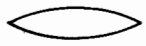


Figure 2

The reed formed with the edges thinner than the centerline (see Figure 3), will give the tip opening greater structural strength due to the "bow" in the channels of the blade through warping. (The edge taper is usually steeper and may be nearly parallel.) This type of profile will result in an "oxbow" tip opening (see Figure 4). It will close from the sides to the center when squeezed shut. The oxbow tip opening helps give the reed a more focused tone and higher pitch. The bowing effect also adds resistance.

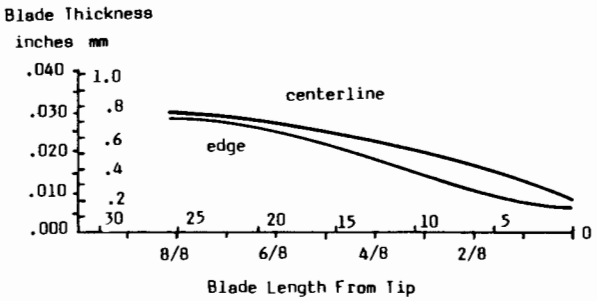


Figure 3

Figure 4

The space between the blades at the center of the tip is normally 1.5mm (1/16"). A smaller opening increases response to tonguing and generally raises the pitch. A larger opening generally lowers the pitch and gives a bigger tone with added resistance.

The Tip Profile

The most important element in finishing the reed, is the sculpturing and tapering at the tip and corners of the tip section. The type and contour of the tip profile in cross section affects the responsiveness, and resistance, as well as the overall length and final dimensions of the basic blade profile. See Figure 5 for a side view of three basic tip profiles. Type A Thin/long tip gives quick response to tonguing and requires substantial "weight" (thickness) behind the tip and/or the back. Type B A medium/tapered tip takes more air to respond. Type C A thick/short tip will take a lot of air and gives a big tone. The back must be quite thin for good response. Generally there is an inverse relationship between a big tone and quick response.

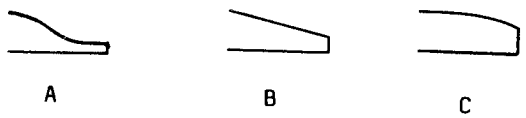


Figure 5

All three tip types require the corners of the tip to be thinner and increase in thickness toward the center. A common tip ratio for Type B is edge 3, midline 4 and center 5 or 3:4:5:4:3. See end view of tip in Figure 6. The difference between the center and the edge of the tip is greatest in Type C and least in Type A (Figure 5).

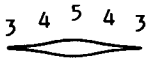


Figure 6

Balancing the Scraping

If there is too much resistance, the reed will not respond to articulation and feel dull and lifeless. To get the reed playing, many reedmakers start scraping the reed in the heart, weakening the resistance much too early in the testing process. Reeds adjusted in this way end up being flat, unstable and difficult to control in pianissimo. To achieve the right feeling of resistance, yet proper pitch and response a careful balance must be struck between the thickness of the back versus the tip, and the overall thickness versus the blade length (tip to the 1st wire). Many of the temperamental notes with inherent tendencies toward sharp or flat must be adjusted as well through proper thickness in critical areas in the channels and tip section (tip and corners). Adjustment of the reed's resistance should be saved for last. If the reed feels too strong the heart may need to be scraped.

* * *

The Blade Length

The length of the blade is one of the most important elements affecting pitch. The average blade length is 27mm (1-1/16"). High note playing is generally more comfortable with blade lengths as short as 24mm (7/8"), low register solos could find blade lengths at 30mm (1-3/16"). When a reed is scraped for the desired flexibilty/pitch temperament and response for the solo material at hand, both profile and blade dimensions will vary significantly.

A reed that has been cut back to a short blade length for high note response, must be scraped thin enough to keep the pitch of the lower notes down. The highest notes on the bassoon require the reed to have sufficient strength (and a higher pitched crow). If you require low note response or low register pianissimo playing, generally a longer blade is desired. However, if the low register is in tune, but the high register is sharp (because you must "bite" to get response) the blade is too long. If you require both high and low response the blade must be shorter and the back of the reed scraped thinner. And, there must be greater thickness at or near the tip to compensate for a weakened back. Most bassoonists change reeds and/or bocals for special solos in the extreme registers.

Cane Hardness and the Gouge

The hardness of the cane also affects the total length and thickness of the blade. Soft cane produces better response in the low register and requires a thicker profile and shorter blade lengths. Hard cane produces higher pitch in the overblown octave and above, can be longer in length, but must be scraped thinner. To compensate for variations in hardness from one cane source to another, the gouge thickness may be adjusted. A thicker gouge equals softer cane, thinner is harder.

* * *

TWELVE RULES FOR TESTING

1. Always use a tuning meter (an automatic digital meter is preferred). A reed may pass all the tests but be a quarter step flat. Always close your eyes and blow the test notes where they resonate and feel comfortable. Open your eyes and check the pitch.

2. Never test during extremes of humidity, temperature or barometric pressure. (Unless you are immediately faced with these conditions.) Ideally test a reed at your hall's performance temperature. Be sure the instrument is up to that temperature too. If it is 80° on stage and you've tested at 70°, you'll play sharp. If you test a reed at 29.5" barometric pressure and today is 30.5" your reed will feel "soft" and some notes will be flat and/or unstable.

3. Always check the condition of the 1st wire tightness before testing. If a reed is not completely "soaked up" the wire may slip down or be too loose causing the reed to play flat. On the other hand, the wire may be too tight when the reed is soaked up. An overly tight 1st wire will choke the tone and hinder low register response. You should be able to move the 1st wire down without undue effort on the soaked up reed. Some reeds (old ones, or those with "porous" string bindings) may take up to a half hour to stabilize. Be sure to wet the whole reed.

4. Always cut the length of the blade slightly longer than what you expect for the finished reed. This will not only give you a margin for error when scraping the tip, but will also allow for a harder piece of cane that will vibrate up to pitch at a longer length.

5. Always scrape and break in the reed over a period of several days or preferably longer. In the first few testing sessions, stop scraping the reed when it passes the first four tests reasonably well. Don't expect it to be great yet. Stockpile reeds at this point. When you need to finish a reed, chose one that has the characteristics required for the music you are preparing. Once you have chosen a candidate, expect it to change more as it is refined. Learn to know the difference between a reed that has changed due to "settling" and the one that has changed because of the weather. Use a throat mandrel between scrapes to encourage the reed to relax into its finished state. (See ARC publication Throat Mandrel Instructions.) Even tubes that have been seasoned for years change after scraping, due to changes in blade tension caused by scraping. Usually the reed will start feeling heavier, especially low note response, after several days of playing. A reed formed today, scraped and played tonight will be radically different tomorrow.

6. Always sharpen the finishing knife before and during testing. Bassoonists rarely use a sharp enough knife. With a sharp knife, refinement of the tip is quite easy. A hollow ground razor type knife is recommended for finishing work. With a dull or improper burr on the knife edge you will remove chunks of cane when thinning the tip. It is possible to carve tiny peelings or broad scrapings with a sharp blade. If you feel you must use a file extensively to finish the tip, your knife is probably too dull. See ARC publication Secrets to a Better Bassoon Reed for information on knife sharpening.

7. Always have a purpose for every scrape (never scrape indiscriminately). Think of the blade as a sculpture that has hills and valleys. Avoid broad scraping that may remove too much cane in adjacent areas. Use the tip or "heel" of the blade to scrape in the channels and near the edges. If the initial tip opening is symmetrical, early adjustments should be made in equal amounts to both blades. If the initial tip opening is not symmetrical, take several scrapes down the channel(s) of the strong side first.

8. Always turn the reed rather than the knife when scraping the tip section of the reed. See Figures 7(a), 7(b) and 7(c).

(a) (b) (c)

Figure 7

Note that a normal holding mandrel won't work comfortably when working on the tip section in this fashion, especially as in Figure 7(c). Remove the mandrel first, then turn the reed to the right or left holding the reed in the finger tips. It is easier to duplicate the same taper or scraping technique if the knife is held in the same place and the reed changes position. Also rotate the reed right or left when scraping the channels. Often what happens is the right side of the reed is scraped thinner because it is easier to scrape on the right.

9. Always recheck all test notes after every adjustment. When you are in the final phase of testing, work in only one "quadrant" of the blade's surfaces at a time, removing only tiny amounts of cane in the desired area.

10. Always strive for a balanced (symmetrical) tip opening and tip closure. A reed that is balanced will pass the "pop" test: Place a finger over the butt end of the reed and suck the air out from between the blades. If the reed is properly constructed and carefully scraped the blades will stay shut for a second or two (due to suction) and then the tip will open with a resounding "pop".

11. Never rely solely on the balance of shading as an indication of where to scrape in the final scraping. A strong light is good as a preliminary guide to the evenness and depth of scraping. However, imbalances in blade tension due to cane warps or hardness variations, unevenly slipped blades and other structural anomalies may need to be compensated for through uneven scraping.

12. Always clean the inside and between the blades of the reed as you test. Pass a pipe cleaner through the butt and out the tip, swinging it from side to side separating the blades slightly to remove dust and residues from scraping, sanding and reaming.

* * *

ADVANCED REED TEST PROCEDURE

The following sequence of tests should be taken in order initially. (If you prefer a reed with an especially thick tip, skip to Test 3.) In the final phase of testing you will need to jump back and forth from the various tests to double check all tests. Strive for a singing tone on the notes that give you the most problem. The end result should always be a reed that is: 1) comfortably in tune, 2) responsive, 3) has an even tone color from note to note, and 4) the freedom and flexibility to play with expression. Be sure to insert a plaque to support the scraping at the tip, corners and channels at the front of the reed.

Test 1 Harmonic B

After you have cut the blade to the desired length, slur back and forth from the standard fingering for B to the harmonic fingering (fingered the same as low E but with the B/C octave key added--see Figure 8).

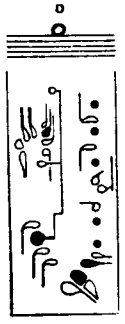


Figure 8

Slice and/or scrape and taper the tip thinner (from **b** to **a**, see Figure 9) until the harmonic B drops in pitch and matches the pitch of the standard fingering for B. If either B is flat, clip the tip and start again.

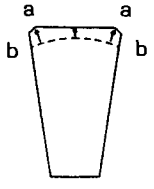
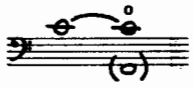


Figure 9

Test 2 Harmonic C



Slur back and forth from the standard fingering to C to the harmonic fingering (fingered the same as low F but with the B/C octave key added--see Figure 10).

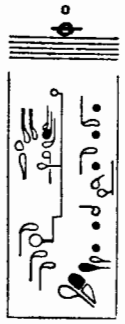


Figure 10

Slice and/or scrape and taper, thinning to the corners of the reed (**d** to **e** to **a**--see Figure 11) until the harmonic C drops in pitch and matches the standard fingering for C. Be sure that the scraping tapers from the center of the reed to the corner.

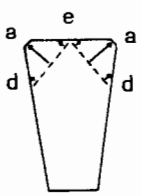
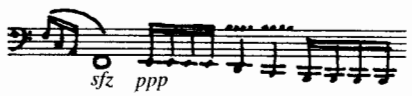


Figure 11

Be careful not to scrape over the edges (**d-a**) near the corner. Leave them heavy for now. Making the tube more oval helps lower the harmonic pitch (squeeze both the 1st and 2nd wire from the top and bottom). If either C is flat, clip the tip and start again.

Test 3 Low F pitch/ Low B response



Slur down to low F from open F (or F triad down) slamming into low F as loudly as possible. The pitch will be sharp and /or the tone color will sound false (bright compared to the other notes) if the back of the reed is too heavy in relationship to the tip. Scrape the back 1/3 of the blade near the wire (**c** to **f**--see Figure 12) until the pitch drops. In scraping do not lighten the edges at the back too much.

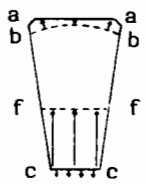


Figure 12

If you have scraped a lot out with little change, narrow the collar back closer to the wire (**c-c**--see Figure 12). (This operation will also cause the tip to be more open.) If the low response continues to be a problem or you want to keep a heavy back but improve low response, notch out under the first wire. Slip the wire back and file 3 notches on each side with a round needle file. See Figure 13. Then slip the wire back to the notches.

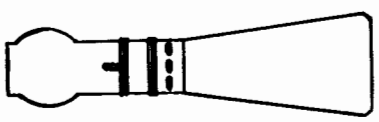


Figure 13

Once low F is satisfactory, articulate rapid 1/16s pianissimo from low F down to low B. If low B is difficult to articulate, i.e., cuts out, hesitates, etc., scrape more out of the back. It may also require a thinner tip as well. (Scrape from **b** to **a** -- see Figure 12). If you do not require pianissimo low note response in your playing, but do require the extreme high notes, do not scrape too much out of the back. Scraping the back weakens the reed and lowers the pitch of the reed significantly.

Test 3 should precede **Test 2** (or even **Test 1**) if you require a reed with more weight at or behind the tip. If you require a reed with a heavy back to have good low note response, scrape more out of the corners and edges near the tip (and the heart only as a last resort). On the reed properly adjusted for low notes, you should be able to get the reed (alone) to produce a short, single low pitched "putt" sound when tongued in a light staccato fashion with the embouchure near the middle of the reed.

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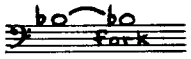
Test 4 Bb / fork Bb 

Slur back and forth from the standard Bb fingering to the fork (fake) Bb (finger low G without pp key and remove the 2nd finger of the right hand--see Figure 14).

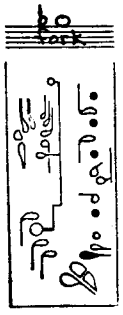


Figure 14

Carve light "mini-channels" on either side of the centerline from the heart out to the tip (**g** to **h** -- see Figure 15) until the pitch of the fork Bb drops and matches the pitch of the standard fingering. If the channels do not lower the pitch of the fork Bb, thin and taper the additional areas near the ends of the channels: **i-j** to **k**, see Figure 16.

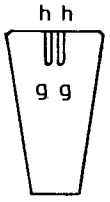


Figure 15

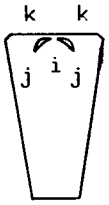
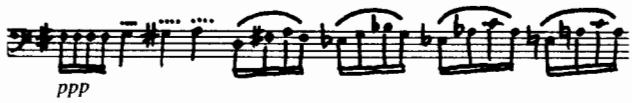


Figure 16

These operations in the "heart" will brighten the tone somewhat. Making the tube more oval will help lower the pitch of the fork Bb. See wire instruction for **Test 2** (above). A good fork Bb early on, is a positive indicator of cane quality.

Test 5 Pianissimo pitch and response on overblown F#, G, G# and A



Carve, scrape and taper channels from **l** to **m-n** (see Figure 17) along the front 1/3 of the blade--a "W" scrape.

Figure 17

Often there is a tendency for these notes to be sharp when they appear as the major third of a scale or chord or balky when approached slurring over the break. Thin the channels until the pitch drops sufficiently and these notes are stable in articulation and when slurring to these notes from above and below pianissimo. Start close to the tip and work your way back (but always scraping and tapering toward the tip). Do not scrape the edges of the blade by accident--leave them alone. Using a half round file may be easier than a knife. File from the tip up into the channels.

Remove the plaque and check the evenness of your work by running the fingertip from the reed's tip up the channels. Compare the blade halves by running the tip of the forefinger and the thumb up the channels at the same time. Compare the channels in each quadrant to each other. Adjust the scrape so the taper in each channel feels the same.

If scraping in the channels causes flatness in any notes in the overblown 2nd octave, narrow the belly of the reed shape **b-b** to **c-c** by filing or sanding the rails from **c** to **b** (see Figure 18).

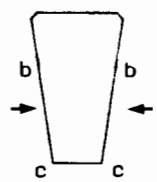


Figure 18

* * *

Test 6 Pitch and Resonance on High E, F, F# and G

Slur up a minor 6th to each of these notes checking for solid pitch and resonance on the upper test note. If these notes are sharp or sound thin in tone, carve, file or sand channels in the middle 1/3 of the reed's channels (start at the back and scrape forward **o** to **l**--see Figure 19) until the tone is full and resonant.

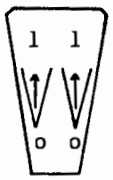


Figure 19

Check the eveness of the scraping by running the fingertip in the channels as outlined above. Blend the channel into the front 1/3 of the blade's channels. If the pitch becomes too flat on the test notes, narrow the tip width **a-a** of the reed shape by filing or sanding from **b** to **a**, see Figure 20.

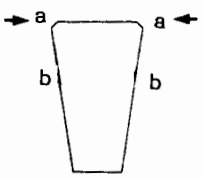


Figure 20

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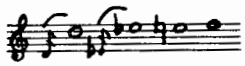
Test 7 Pitch and Response on High D, Eb, E and F



Slur up to these notes using the fingerings shown in Figure 21.

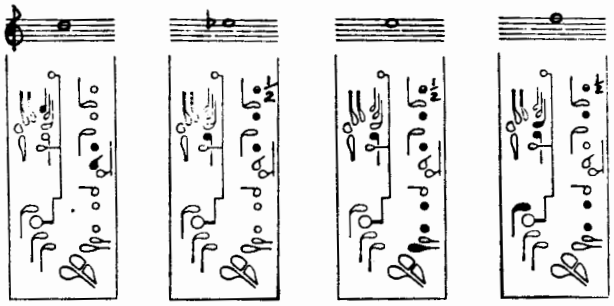


Figure 21

If D speaks, but Eb is flat by comparison, clip the tip back slightly (shorten the blade length). It usually takes a better than average piece of cane to play easily the fingerings for E and F. Shorter blades or harder cane will help, but tapering the edges at the corner of the tip section from b to a (see Figure 22) also helps. The taper can be short or long-- see Figure 23 (a) and (b) for side views. This function will also brighten the tone and change the resistance of the reed to a certain extent.

Figure 22

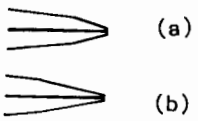


Figure 23

The amount of pressure along the contact point of the rails (between the blades) should be equal both right and left. One way to check this is to hold the rails up to a light and view the seam through the tip of the reed. They should look the same all the way back.

Another way that is more objective for the front half of the rail contact is to swing a contoured plaque to the right and left separating the blades. Any difference in the amount of "grip" should be adjusted by additional scraping on the strong side, and/or sanding between the rails with a sanding plaque. However, endeavor to keep the rail contact as strong as possible. If a reed has too light a back, has too soft a piece of cane or is too low in pitch generally these highest notes will not be possible. Many bocals favor the low register also preventing response in the extreme high register.

Test 8 Air Attacks and Diminuendos

When the reed is in the final phase of testing check test notes in the various registers for ease of attack with only the air. If the reed is balanced properly the reed will speak in tune and not sound "spitty" or "whistle" at the end of a diminuendo. The tone should be clear with no evidence of a sizzle at any dynamic. Often these problems result from cane that is warped, unevenly scraped or gouged, or reeds formed with slipped blades. If there are sizzle problems or difficulty in air attacks in one register but not another, work in one quadrant at a time scraping in the zones affecting that note. If sizzle or attack becomes worse, you are in the wrong area, shift to the opposite blade adjacent to the area just worked, or the other side of the same blade. Be sure to recheck rail tension and tip opening and closure symmetry. Most often sizzle problems are due to uneven scraping at or near the tip.

Quick Tests Can you play the opening passage of Vivaldi's Concerto in E minor easily and clearly, without "flicking"? Can you play the reed in tune out of the corner of your mouth? Do the octaves in the Hummel Concerto speak quickly enough? Do the alternate and the regular fingering for high F# match in tone color? The best reeds will do these things early on as well as match the harmonics listed in Tests 1, 2 and 4. A last minute check of the harmonic C, B and fork Bb notes after you are warmed up will let you know the status of the reed's current condition. Harmonic C (Test 2) is the most changeable with the weather and as the reed plays itself out.

The Final Test Do you feel comfortable playing the reed in your ensemble? Do you tire easily when playing in the overblown 2nd octave? Are you able to play pianissimo in the low register? Are you able to tongue pianissimo up to high E? More than likely as you go through these tests you have had to clip the tip several times and perhaps you now have a reed with a shorter blade than you ever experienced. So often I have stopped and said "this is acceptable" when I could have clipped it again and said "this is great". I think most bassoonists call it quits when the reed plays well but is slightly flat, and we "humor" the reed up to pitch with a firm embouchure. Since we spend so much time working on the reed we want it to be done. But when should we stop fussing with it? Obviously, bad pieces of cane will never produce in tune harmonics and soft cane gets shorter and shorter, and hard pieces get thinner. Learning to recognize a good piece of cane is a tremendous time saver. Knowing exactly where to scrape is too. Unfortunately, too much cane is often removed from critical areas early in the process, and there is no hope for that reed. That is why it is important not to "overscrape" or hit adjacent zones by accident or through nervous last minute adjustments. Stop scraping when the reed will go where you want it to go musically and technically. Hopefully this scraping will not be at the last minute. Know that you have total confidence in the reed just before you play a big solo, because of the care you have taken to adjust the reed. If you fail on some simple solo, have "squawks" or cracked notes frequently, either your reed technique or your instrument are failing you. It may take hours to get the scrape right, especially if you are compensating for problems that may be inherent to your instrument or bocal.

Obviously, all of the above tests would be futile if the instrument was poorly adjusted, the wrong bocal or reed shape used, or the reed poorly designed or constructed.

THE INSTRUMENT

It is extremely important to have an instrument that does not leak. Leaks occur in a variety of places:

1) There may be leaks at, around or through the pads. Skin or cork pads can be cracked, dirty, porous, hardened from moisture damage, improperly seated, or seated on uneven or chipped toneholes. Check each joint and section of the bore to see if it will hold a suction by plugging one end of the bore, closing all open keys, and covering fingerholes. Forcefully suck all the air you can from the bore. The instrument should hold the suction; if not, leaks are present.

Another test for leaky pads is pianissimo playing. If it is generally a problem and very difficult in the low register, the instrument probably leaks.

2) Most bassoons develop leaks at the U tube. To check this, uncap the boot, and immerse the U tube end in water up 1/8" onto the wood. Cover the biggest bore opening with the left hand and close all keys with the right. Blow forcefully into the small bore. Have someone look for the source of air bubbles. If they occur at the gasket try tightening the nuts slightly. A new gasket or sealing wax may be neccessary.

More often the leaks occur between the upper portion of the metal and the wood itself. If this is the case, the metal cap must be removed from the wood and sealed. This job is best left to an experienced bassoon repairman.

3) If the bassoon has problems playing loud or loses resonance when playing down the scale, the pads may be "blowing out" with greater amounts of air pressure. The instrument may also leak across the bore of the boot at the "double" A and Bb toneholes.

4) There may also be leaks through porous wood and/or behind the liner, emerging around posts and screws, or into other toneholes, etc. Finding the source of all leaks and repairing them is an important first step for any serious bassoonist.

* * *

RANDOM THOUGHTS AND OBSERVATIONS

1. Orient the strongest blade up. The upper blade should be heavier and have a "tap tone" that is higher pitched than the bottom blade.

2. Reeds that hold a normal tip opening and play when dry are properly made and adjusted. Take a cue from the crow and symmetry of the tip opening of the dry reed for where to scrape.

3. Adjust your reed for pitch and response. If the tone is right, that's a bonus. If all your reeds are too bright or dark change the cane type or gouge.

4. Microscopic observation with a 5 power 2 inch focus jeweler's loupe (magnifier) will reveal the accuracy of the scraping, especially the tip.

5. A tip that is too light (thin) and long will cause the notes C#, E and open F in the primary octave to play flat.

6. Some bassoons are extremely shape sensitive. The wrong shape causes the scale of the primary octave to have uneven intonation. Often C is sharp in pitch. The right shape gives the tone resonance and a good scale.

7. The pitch of the split octave crow can range from D to A. Although F is standard, shorter bocals and sharp instruments need a lower crow and longer bocals and flatter instruments need higher crows. See also Rule 2.

8. The gauge of the wire affects the reed's pitch and response. Low register playing is better with #22. High register is better with #21. The tone will be more focused if a #20 copper or steel wire is used under the binding.

9. With so many variables to consider as we make reeds, it's amazing that we have come as far as we have, however, there is so much more to learn. We must consider that there are both fixed and unfixed variables for dozens of steps of forming, nearly infinite possiblities for the shape and profile and the climate to deal with for our instruments and cane.

10. The channels are "sensitive" to the notes in the overblown second octave. Think of overblown F# as being closest to the tip with the rest of the notes (ascending the scale) further up the channels toward the back.

11. When finishing the reed the tip should be shaved down as cleanly as possible with a sharp knife. Roughness at the tip from clipping or scraping, or extensive use of a file to finish the tip may give the fibers of the cane a "bearded" effect dulling the tone.

12. The length of a reed is largely a matter of personal preference. Achieving the desired tube and blade length at the correct position on the shape and profile may require the butt of the tube to be cut off. Generally reeds range in total length from 52 to 56mm (2-1/16" to 2-3/16"). Blade lengths (tip to 1st wire) vary from 24 to 30mm (7/8" to 1-3/16").

13. Cane is like vintage wine. There are good and bad years, hard cane should be used now, soft cane may be aged. Some gives a dark tone, some bright. Some is brittle, some spongey. Some is greenish, some is golden. What is great cane for you, is not necessarily great for someone else!

ADDENDUM
TO
ADVANCED REED DESIGN AND TESTING PROCEDURE FOR BASSOON

FOREWORD

A year has passed since the publication of this work and it is appropriate that more material be added to bring it to conclusion. I wish to thank my colleagues in the Oregon Symphony, Bob Naglee and Juan DeGomar as well as two of my students, Mary Harris and Eric Lindberg for their many questions and suggestions which have led to refinement of these techniques. A special thanks to Brad Buckley for his comments and support of this work. And finally, thank you to Bonnie Cox, Janice Richardson and Pablo Izquierdo who have worked so diligently over the last several years at Arundo Research Company. Without their help, none of this would have been possible. It has been exciting for all of us to see this work unfold, and after testing thousands of reeds it is clear these tests not only work, but also demonstrate the fundamental principles of vibration for all double reeds.

THE BEST WAY TO THIN THE REED TIP

Problems occur in thinning the tip if the knife is used in a "scraping" manner (digging into the cane in an abrasive manner rather than slicing through it). Often the cane is thinner just behind the tip than at the end of the tip due to the nature of scraping, as well as not following through properly with the knife ie. digging a hole in the cane.

The preferred method for trimming the tip is a "paring" or "whittling" cut as in sharpening a pencil. This is nearly impossible to achieve with a beveled knife, because the bevel does not allow the knife to be held at a low enough angle. The preferred knife for tip work is a razor type knife or other types that are thin just behind the knife tip. Heavier beveled knives are quite effective in working at the back of the blade and channels.

The initial work at the tip should be done in several overlapping cuts when using a contoured plaque. See Figure A. (Drawings appear on the last page.) Be sure to follow up with light "clean-up" cuts to catch any high spots you may have missed. Start with the knife back 2mm (1/16") from the tip and exert a downward pressure with the left thumb against the back of the knife blade. (This assumes a right handed approach.) Once the knife starts to dig in, lower the angle of the blade and with guidance from the thumb, slice through the cane. See Figure B. The thumb guides its progress, the amount of additional downward pressure from the right hand aids in controlling the amount and expanse of cane removed. If the blade has the proper "burr" then you can remove a tiny sliver to a large peeling of cane without fear of tearing a hole in the tip. See A.R.C. publication Secrets to a Better Bassoon Reed for knife sharpening instructions.

After the tip has been evenly thinned, make additional cuts that blend the tip into the corners. See Figure C. To avoid a "dip" behind the tip, be sure that when working at the tip, and especially when making the clean-up cuts, that the end of each knife stroke always "sounds" as the blade hits the plaque. Obviously, if the knife hits the plaque frequently during the tip work, the burr on the blade will need to be renewed after a short time. Some prefer to use plastic plaques which do not dull the knife as quickly. If the knife is sharp, restoring the burr takes only a few seconds. Only a stone with an ultrafine grit will give the desired burr. A Hard Arkansas stone is our first choice.

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PROBLEMS IN "BLOWING" THE HARMONIC AND ALTERNATE FINGERINGS

When you shift from the normal fingering to a harmonic or alternate fingering during testing, keep the same air speed, embouchure, and "vowel" shape inside the mouth (oo--ah etc.). If you are scraping in the specified area with little or no results, there may be acoustical considerations that are affecting the tests (either the particular bassoon's bore, pad heights or the bocal). Tests #4 and #6 have caused problems for some players. Solutions to these problems are listed below.

ADDITIONS TO TESTING PROCEDURES

Test 1

Here is an additional check to determine if the extreme tip is the proper thickness and the blade the proper length for your needs. Check the pitch of 3rd space E (normal fingering) against alternate E (using 2nd finger left hand). If the alternate E is sharper than the regular fingering, further thinning of the tip is recommended. If the alternate E is flatter, then the tip should be cut to shorten the blade length. An exception to this is for second bassoonists...the lowest notes will have more flexibility with a flatter alternate E. This alternate E is sometimes referred to as the "mute fingering". It is also useful in technical passages back and forth across the break from E to 1/2 hole fingerings--freeing the 1st finger for exact placement.

Test 2

Sometimes a reed will pass all tests including this one but not feel right, especially on the basic forked Eb fingering (no extra keys) in pp dynamics. It is especially important to refer to the Eb test in A.R.C. 1982 publication Reed Testing Procedures as one of the *most important final indicators* of the reed's status. Basically, this test is to slur at the softest dynamic possible from E to Eb. If the reed fails this test, more scraping is needed in the corners, tip section, and possibly the channels as well.

Test 4

Of all the tests, this one has caused the most problems. If the pad of Low E (pancake key) is exceptionally high, or if all the pad heights on the "bass" side of the bore are high, there may not be enough resistance to allow the fork Bb to drop in pitch to match the regular fingering. Further, some bassoons, particularly Fox long bores, and early 7,000 series Heckels may not be able to produce a matching forked Bb. Another approach is outlined below.

This test is always more effective if it follows Test 5. The main objective of this test is to stabilize the Ab/Bb trill in both octaves. If you have tried lowering the pad heights and still can't get the pitch to match, try the trills. The low Ab/Bb trill is best. Finger low Ab with the low Db key added. Trill the 2nd finger in the right hand. If the Bb is unstable or "gargles" remove more cane in the prescribed areas. In the drawings in Test 4, the mini-channels in figure 15 can be scraped or sanded longer and wider than indicated. But it is working in close to the spine in the heart area that creates the desired effect. The "eyes" in figure 16 (i,j,k) should be blended and tapered out to the tip rather than digging "holes".

Test 5

We have discovered a simpler approach to test these notes. In the last bars of the opening phrase of

Vivaldi's Concerto in E minor is a repeated B major triad starting on 2nd line B. (B-D#-F#-D#-B -D#-F#-D#, etc.). Use this as the initial test to work the channels at the front of the reed since critical areas for F# are at and behind the tip, and D# is also sensitive to this area as well as the corners of the tip section and channels. Remove cane by working the area of the channels as shown in figure 17 starting at the extreme tip. If a knife is used, think of it as removing small "blocks" of cane with the knife, one at a time working back into the channels until the F# drops in pitch. Be sure to scrape all the way through the previous starting point with the knife to get a "click" on the plaque. See Figure D.

Exact scraping is a must for these important test notes. It may be difficult to control the knife when working in the channels, especially if the plaque does not have much contour. For this reason , some find the work in the channnels much easier with sandpaper. Use the tip of the finger to rub in the channels and again be sure to work past the tip. Richard Plaster uses the following technique with sandpaper: "a piece about half the size of a postage stamp is folded in half around one edge of the reed, held between the thumb and index finger, and used to sand the edges and channels, both blades at once..."

Once the B major triad is in tune with a low enough temperament on the 3rd and a comfortable F#, go back to the test notes listed for Test 5. The critical areas for the notes of the overblown octave are located further up the channels, as you ascend the scale. *Each of the triads should be repeated* rather than playing the whole string of notes. You may need to scrape more out of the front of the channels to get a low enough F# in the first triad. The last triad (E-A-C-A-E etc.)--also part of the opening phrase of the above mentioned concerto, is the most difficult to achieve without flicking. Response on these intervals is clearly a test of cane quality. However, often these notes are unresponsive because the blade is too long, or the tip opening and closure are not symmetrical or other "imbalances" are present either at the extreme tip or further back in the channels. See Reed Testing Procedures for more information.

Another quick test and *final indicator* that relates to the channels is slurring both loudly and softly from 3rd space E to "middle C" above the staff without flicking. The C should speak without hesitation. Also compare the test notes (F#,G and G#) to the harmonics of overblown low(est) B, C and C# (half-hole the first finger left hand). For test note A, finger low D with the A octave key added.

Test 6

If you have scraped a lot in this area of the channels and had no success in lowering the pitch of the upper notes, especially high F# and G, the bocal is usually the culprit. If the tip opening of the bocal is too small, these notes won't play low enough. Conversely, if the bocal's tip opening is too big, the Eb, E and F will be too flat. Reaming out the tip of a bocal that is too small, is easy enough to do, but swedging the tip of the bocal is a delicate operation. It can be accomplished by using a long pair of needlenose pliers. Hold the pliers open slightly and spin (rotate) the tip of the bocal into the smooth part of the pliers jaws down close to the cutter. Don't squeeze the pliers shut as you do this!

This test should also include harmonic fingerings. Checking these will help blend the "double sensitive" notes (overblown A, B, and C are sensitive to the tip and corners as well as the channels) into the channels of Test 6. Finger low G (without the whisper key) and slightly "half-hole" the first finger of the right hand. This should produce a harmonic D. If it is considerably sharper than the regular fingering more cane should be removed from the front of the channels as indicated in Figure 19. Do the same with low Ab (Eb harmonic), and A (E harmonic) fingering again with a half-hole. If the tip width has been narrowed to raise the upper notes, be sure to thin the edges of the rails near the tip.

Test 7

Slurs were inadvertently omitted from the test notes. Slur from the Eb to E, and E to F. Once you have the high Eb and E in tune, compare them to the pitch of the high Eb and E keys. Most often these toneholes are too small, often caused from moisture damage (swelling of the wood). Most bassoons need to have these toneholes reamed out to bring the pitch up, unless you prefer to "eek them up".

FINAL THOUGHTS AND OBSERVATIONS

1. The goal of this testing procedure is to bring quick response and exact intonation for the bassoonist through "zone" scraping. The properly adjusted reed will be *flexible* enough to play both sharp and flat on the temperamental notes. This means that you can "sing" an interval as it is being blown, and achieve lowered major 3rds and raised minor 3rds, etc., and produce consistently "pure" intervals. What are pure intervals and exact intonation? This is a complicated subject, however, all the great performers have it in common, be it voice, violin or bassoon. It is a "natural" approach where every note is pleasing to the ear through pitch placement related to the simple ratios of the overtone series for a particular tonality. (Equal temperament is neither in tune nor pleasing to the ear.) The bassoon reed must be flexible enough to bend, but stable enough to allow a *relaxed* embouchure. Careful adjustments to the reed using the techniques described here will allow this.

2. My philosophy is that on the properly sealed and adjusted bassoon, the toneholes are usually the right size. Many players have resorted over the years to the use of "tuning tape" to reduce the size of the toneholes of notes with tendencies toward sharpness. What I usually experience when playing a bassoon adjusted in this manner is a "stuffy sound", uneven timbre and hindered response. If anything some of the toneholes are too small, because of the effects of shrinking wood as the instrument ages and swelling of sections of the the bore and toneholes as a result of prolonged contact with moisture.

3. For total mastery of our fickle friend, Arundo Donax L., each reed must have a different approach both in forming and scraping. The hard piece of cane must be weakened, the soft cane strengthened. Further, every scraping operation on the blade has a dual effect: it makes some component of the reed softer and another area harder until the balance point is found for that piece of cane.

4. I have pondered for years, as has my friend Bob Riggs, why the single reed invariably feels softer after the first playings and the double reed stronger. I believe that there are several forces at work. Cane has "shape memory" (it wants to return to what it was before you warped it into a tube) and normally after several days of playing it quits feeling stiffer and "settles", remaining relatively stable. Some cane is instantly playable, yet cane from another batch only works well if the tubes are formed and allowed to age. But some cane, aged or not, changes radically every time you play it. This "stability factor" has caused us all problems at one time or another. The times I have failed miserably as a performer, have been the times I assumed that the reed was ok and (for what ever reason) neglected to give the reed a thorough check of the harmonic and final indicator tests. Yes, double reeds are temperamental and subject to changes in the weather, but these tests make it very clear whether the reed played yesterday, is playing the same today...

Figure A

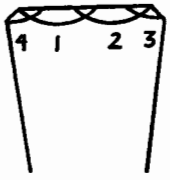

Figure B

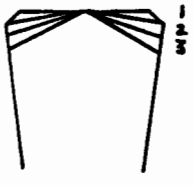

Figure C

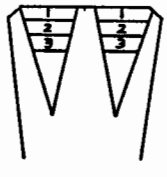

Figure D