# Reed Contribution

**[First of Two Installments]**

**by Lewis Hugh Cooper**
**Professor of Music (Bassoon)**
**The University of Michigan**
**School of Music**
**1986**

**edited by**
**Dr. Mark D. Avery**
**Professor of Music (Bassoon)**
**The University of Northern Michigan**
**Department of Music**
**1990**

[The following article, published in two installments, represents the expanded text of an excellent bassoon clinic presented by Professors Cooper and Avery at the I.D.R.S. Conference in Baton Rouge, Louisiana, on Aug. 6, 1990. This printed version will also appear as one of the numerous chapters in Prof. Cooper's new book entitled *Bassoon Clinic Series,* now being final edited by Prof. Avery. Each of the book's chapters will relate to a specific topic and, in essence, are refined examples of the lecture notes distributed over the years by Prof. Cooper during his varied clinic sessions. Publication of *Bassoon Clinic Series* is anticipated within a year. *Reed Contribution* is reprinted here with the kind permission of its authors who remain the sole owners of its contents. ED]

## ACOUSTIC RATIONALE

A straight-sided standard cone is one of the few geometric shapes whose vibratory modes correspond to the exclusively whole-number recipe of the Natural Overtone Series. When the air within a standard cone is excited by some generating source, the enclosed molecules will resonate at a specific fundamental frequency and, in addition, will produce a complex series of overtones representing precise whole-number multiples of the cone's fundamental. Thus, a given complete straight-sided standard cone, whose physical length resonates a fundamental frequency of $A_1$ 110 Hz, would also generate the following overtones: $A_2$ 220 Hz, $E_3$ 330 Hz, $A_3$ 440 Hz, $C\sharp_4$ 550 Hz, $E_4$ 660 Hz, etc. These whole-number resonance modes of the complete standard cone perfectly satisfy the harmonic requirements of our music system.

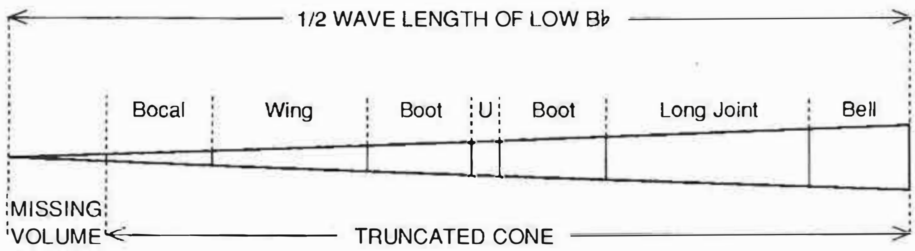
The various registers of such an ideal conical bore instrument would have perfect whole-number frequency relationships; however, in the world of real musical instruments such is not to be. For a number of practical reasons the cone's acoustically perfect shape must be distorted, thereby perturbing its harmonic qualities. One major distortion necessarily occurs when the cone's tip is cut off so that the instrument may be energized (blown) from the small end. This truncation of the cone has an effect of perturbing the normal frequency relationship between registers in a near exponential manner. Truncating a cone by an amount sufficient to raise the fundamental mode by a barely discernible 3 Hz would have the approximate effect of raising its second mode by $3^2$ or 9 Hz, its third mode by $3^3$ or 27 Hz, its fourth mode by $3^4$ or 81 Hz, its fifth mode by $3^5$ or 243 Hz, etc., thereby grossly perturbing the internal tuning of the cone's normal modes and destroying the harmonic qualities of the instrument. In effect, a nearly complete truncated cone will sound in its fundamental mode as though it extended back to its vertex, while its subsequently higher modes are raised increasingly greater amounts.

Although variable, the practical "cut-off" point of a real conical bore instrument is approximately 10% of the cone's total length. This "Missing Volume" of air, extending back from the "cut-off" point to the cone's vertex, plays a critical role in determining the physical parameters of a compatible reed. Whatever the preferred style, shape, or size a reed may be, THE REED'S ACOUSTIC CONTRIBUTION MUST EQUAL 100% OF THE MISSING VOLUME'S ACOUSTIC CONTRIBUTION. Only when this basic acoustic requirement is fulfilled does a reed become a compatible element of the coupled system.

Even with ideal compatibility, a reed is only capable of "Holding the Line," against the pervasive sharpening influence of truncation, through the instrument's second register. However, even this small victory affords the very real advantage of a similar set of finger patterns for both the primary and second registers. Upon reaching the third register the pitch is distorted upward so far that the cone's normal third mode twelfths become augmented twelfths or thirteenths. Fortunately, this harmonic distortion always equates to a minor or major second and can be accommodated in its raised form by simple mechanical transposition of finger patterns. Fourth register distortion is even greater, with normal modal frequencies raised as much as an augmented fourth. For additional discussion of the physical implications of Reed Contribution, see the following.

# PHYSICAL RATIONALE

### Diagram of the Coupled System




"MISSING VOLUME" = "REED CONTRIBUTION" = "PHANTOM BORE"

ACOUSTIC REQUIREMENT:

TO INSURE HARMONICALLY TUNED MODES WITHIN A COUPLED, TRUNCATED, CONICAL BORE INSTRUMENT, THE REED'S ACOUSTIC CONTRIBUTION MUST EQUAL 100% OF THE MISSING VOLUME'S ACOUSTIC CONTRIBUTION.

## THREE WAYS A REED MAY CONTRIBUTE

I. STATIC VOLUME (REED CAVITY) = The measurable internal capacity of a free standing reed while at rest (sans bocal overlap). Matching the reed's Static Volume to the cone's Missing Volume would satisfy the above acoustic requirement; however, in a functioning musical instrument the Static Volume must always be substantially less than the Missing Volume, so as to allow for inclusion of the necessary Vibratory Contribution and Damping.

II. VIBRATORY CONTRIBUTION = A measure of the relative violence with which a given reed vibrates. This contributing factor, functioning largely independent of the reed's vibrating frequency, reflects both the amount of blade area involved and the amplitude of a reed's oscillatory motion. An increase in Vibratory Contribution acts as an effective substitute for Static Volume and/or Damping.

III. DAMPING = Any element(s) included in the reed's design, construction, or function that reduces the speed and vigor of oscillation of the oscillatory body. In short, Damping is acoustic friction, whether present in the reed or other parts of the coupled system. Reed Damping plays a relatively minor contributory role compared to that of Vibratory Contribution or Static Volume; however, in addition to other subtle but important functions, Damping also serves as a substitute for Static Volume and/or Vibratory Contribution.

Maintaining a constant harmonic mode relationship in the face of either an increase or decrease in one of the three contributing areas, necessitates an equal but opposite change in one or both of the remaining two. Although these three contributing factors may be combined in an infinite number of ways, any successful combination must compositely total 100% of the Missing Volume's acoustic contribution.

Decreasing the reed's total acoustic contribution beneath 100% augments the frequency relationship existing between the modes (registers), resulting in the upper modes being sharpened in a near exponential manner.

Increasing the reed's total acoustic contribution a commensurate amount above 100% will have an equal but opposite effect, diminishing the mode relationship by a like amount and flatting the upper modes (registers) in a similar manner.

Most criticism regarding abnormal tuning characteristics of the upper modes of a conical bore instrument (excessively sharp or flat) should more properly be directed toward the acoustic incompatibility of the Reed Contribution.

Note: For specific details of the subjective aural characteristics of an acoustically compatible bassoon reed, see "BASSOON REED CRITERIA."

Understanding how Reed Contribution helps determine acceptable harmonic modes in a conical bore woodwind instrument leads logically to the following general conclusions (assuming equal damping).

1. THE LARGER A REED, THE MORE RESISTANT (Harder/Stiffer/Heavier) IT MUST BE.
2. THE SMALLER A REED, THE LESS RESISTANT (Softer/Freer/Lighter) IT MUST BE.

Thus, two hypothetical reeds with widely divergent physical characteristics could still maintain identical modal relationships, as long as the two major contributing elements remain complementary (i.e., assuming equal acoustic weighting of Static Volume and Vibratory Contribution). For example, two simplistic Reed Contribution formulas (in which S.V. represents Static Volume and V.C. represents Vibratory Contribution) might be expressed as:

REED #1 = 2 S.V. + 1 V.C. = X Pitch Relationship,

in relation to a second reed that is only one-half as large but twice as vibrant,

REED #2 = 1 S.V. + 2 V.C. = X Pitch Relationship.

Obviously, there are many possible variants that would satisfy the modal equation; however, each variant would produce a different tonal spectrum (timbre).

Interjecting REED DAMPING into the system further complicates matters, but offers an even richer variety of timbral possibilities. Damping not only acts as a positive factor in determining REED CONTRIBUTION, but also reduces the amplitude of the upper partials in an exponential manner. Therefore, Damping may be used in an expedient manner to "Darken" the sound by lowering the energy level of, or eliminating high partials in the tonal recipe. With REED DAMPING included in the formula, three general, but divergent, reed types might be conceptually portrayed as follows:*

*Percentages of REED CONTRIBUTION distribution are not necessarily actual but only reflect conceptual representations.

## THREE DIVERGENT REED TYPES

### COMPARATIVE CONTRIBUTORY MIX

| GERMAN | AMERICAN | GARFIELD* |
|---|---|---|
| STATIC VOLUME = 60% | STATIC VOLUME = 50% | STATIC VOLUME = 40% |
| VIBRATORY CON. = 20% | VIBRATORY CON. = 40% | VIBRATORY CON. = 40% |
| DAMPING = 20% | DAMPING = 10% | DAMPING = 20% |
| 100% | 100% | 100% |

### COMPARATIVE PHYSICAL CHARACTERISTICS

| GERMAN | AMERICAN | GARFIELD |
|---|---|---|
| LARGE | MEDIUM-SIZE | SMALL |
| RESISTANT/HEAVY | FREE/LIGHT | FREE/LIGHT |
| HEAVILY DAMPED | LIGHTLY DAMPED | HEAVILY DAMPED |

### COMPARATIVE SUBJECTIVE TONAL CHARACTERISTICS

| GERMAN | AMERICAN | GARFIELD |
|---|---|---|
| RESTRICTED | FREE | FREE |
| LESS FLEXIBLE | FLEXIBLE | FLEXIBLE |
| DARK | SOMEWHAT BRIGHT | DARK |

### EXTERIOR DIMENSIONS**

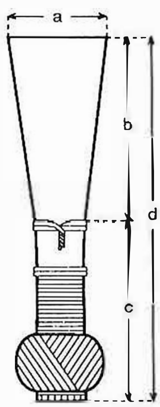
(See following page)

*Eponym for a small American reed type popularized by Bernard Garfield, currently Principal Bassoonist of the Philadelphia Orchestra.

**A simplified conceptual representation, because several elements other than exterior dimensions are also involved in determining a reed's STATIC VOLUME. For additional information, see sections on gouge, shape, structural arch, mechanical fulcrum, and reaming.

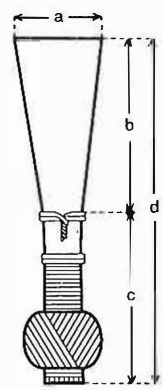
## EXTERIOR DIMENSIONS

### GERMAN



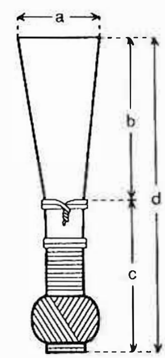

a = 5/8 " (15.9mm)
b = 1-3/16" (30.2mm)
c = 1-3/16" (30.2mm)
d = 2-3/8 " (60.4mm)

### AMERICAN




a = 9/16" (14.3mm)
b = 1-1/8 " (28.6mm)
c = 1-1/8 " (28.6mm)
d = 2-1/4 " (57.2mm)

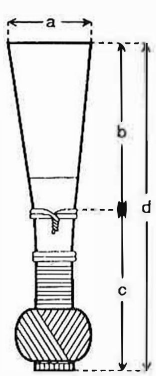
### GARFIELD




a = 17/32" (13.5mm)*
b = 1-1/16" (27.0mm)*
c = 63/64" (25.0mm)
d = 2-3/64" (52.0mm)

Assumed depth of bocal insertion for all three reeds = 5/16" (7.9mm).
Metric measurements are rounded to the nearest .1mm. The drawings are full scale.

As a point of interest, the exterior dimensions and Reed Contribution mix of the author's reed lies between that of the American and Garfield types.




### COOPER

a = 17/32" (13.5mm)
b = 1-3/32" (27.8mm)
c = 1-1/16" (27.0mm)
d = 2-5/32" (54.8mm)

### COOPER

| | | |
|---|---|---|
| Static Volume | = | 45% |
| Vibratory Con. | = | 40% |
| Damping | = | 15% |
| Total Reed Con. | = | 100% |

Bocal insertion = 1/4" (6.4mm)

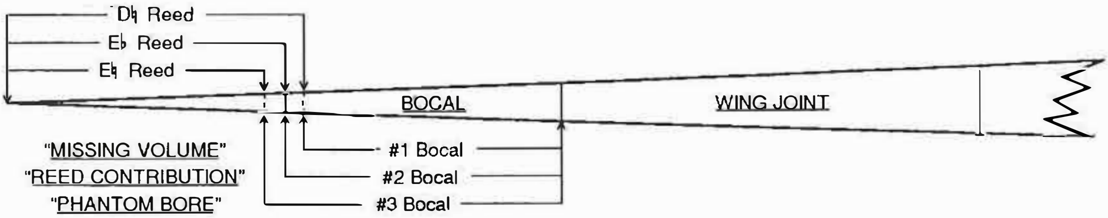
The terms used to describe the reed's physical and tonal aspects would apply proportionately.

Despite such disparity in size, all of these reed types will generate the same tuning characteristics if their Vibratory Contribution and Damping are varied in a compensatory manner. It is only the subtle aesthetic elements which individualize each artist's reed style that will be affected.

*Until recent years Garfield's reed was only 1" (25.4mm) from the tip to the first wire, while the tip width was as narrow as 1/2" (12.7mm).

# INFLUENCE OF THE BOCAL LENGTH ON THE MISSING VOLUME

### IDEAL BOCAL/REED PAIRINGS AT $A_3$ 440 HZ




Varying the bocal's length changes the physical presence of the instrument, and inversely affects the residual length of the projected MISSING VOLUME. Therefore, in order to maintain a constant pitch center while changing to a shorter or longer bocal, the REED CONTRIBUTION must be varied to compensate for the alternation in bocal length. As a valid subjective test of the reed's acoustic compatibility, its dominant crow-pitch must shift one full semitone for each change in bocal number. Thus, an instrument that tunes at $A_3$ 440 Hz with a #2 bocal while using a reed with a dominant crow-pitch of E♭, would continue to produce the same pitch level if a #3 bocal were to be used with an E reed, or a #1 bocal were to be used with a D reed. An extension of this basic rule would also ideally pair an F reed with a #4 bocal and a D♭ reed with a #0 bocal to maintain the same centrality of pitch.

Conversely, assuming a constant REED CONTRIBUTION coupled with a well designed system, each numerical shift in bocal designation will respectively raise or lower the pitch center of the instrument, in its fundamental mode, by one-tenth of a semitone. For example, an instrument that tunes at $A_3$ 440 Hz with a #2 bocal while using a reed that crows with a dominant pitch of E♭, will sound at $A_3$ 442.5 Hz with a #1 bocal, or $A_3$ 437.5 Hz with a #3 bocal.* In theory, shifting ten bocal numbers in either direction would respectively raise or lower the instrument's pitch, in its fundamental register, by one semitone. However, adding that much additional length at the instrument's reed end would grossly distort the tuning of its scale, and destroy the harmonic relationship between registers.

An analogous second method would be to maintain a constant bocal length and vary the tuning by changing the reed's dominant crow-pitch. Each semitone shift in crow-pitch would respectively raise or lower the instrument's pitch, in its primary mode, by one-tenth of a semitone, while upper mode frequencies would be affected by a near exponential manner. Although altering the reed's crow-pitch ten semitones in either direction theoretically changes the instrument's tuning by one full semitone, such major distortion of the REED CONTRIBUTION would also have a disastrous effect on the scale and modal relationships.

An obvious third composite approach could involve both shortening the bocal while raising the crow-pitch or lowering the crow-pitch while elongating the bocal. This compound sharpening or flatting effect would maximize pitch change in the primary mode, and doubly disturb the normal scale and modal tuning of the instrument.

In actual practice the allowable pitch excursion, by any method, should ideally be limited to one-tenth semitone above or below the optimum design pitch of the instrument. For example, slightly raising the tuning pitch from $A_3$ 440 Hz to $A_3$ 442.5 Hz can quite easily be accommodated by bocal/reed-crow adjustment and embouchure manipulation, usually with little loss in resonance. A drop to $A_3$ 437.5 Hz would likewise be within acceptable limits of control. Also, an orchestral first player might choose to use a #1 bocal with an E♭ reed, or an E reed with a #2 bocal to reduce the need for additional embouchure tension in the upper modes. In contrast, an orchestral second player might use a D reed with a #2 bocal, or an E♭ reed with a #3 bocal to simplify pitch and dynamic control in the lower register. Such minor acoustic perturbations represent the normal flexibility needed in a professional performance environment. It is only when an instrument designed to resonate at $A_3$ 440 Hz is forced, by any means, to tuning extremes of $A_3$ 445 Hz (or higher) and $A_3$ 435 Hz (or lower) that its inherent musical qualities are compromised and near insurmountable burdens are imposed on the performer.

*one-tenth semitone increments are rounded to the nearest .5 Hz.

# INFLUENCE OF THE ANGLE OF BORE CONICALITY ON THE MISSING VOLUME

Variation in the angle of bore conicality affects the projected length of the MISSING VOLUME in an inverse manner. All else being equal, the greater the angle of bore conicalness, the shorter the projected MISSING VOLUME; while the smaller the enclosed angle, the longer the projected PHANTOM BORE will be. As a result, truncated conical bore instruments of the same physical length but with various angles of bore inclination will produce dissimilar pitch centers, and each will require a different REED CONTRIBUTION to maintain acoustic compatibility. (Fig. 1)

It is also feasible to construct instruments of different lengths and bore angle conicalness that will produce the same pitch center but require diverse REED CONTRIBUTION, a design differential that largely exemplifies the German versus French bore types. (Fig. 2)

A third variant is the instrument that is physically shorter than another, but because of its lesser angle of conicalness and extended MISSING VOLUME, sounds at a lower pitch than the longer instrument with its greater angle of bore inclination. An example of this phenomenon would be the physically shorter but low pitched Baroque instruments in comparison to the physically longer but higher pitch modern German design. (Fig. 2)

In any respect, a reed type that functions well on a given modern German type instrument will not be compatible with either French or Baroque instruments.

To a lesser degree, the bore conicality variants within the several successful German designs will each require a commensurate modification in REED CONTRIBUTION to insure maximum compatibility within the specific coupled system.

Fig. 1*

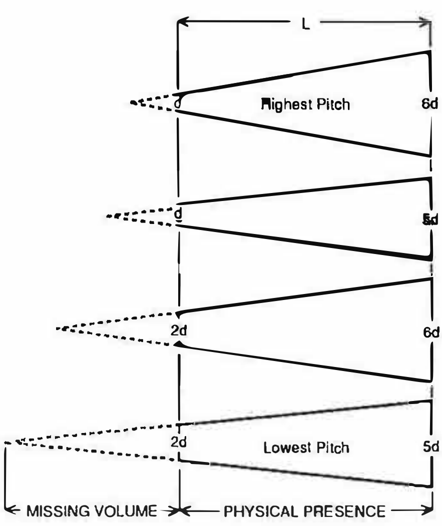
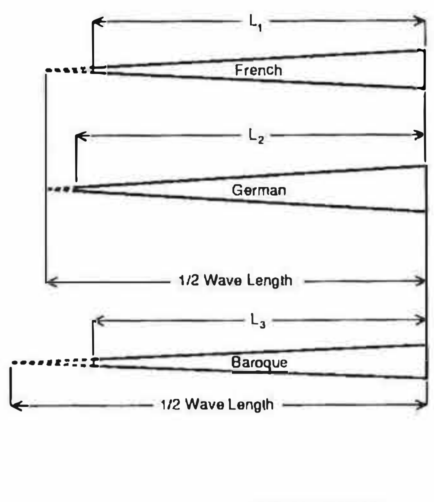



Fig. 2*




COMPARISON OF THREE REAL BORE TYPES

*The angle of bore conicality may be changed, ad infinitum, by varying the design relationship of the instrument's throat and/or emitting diameters (d). The vertical scale has been greatly exaggerated in the above drawings to enhance the visual imagery.

# BASSOON REED CRITERIA

Although the total contributory mix of a specific reed can be accurately measured by technically complicated laboratory methods, the process would be time consuming and the reed severely damaged or destroyed by the procedures. Fortunately, there is a practical set of subjective aural tests that may be utilized to quickly ascertain a reed's acoustic compatibility within the coupled system, without physically damaging the reed. Essentially, reeds that comply with the following seven reed criteria will function adequately as an integral part of a coupled musical system when they are used in conjunction with the instrument. Many knowledgeable performers and/or reed makers leave the instrument in its case until their reeds conform to the following criteria.

I. THE REED, WHEN BLOWN WITH A PROPER EMBOUCHURE, SHOULD "CROW":
(A crow consists of a heterogeneous, multiphonic, simultaneous sounding of the reed's fundamental plus all of its partials. [In the author's opinion, a reed-embouchure combination which will only produce a homogeneous pitch is indicative of an inherent fault in the reed and/or embouchure.])
   A. With a dominant pitch of E♭ for use on a #2 bocal.
   B. With a dominant pitch of D for use on a #1 bocal.
   C. With a dominant pitch of E for use on a #3 bocal.

II. THE REED PLUS BOCAL, WHEN BLOWN WITH A PRIMARY REGISTER EMBOUCHURE, SHOULD PRODUCE A SLIGHTLY FLATTED MIDDLE C.

III. WHEN THE EMBOUCHURE IS RELAXED AND THE REED ALLOWED TO "BALLOON" TO ITS LARGEST INTERIOR VOLUME, THE PITCH OF THE REED PLUS BOCAL SHOULD DROP TO A STABLE B.

IV. ATTEMPTS TO LOWER THE PITCH OF THE REED PLUS BOCAL BENEATH B SHOULD RESULT IN AN OCTAVE B "CROW." THE LOWER OCTAVE IS ADDED BY AN INTERNALLY GENERATED DIFFERENCE TONE EFFECT:
   A. If the octave relationship is out of tune, the pitch relationship between the various registers on the bassoon will be distorted in a similar fashion.
   B. Pitches other than the octave will be present in the crow; but, it is the tuning of the octave which is of prime importance.

V. THE MINIMUM RANGE OF THE COUPLED REED PLUS BOCAL MUST BE A MINOR THIRD (e.g., B through a slightly flatted D). THIS RANGE REPRESENTS THE NECESSARY DEGREE OF REED AND EMBOUCHURE FLEXIBILITY NEEDED TO SUCCESSFULLY PRODUCE THE VARIOUS REGISTERS OF A BASSOON. ALTHOUGH THIS RANGE REPRESENTS A CONTINUUM WITHIN AS WELL AS BETWEEN REGISTERS, IN ESSENCE:
   A. B represents the Low Register Embouchure.
   B. C represents the Primary Register Embouchure.
   C. C♯ represents the Second Register Embouchure.
   D. D represents the High Register Embouchure.

VI. THE "CUT-OFF" FREQUENCY OF THE REED, WHEN BLOWN ALONE, MUST BE A MINIMUM OF A PERFECT FIFTH ABOVE THE DOMINANT CROW PITCH:
   A. D reed to A, E♭ to B♭, E to B, etc.
   B. The pitch change is produced by embouchure manipulation and change in oral resonance cavity.
   C. The "cut-off" frequency represents the highest fundamental pitch the reed will produce under any circumstance.

VII. THE REED, WHEN BLOWN ALONE, MUST HAVE A MINIMUM RANGE OF ONE OCTAVE:
   A. D reed = A to A, E♭ reed = B♭ to B♭, E reed = B to B, etc.
   B. An extension of this range is generally a desirable attribute.
      1. An extension upward indicates that the reed has a propensity for being a better high register reed.
      2. An extension downward indicates that the reed has a propensity for being a better low register reed.
      3. An extension in both directions indicates that the reed is one of those rare reeds which plays equally well in all registers.
   C. Melodies with a range of one octave or less can be played on the reed alone.
      1. The playing of such melodies on the reed alone should be an integral part of first and subsequent lesson assignments.
      2. The mobility inherent in such performance is indicative of the flexibility necessary in embouchure, oral cavity, and reed while playing the bassoon.

# CONCLUDING COMMENTS

A reed must satisfy specific acoustic requirements if it is to function as a compatible component of a truncated, conical bore instrument. Regardless of its style or artistic merit, the total acoustic contribution of an ideal reed should exactly equal that of the missing portion of the cone, and is compositely derived from three major sources: 1. STATIC VOLUME, 2. VIBRATORY CONTRIBUTION, 3. DAMPING. These three contributory elements may be varied in an infinite number of ways; however, the total contribution must be tailored to meet the acoustic needs of a given instrument. In effect, to maintain an acceptable harmonic resonance within the instrument, a compatible reed must figuratively "fool" the instrument into thinking that it has not been cut off.

When the variables in instrumental design are modified, such as the angle of bore conicality and/or degree of truncation, the three major contributing factors in reed design must also be varied in a compatible manner. For example, reeds that are excellent on French instruments would have to be greatly modified for use on large-bore (short-bore) German instruments. To a lesser degree, small-bore (long-bore) German models require a somewhat different "Reed Contribution" than that required by a modern large-bore (short-bore) version, while either reed would be totally incompatible with a Baroque design.

Even among instruments of the same design, there are minor individual variants in bore and tone-hole configuration that require accommodation in "Reed Contribution." The reed's primary function, as an integral component part of a coupled system, is to complete a complex acoustic equation that is predetermined by the design characteristics of the system; however, an idealized reed should be customized to concur with the individual requirements of a specific instrument.

In addition to design compatibility, more excessive obligations are often dictated by the performance environment. One such parameter is pitch, which now varies widely on an international basis. Under ideal circumstances all performances would be played on instruments acoustically designed to resonate best at the tuning frequency used in the performance. Unfortunately, this is seldom the case. For example, many fine old instruments still in use were designed to resonate at the former Paris International Pitch of A435 Hz, while others were built to A437.5 Hz, an unofficial intermediate step in the upward climb to the current official International Pitch of A440 Hz agreed upon at a London conference in 1939. Now, fifty years later, A442.5 Hz is the unofficial norm and the Continental European Pitch of A445 Hz (or higher) represents a forty cent rise above A435 Hz, the original finalized design pitch of all orchestral woodwinds.

A rise in tuning pitch of even ten or twenty cents should be accompanied by a redesigned instrument whose bore length, angle of bore conicality, and tone-hole spacings are commensurate with the higher pitch level. However, at best, the various manufacturers have, over the years, simply cut a little off here and a little off there to shorten the bore, and left the rest of the pitch accommodation up to the performer's embouchure and long-suffering reed.

For a performer to achieve A445 Hz on an A435 Hz instrument, gross compromises must be made in reed and bocal compatibility. Reality dictates that the musician, to play in tune at the higher pitch, must use a reed that crows at a dominant pitch of G with a #2 bocal, or an E♭ reed with a shortened #00 bocal. Most probably, a combination of a #0 bocal with an F reed would be a more logical approach to effect the needed forty cent "correction." Whatever the solution, it is accomplished by a sacrifice of natural resonance in the instrument and the need for a "hard" embouchure to control the necessarily stiff reed. Even the "modern" A440 Hz instruments must be acoustically compromised to reach such heights of tuning folly.

Other less traumatic external influences affecting reed design relate to the performance venue. Reeds intended for use in a superlative concert hall needn't be as projective but should be somewhat damped so as to be less obtrusive under the ideal acoustic circumstances. A studio artist might also increase damping to reduce "presence," especially if working close to a microphone. Conversely, large halls with less than ideal acoustic characteristics require less damping and, for additional projection, a compensatory increase in "Vibratory Contribution." Naturally, the reed size (Static Volume) may be modified ad infinitum to compliment desirable adjustments made in the other two areas. It is the subtle manipulation of these three contributory elements that allow individual artists to adjust to their environment with the least possible effort, while satisfying the aesthetic demands of musical performance within their own tonal parameters.

In recognition of such broad diversity in instruments, tuning, timbral, and other environmental requirements, one must conclude that there can't be a "Perfect Reed Type" that will suffice under all circumstances for all individuals on all instruments. Serious performers must, with open mind, curiosity, and observation, intelligently seek solutions to the many personal reed problems they confront. Each must learn and apply directional reed making technics that will allow them to craft a final product that is uniquely theirs. Survivors within the highly competitive professional performance field represent those individuals who have already developed personal reed styles that successfully address their problems. Learn from the successful ones, but never slavishly copy their reeds in minute detail, for to do so is tantamount to "painting by number." As in other art forms, only the original represents a true artistic statement, while at best the imitator produces an ersatz copy of the real thing. Strive to create a reed type that solves your particular needs, for only in this manner can an individual achieve maximum artistic results.

Finally, in essence, there are as many successful reed styles as there are successful individual performers; however, each individual recipe, regardless of style, must first fulfill an acoustic obligation to the specific coupled system and secondly function efficiently within its unique musical environment. The ability to sensitively balance the three components of "Reed Contribution" is primarily dependent on an open mind and complete mastery of the art of reed making in all of its intricate detail. This indispensible but elusive goal represents an essential prerequisite to achievement of success in the professional arena.