A New Organ
For St. Mary of the Hills
Episcopal Church
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COLOPHON
FOREWORD

O SING UNTO THE LORD
A NEW SONG;
FOR HE HATH DONE
MARVELLOUS THINGS.
+ PSALM 98:1

The prospect of a new organ is easy to look on in terms of the difficulty, disruption, expense, and uncertainty it must, of necessity, involve for the church. It is tempting to focus on the solemn duties that attend an investment of such magnitude, or the logistics of schedules and resources. Such concerns are justified and responsible stewardship, but they mask the deeper duty to see all change as an opportunity for renewal.

Here is the chance to sing a new song. In such a fast changing world we do not lack for opportunities to cope with change, but a new organ is a chance to do more than cope; it is an opportunity to steer that change and create a landmark which will help inspire and uplift a future generation through even greater changes, which we can scarcely even imagine today.

A new organ is the chance for craftsman, clergy, musicians and congregation to put their efforts towards making a piece of the new world. If we do it right, we can take our ancient inheritances of liturgy, music, and craftsmanship and prove them evergreen.

Bradley Gawthrop
The life of a small pipe organ in America is not an easy one. On all counts it seems the deck is stacked against it. It is denied the luxuries of space, budget, time, and good acoustic environment. Often it is denied something even more vital: attention.

A small parish organ, no matter how admirably executed, is unlikely to earn an American organ builder either the admiration of his peers or major financial rewards. In recent history American organ building firms have given real attention to small organs only long enough to develop the reputation needed to secure larger contracts, after which point small instruments were given only token attention, if they were created at all.

In Europe, by contrast, the small organ was the bread and butter of prominent organbuilding firms in virtually every national style. The greatest minds of European organbuilding all engaged seriously and for sustained periods in the art of building effective small instruments. Consequently, the European countryside is a rich tapestry of diverse and colorful small organs. These are widely divergent in style, so much so that an educated listener could often tell the nationality of a given instrument while blindfolded. As diverse as these organs are, it must be said that one of the things they all have in common is how much more effective they are than most of their American counterparts of similar size.

Why should this be so? It’s a subtle conspiracy of many elements which ultimately compromise most small American organs. These elements include a far greater propensity toward standardization which, unchecked, can create a sort of drab sameness in American pipework, especially reeds. There is also, it must be said, a rich vein of Europhilia in both the American Arts and the American religious life which perpetually suggests that nothing American could possibly be sophisticated enough. This instinct leads American organbuilders (and other artisans) forever back into periods of historical and national imitation which hold back the development of a truly American style.

By far the largest impediment to effective small American organs is the siren song of eclecticism. This desire, quite natural in a
country full of diverse immigrants, finds a
noble expression in large instruments. There,
the elements of many different national styles
are presented together and their interactions
make for a rich, flexible, and powerful instru-
ment. It is when the desire for eclecticism
begins to be applied to smaller organs that
things begin to go awry.

What does one do when there isn’t space
for the elements of three different styles of
organs behind a single case? Naturally (and
often catastrophically) the temptation arises
to split the differences; to create pipe organs
that sit, as it were, dead in the center between
England, France and Germany. We cannot
have both the high pressures of English organs
and the low pressures of German organs, so
we split the difference. We cannot have both
the blast created by the paper-thin tongues
in French reeds and the thick dark gravitas of
English reeds of the opposite design, so again,
the American organ tries to be in the middle.
The result is an ensemble of sounds trying
desperately not to have too much personality
and, unfortunately, succeeding. This is how
you create an organ which can play almost
anything very approximately, but nothing
effectively, let alone vivaciously. Where in
the large eclectic organ, bold strokes of color
contrast against each other like stained glass,
the small organ which attempts to be eclectic
forces the diverse colors to bleed together into
beige.

Rather than attempting to render every-
thing ever written for the organ, with only ap-
proximate results, we suggest an instrument
along English lines which can authentically
and effectively render the choral anthems and
hymns in the English style heard every Sun-
day at St. Mary’s.

Acoustics
AND THE WORSHIP ORGAN

It is a favorite phrase among organ builders
that “The room is the most important
stop on the organ” and while this over-worn
phrase contains a certain grain of truth, it also
carries with it a certain self indulgence which
deserves to be called out.

We must remember that organs are built
for churches, not the other way around. The
reason organs were adopted for use in worship
settings in the first place was to assist growing
congregations in growing spaces to sing ef-
fectively despite the acoustic challenges. It is
the proper and responsible role of the organ to
help improve singing in a poor acoustic situa-
tion. Bad acoustics are a problem the organ is
there to help ameliorate.

In this sense, the modern fashion of organ
builders throwing up their hands at poor
acoustic conditions and claiming to be en-
tirely at their mercy is an abdication of one of
the organ’s primary responsibilities.

A very effective liturgical organ may be built
in any acoustic environment, but you cannot
simply build any organ in such a space and
expect it to work. Such conditions call for the
application of some ingenuity, flexibility, and
common sense. Contrary to popular mythol-
gy, this is not a new problem in the United
States. Lively acoustics were the exception
rather than the rule in America by the turn of
the 20th century. Early 20th century builders,
undaunted by these developments, put ears
and brains to work, coming up with a variety
of techniques for dealing with them.
~ HIGH PRESSURES ~

It is intuitive to imagine that blowing organ pipes with a higher pressure would simply make them louder but the reality is more complex.

In flue pipes, higher pressures tend to attenuate overtones and promote fundamental pitch. Since this is the opposite of the effect of a dry room (which tends to love treble and hate bass) it makes pipes in such a room sound more focused and sonorous. Additionally, such techniques cut down on any tendency towards the tubercular coarseness that frequently results from attempts at trying to get the maximum volume level out of a timid wind supply. Flue pipes blown on high pressure are often not any louder in measured sound level terms than their low pressure counterparts, but their sound has proportionally less air noise and more musical pitch. Singers will be familiar with this phenomenon; it is the same as the difference made by singing from the diaphragm.

In reed pipes the differences made by high pressure are much more dramatic. Where low pressure reeds tend to sound thin, bright, and coarse, high pressure reeds are broad, warm, and smooth. They are also more stable in speech and tuning, and produce bass notes more solidly. These are all desirable characteristics in dry acoustic environments.

~ GREATER UNISON EMPHASIS ~

The organ builder who is content simply to make an organ louder can do so very inexpensively by adding row upon row of small pipes one or more octaves above unison pitch. If, however, you want to make an organ more effective at leading singing, (especially in a dry acoustic) it needs more pipes which produce the same notes the choir and congregation are actually singing. These pipes are called Unison pipes or 8’ pipes (after their approximate height.)

Unison pipes are expensive, inconveniently large, and hungry for wind. They are also absolutely essential. It is not possible to lead a group of singers with a choir of piccolos; you must support singers in their own tonal range. English organs, arguably those most focused on choral accompaniment, frequently had duplicates or triplicates of their critical unison pipes for precisely this reason.

~ EFFECTIVE EXPRESSION ~

Effectively accompanying a fine choir calls for an instrument of extremely wide dynamic range. A piece of music might require any volume, from barely audible to truly commanding. Any of these volumes might also be desirable in a variety of different tonal colors. In an instrument of modest size, the only way to achieve such range and flexibility is to make extensive use of expression shades, where many stops in the organ are placed behind louvres which can close even loud sounds down to a purr. Such effects require expression shades made of stout material, and must be tightly fitted to be effective.

~ GREATER VARIETY ~

In a reverberant space, the sound of an organ reaches the listener in the form of thousands of reflections from nearly every direction. This effect imparts richness, depth, and interest, as any given rank of organ pipes will sound slightly different in different places in the room. This creates a sort of reservoir of variety that can keep an air of freshness and interest around an organ you hear every Sunday. Even though the pipes themselves do not change, they are forever being filtered and enhanced in new ways by acoustic interactions.

In a space which is not reverberant, we have to replace the variety which is lost when these rich reflections no longer color and enliven the sound of the organ. A single stop will not sustain a listener’s interest for nearly as long in these conditions, so the organist must be well supplied with markedly contrasting sounds to close the gap. By switching among these, the organist keeps the music from becoming monotonous. This coloration is not a cheat or a “special effect”, it’s simply making up for the variety which the building would supply in a better acoustic setting.

PROOF IN THE HEARING…

If you ask an organ builder or acoustician to describe the worst imaginable environment for an organ, they will paint a scenario involving a room which is wide, shallow, short, covered in absorptive materials on all surfaces with the organ placed in deep chambers having small openings which are not given central placement in the room. This perfectly describes the environment of any given theatre organ. While we would not put a Wurlitzer-like organ in a church, it is telling that such instruments made extensive use of all the techniques described here. Theatre organ builders didn’t have the luxury of the room being the most important stop in the organ, they had to adapt the stops they had to their environment. So shall we.
Since we have resolved that the basic framework for this organ should be based on the patterns of small English liturgical organs rather than German or French concert instruments, it would benefit us to ask what makes these organs in particular so fine in their execution of service music.

In the past few years it has begun to become fashionable among some builders to play lip service to having English inclinations or influence. This is more often based on vague (and often quite distorted) ideas of what an English organ sounds like than anything resembling research or authentic practices. Consequently, the things that really do make an English organ identifiably English, the Rules Britannia, if you like, are overlooked. So what does one see, peeking inside small English parish organs, which stands out?

**Lead**

For starters, you see a lot of lead. Lead and ‘common metal’ Diapasons with leathered upper lips are very much part of what makes these organs distinctive. While it has become popular in some circles to consider pipe metal crude unless it contains at least 50% tin, Victorian and Early Modern English builders were under no such illusions. Tin was typically reserved for those special ranks for which it has demonstrated advantages (most notably strings).

**Variable Scaling**

English builders arrived at their pipe scaling by experimentation, and the results were often treated as trade secrets. While it has become a common practice to scale all styles of pipes by a single mathematical formula designed to create a sort of flat tonal consistency from the bottom of the keyboard to the top, many English organ builders would have considered this a rather peculiar goal. Upon reflection, you can see why: No other musical instrument has such a consistent timbre between low and high notes. The human voice certainly doesn’t follow such a pattern, why should an organ? In the 20th century however, the commercial realities of factory mass production of organs made such standardization financially unavoidable; the standardized pipe measures slowly washed over the art like a coat of gray paint. The greatest resistance to this was in England, and it is worth noting that respected firms Henry Willis & Sons, and Harrison & Harrison use many of their historic pipe measures even today.

Historic English Diapasons are variably scaled, with the bottom and top of the manual compass being made larger and more flute-like than the standardized versions, and the center leaner and more string-like. This is an essential component of the English choral accompanying sound, yet it is almost invariably ignored by American organbuilding firms claiming to have English tonal aspirations. Another often overlooked element of such scaling systems is that larger pipes have correspondingly larger mouths, making them louder when similarly treated. An English variably scaled Diapason therefore typically does not need the “treble ascendent” voicing techniques popular in American practice, as the larger scales in the treble create similar effects without special treatment.

**Differentiated Tone**

American eclectic organbuilding has long nursed an obsession with reining in the differences between the various classes of organ pipes in order to promote their capacity to “blend” when played together. This notion has taken such strong hold that many American stops which are ostensibly strings are in fact just slightly anorexic ‘Diet Diapasons’. The Flutes have been similarly lobotomized, becoming slightly tubby Diapasons voiced so that all the personality of the pipes is extinguished.
The different classes of flue pipe tone in the small English parish organ stand in very marked contrast to this sad state of affairs; they could not be more strongly differentiated from each other. The Diapasons are broad, bold and singing. The strings are keen and pungent. The flutes are round and liquid. Where a second Diapason is useful (which it frequently is) it is provided honestly – no attempt is made to fatten up a string, or starve a flute to serve as a stand-in.

Diversity notwithstanding, the English stops also play together very nicely in virtually any combination. Their strong personalities create surprising and musically useful interactions. The example of an orchestra is useful here; conductors would not routinely ask the woodwinds, brass, and strings to sound as much alike as possible to ensure that they “blend”; it is understood that their differences make the ensemble richer.

These elements, taken together, are typical of the English emphasis on accompanimental rather than solo duties which is appropriate in a church organ. These are organs built to lead singing. Here are organs which have been earnestly designed for the liturgical needs of the church, rather than the concert ambitions of the organist or organbuilder.

Here is a perfect expression of the small parish organ. At 18 ranks, this instrument is quite modest by modern standards, but what an impact these well chosen ranks make. Each rank is essential, nothing here has been left to pattern or rule of thumb. Each detail bears the stamp of having been seriously considered.

The first thing to note is that of the 18 ranks, only five are above unison pitch. The organ has no mixtures, and only one manual reed. The builder has been very sly here, in finding ways to make the organ sound larger than it is. For example: The Cornopean in the swell is quite smooth, the secret to its flexibility is the presence of a Keraulophon. This is a stop not much considered these days: a very powerfully voiced solo string. Combine it with the Cornopean and the ensemble becomes fiery and snarly. Two different reed characters for the price of one - and a solo Keraulophon as a bonus.

Notice too, the indispensable Trombone in the pedal. Certainly this stop is one of the organ’s secret weapons, lending pedal lines real gravitas even under full organ. Many an organ twice this size never sounds as grand because the designers stopped giving the resources to service music too soon, and began ticking boxes related to solo organ literature.

In that sense, this organ is an example of what can be accomplished when an organ designer gives an instrument over wholeheartedly to a single goal.
## GREAT EXPRESSIVE

<table>
<thead>
<tr>
<th>16 Stopped Diapason</th>
<th>61</th>
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<tbody>
<tr>
<td>8 1st Diapason</td>
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</tr>
<tr>
<td>8 2nd Diapason</td>
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</tr>
<tr>
<td>8 Keraulophon</td>
<td>Sw</td>
</tr>
<tr>
<td>8 Claribel Flute</td>
<td>49</td>
</tr>
<tr>
<td>8 Flute Celeste II</td>
<td>122</td>
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<tr>
<td>8 Celestes II</td>
<td>Sw</td>
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<tr>
<td>4 Octave</td>
<td>61</td>
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<tr>
<td>4 Harmonic Flute</td>
<td>61</td>
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<tr>
<td>2 Super Octave</td>
<td>61</td>
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<tr>
<td>III Mixture</td>
<td>183</td>
</tr>
<tr>
<td>8 Tromba</td>
<td>61</td>
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<tr>
<td>4 Tromba Clarion</td>
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## SWELL EXPRESSIVE

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<td>8 Gedact</td>
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<td>4 Gemshorn</td>
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<td>2 Flageolet</td>
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<td>16 Bass Tuba</td>
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## PEDAL EXPOSED

<table>
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<th>32 Open Wood•</th>
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<tr>
<td>16 Major Diapason•</td>
<td>32</td>
</tr>
<tr>
<td>16 Sub bass•</td>
<td>32</td>
</tr>
<tr>
<td>16 Viol•</td>
<td>32</td>
</tr>
<tr>
<td>8 Major Octave•</td>
<td>32</td>
</tr>
<tr>
<td>8 1st Diapason</td>
<td>Gt</td>
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<tr>
<td>8 2nd Diapason</td>
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<td>4 Super Octave•</td>
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<td>16 Trombone•</td>
<td>32</td>
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<tr>
<td>16 Bass Tuba</td>
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<td>8 Tenor Trombone•</td>
<td>32</td>
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<tr>
<td>8 Tuba</td>
<td>Sw</td>
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<tr>
<td>4 Tuba Clarion</td>
<td>Sw</td>
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• Digital Stop

31 Ranks (1476 Pipes, 288 Digital Samples)
The heart of the Great division is the Principal Chorus consisting of a 1st Diapason, an Octave, a Super Octave and a three rank Mixture. These stops will be installed in the case for maximum projection and clarity. The remainder of the Great will be installed behind expression shades for greater flexibility.

A 16’ Stopped Diapason adds weight and dignity to the sounds of this division and a powerful 2nd Diapason will offer the flexibility of serving as either a warmly broad solo stop or a chorus stop which can augment or substitute for the 1st Diapason mentioned above.

An 8’ Claribel Flute serves as a solo stop and, because of being under expression, as a versatile accompanimental sound. Similarly, the 4’ Harmonic Flute will combine with the Claribel Flute in accompaniment or ensemble use, and can also serve as a solo stop of contrasting color to the 8’ flute.

The quietest stop on the organ, the 8’ Flute Celeste II, is also located in this division making its two ranks available to accompany solo combinations on the Swell.

An 8’ Tromba (also available an octave higher as the 4’ Tromba Clarion) tops off the Great division as a chorus reed of moderate power and restrained brilliance. It will be found useful in conjunction with the principal chorus and as a contrast with the Tuba chorus found in the Swell (q.v.).

Two additional stops which are actually in the Swell division have been made playable on this manual for added variety in registration: the flexible Keraulophon and the combined ranks of the Viol and its Celeste.

The Swell begins with an 8’ Geigen Diapason, which may be combined with either of the Swell’s 4’ stops to form a useful chorus to contrast with the larger chorus in the Great.

A Gedact which plays at both 16’ and 8’ pitches provides most of the flute tone here, supplemented by a 2’ Flageolet. The Flute Chorus is completed by borrowing the 4’ Harmonic Flute from the Great; this borrow also allows the Harmonic Flute to be used as a solo stop against the accompaniment of the Flute Celeste. For similar reasons the Great’s 8’ Claribel Flute is also playable on the Swell manual.

The rarely seen Keraulophon returns to modern organ building in this instrument and plays several key roles. Voiced to produce a keenly incisive string sound, it will serve as a solo stop when used alone, but will also be found very versatile when combined with other stops. In solo combinations with a flute, principal, or even a reed, it will add a pungent coloration to expand the available tonal palette. It can also be added as a spicing agent to choruses of principals or reeds.

A rich Viol and Viol Celeste pair will fill the room with a warm enveloping glow, useful for accompaniments or whenever congregational offerings begin to fall off.

The role of tonal glue is here served by the 4’ Gemshorn which has the very accommodating virtue of blending seamlessly in chorus with nearly any other stop in the division, adding a touch of complexity and brightness to the sound.

Reed tone is represented by an English Tuba and a companion Bass Tuba which also plays at 4’ pitch as the Tuba Clarion, allowing for a complete chorus without the unsatisfactory practice of two adjacent octaves being drawn from the same rank. Broad and sonorous in character, these stops will add to the power and gravitas of the organ in numerous combinations.

At the 16’ pitch the Pedal’s primary resources are a Major Diapason, a Sub Bass, and a Viol which are respectively the loud, medium and soft stops for supporting the entire instrument. At 8’ pitch the Major Octave provides the principal tone and a Bass Flute supports medium and softer combinations. A 4’ Super Octave completes the principal chorus in this division.

Reeds are both Trombones, one each at 16’ and 8’, which add power and pitch definition to the pedal line.

Both of the Great 8’ Diapasons are made playable here for flexibility, and the Swell’s Tubas are similarly borrowed to allow contrasting color and weight to the Trombones.
Making additions to existing rooms is a difficult enough tightrope act when the room is either generic in style or is built in a style with well established tropes. The difficult architectural work is in rooms where the style of architecture is both strong, and original. This is the situation at St. Mary of the Hills.

On the surface, the style of the sanctuary evokes Gothic. Yet this is deceptive; this room is more austere than that. For example: Gothic woodworking is thick with decorative accent and moldings. Not so here, almost all of the corners in the woodworking are plainspoken and untreated. Similarly the building uses short, almost Tudor arches over the doors; where a Gothic structure (forever accentuating the vertical) would want taller Lancet arches.

What we have here is an architect who has transformed Gothic through the lens of the American Craftsman and English Arts & Crafts movements.

There is definitely an influence of William Morris and Gustav Stickley here, in the lack of molding, wainscotted walls, heavy timber, and human proportions. It is formal, and even decorative, but always stops shy of crossing the line into vanity (a level of aesthetic restraint rarely seen in Gothic).

In addition to the design conventions of the room, organ cases have an architectural language of their own to adhere to. It’s never so simple as assembling architectural fragments from the room into a collage. The case itself has to be a complete architectural sentence which fits, as it were, into the larger text of the room.

In addition to being aesthetically appropriate to the room, the new cantilevered case will allow the choir to stand in the space which was formerly occupied by the visible portion of the prior organ, greatly improving their ability to hear one another.
Having made the musical and artistic case for our instrument, let's spend some time discussing how Gawthrop Organworks will build it and some of the advantages our approach offers over other firms you may be considering for the project.

Because many incorrectly view organ building itself as a sort of historical anachronism, many organ builders fall prey to the temptation to develop an adversarial relationship with technology. Our approach to building pipe organs is exactly the opposite.

Modern Organbuilding

“We are called to be the architects of the future, not its victims.”
~ R. Buckminster Fuller
For most of its long history, the pipe organ was at the crest of technological progress. In the early 20th century, a pipe organ built by Ernest M. Skinner was the most sophisticated piece of technology available to the general public, only eclipsed by telephone relays.

In the middle of the twentieth century, that began to change. A movement was afoot to ‘reform’ organ building, effectively backward several centuries in technology and methodology. Every aspect of our forefathers’ practices became worthy of precise emulation, except, it seemed, their unceasing drive to innovate.

The craftsmen who came before us in this endeavor are rightly remembered and revered precisely because they were not content to build the organs which had gone before them. Just as we would not want to see a 16th century instrument radically “modernized”, we would not see a 21st century instrument built as though discovered in a sealed time capsule.

We believe an organ should be representative of its era, as they have been until quite recently. As a consequence, where we have found benefits in more contemporary technologies, we have adopted them, just as the organbuilders of the past did. We would take up the cause of originality and innovation, as they did.

CONTROL SYSTEMS

When electricity came to organbuilding, it brought with it a whole host of new engineering problems. For the movements of the keys of the keyboard to be translated into hundreds, sometimes thousands of discrete electrical signals on as many wires was a truly daunting challenge to meet with Victorian era technology and materials.

While the incredibly complex and intricate pneumatic control systems built in those days have been supplanted by solid state electronics, they are still with us in a peculiar way; each successive generation of organ control systems has largely been designed to resemble the one that came before.

As a consequence, even the most recent control systems used in organs (themselves designed more than a decade ago) look very much like their Victorian counterparts in basic design. Wires run from the console to a single point in each organ chamber, where the output cards split them out into hundreds or thousands of fine wires, bundles of which snake their way through the organ chambers to the windchests.

These bundles are typically fabricated on-site (at great expense) and they are not terribly robust. Not infrequently, they become damaged, causing expensive and time-consuming troubleshooting. Such long runs of copper wire also make excellent antennae for lightning strikes, which are probably the most common cause of pipe organ damage.

Not being satisfied with this state of affairs, Gawthrop Organworks designs and manufactures our own organ control system based on more modern principles.

The console communicates with the organ via digital wireless transmissions (or, in extenuating circumstances, a single high speed fiber optic cable). Inside the organ, each group of 32 notes are handled by their own self-sufficient output card, placed inside the windchest itself.

The resulting system is less expensive to build and maintain, involves almost no on-site wiring and is far more robust against lightning damage.

Because each card is completely self-sufficient, the impact of any hardware failure is limited to the 32 notes a single card handles, unlike most mass produced control systems where a single failed circuit board can disable whole divisions of the organ at a stroke.

This system is perfectly representative of our approach to technology. We use cutting edge technology not for its own sake, but to build an organ which is more effective, flexible, durable, and affordable.
A New Organ for St. Mary of the Hills Episcopal Church

Traditional System

Gawthrop System

Traditional System

Gawthrop System

Traditional System

Gawthrop System
Touch Control
Over the course of the last 15 years, color touch screens have become high quality, inexpensive, and (consequently) ubiquitous. It’s a technology now in two cellular phones out of three. Organ consoles are a perfect application for touch screens, where the organist needs full-time access to quite simple controls, but occasional access to quite complex controls.

The question naturally arises: why is it that a $200 cellular phone has a touch screen interface, while an organ control system costing many thousands (often tens of thousands) of dollars provides small, difficult to read monochrome displays accompanied by push buttons and knobs used to navigate ludicrously complex menu systems?

If you can’t think of a single good reason, don’t feel bad; we can’t either. Gawthrop Organworks 4.3” touch screen control systems give you easy, intuitive access to memory levels, programmable crescendi, assignable swell shoes, chamber temperature readings, console light controls, and all the other fine details of the organ.

Our touch screen is bright, large, easy to read, durable, fast, and doesn’t require a manual to explain its operation.

Memory
Few things embarrass us more on behalf of our industry than seeing new organs installed, with six figure price tags, having orders of magnitude less digital memory available for organists’ use than is widely sold in flash memory cards for less than the price of a fancy cup of coffee.

There is simply no plausible excuse for a 21st century organ to have fewer than a thousand levels of memory.

We are happy to provide as much memory with our instruments as the customer feels could be useful, typical configurations have several thousand levels available.

Lighting
How many organists does it take to change a light bulb? No need to find out. Unlike many in our industry, we routinely install LED lighting on our consoles for illuminating the pedalboard and music rack. These systems are rated for such a long service life that we don’t expect to have to replace any of them for several decades.

Startup Time
Perhaps it’s a small quibble but we do not feel an organist should have to wait around for an organ control system to gather its wits before they can begin playing. We are baffled by control systems which take longer to start up than the blowers take to wind the organ, and we take steps to make sure our control system does not exhibit such lethargic behavior.
**Free Expression**

The idea of expression shades is simple enough: An organ pipe only speaks at one volume, but if you put the pipes in a box and put moving louvres or shades on the front of the box then you can control the volume, either for gradual changes, or precise steady control.

For either of these goals to be met, the shades must follow the motion of the pedal on the console with extreme fineness. Good expression shades are heavy, so it’s not a trivial exercise to build something which can move them both very quickly and very slowly, with high precision, silently, and without allowing them to slam.

The most common solution to that problem is to move the shades through a series of eight (or in rare cases, sixteen) different static positions in sequence. In this way you can, at some speeds, roughly approximate the smooth continuous movement the music demands.

Now when we say this movement approximates a real continuous movement, that’s really quite generous. It approximates it in the way that you can approximate riding a bicycle down a gentle hill by riding it down a flight of stairs. At some speeds, the defects are less obvious, but at others the experience is jarring.

As seriously as such limited expression systems can compromise attempts at smoothly changing volume, they sabotage the ability to select a static loudness even more severely. Imagine having home stereo which forced you to choose a volume from among eight levels evenly arranged from silent to deafening and you’ll have the idea.

The Free Expression system designed and built by Gawthrop Organworks uses a closed loop servo control system, similar to those used in industrial robotics. Sensors continually monitor the angles of the shades and the expression pedal which controls them and manipulates the shades with a specially designed linear actuator. The result is an effectively infinite number of speeds and positions.

With such precise control, the shades follow the movement of the expression pedal precisely at any reasonable speed. The system is quiet and very durable (owing to its industrial components).
The most important engineering in a pipe organ comes well before building it, during the planning stages. Even organs of modest size have hundreds of components which must be connected together with a labyrinth of metal or wooden wind lines. Frequently (as is the case in this situation) they are going into spaces with awkward shapes and limitations which make a three dimensional understanding of the installation essential. We believe if a modern organ builder is to take their work and the stewardship of customer’s funds seriously they must be firmly rooted in three dimensional Computer Aided Design.

Gawthrop Organworks founder Bradley Gawthrop has been doing professional 3D solid modeling for more than 13 years. Solid modeling is a discipline within computer aided design which is “3D native”, which is to say it views the computer as a tool for doing design and engineering in a 3D virtual environment, rather than as a substitute to a drafting board for generating 2D flat drawings.

At Gawthrop Organworks we build every organ, from the chamber itself down through windchests all the way to individual screws completely and in three dimensions using industry leading solid modeling software before a single piece of material is cut in the real world. All of the complex interactions of awkwardly shaped pieces are worked out at this stage, preventing costly and time-consuming surprises during installations, and the compromises often needed to solve them.

When the software used in the solid modeling industry is too limited for the specialized discipline of organ building, we develop our own. For example, the precise placement of pipes on a windchest is controlled by a complex set of rules concerning the interaction of the valves in the chest beneath and the proper spacing of the pipes above to prevent crowding from spoiling their speech. Rather than relying on rules of thumb or manually laboring over the spacing of every pipe in the organ we developed proprietary software which given the dimensions of the pipes and a series of layout rules will generate mathematically perfect layouts with the press of a button. It can be programmed to optimize the layout for any of a variety of factors which may change depending on the requirements of the organ chamber in question.

Once a design for the organ has been completed, the most demanding parts can be sent electronically to specialized fabrication plants with computer controlled robotic cutting tools which can follow our engineering files to accuracies within a few thousandths of an inch. Parts made using this process come together with an exact fit, every time.
The windchest is to organ building what the human figure is to artists. The very finest minds in the craft have debated and drawn and prototyped and built countless windchest designs over hundreds of years and yet, the work never seems quite finished.

Part of the reason the windchest is forever being revisited is that the desirable characteristics of an ideal windchest are contradictory from the engineering perspective. The air cushion effect provided by the slider chests of mechanical action organs, for example, has desirable effects on the speech of the organ pipes, but slider chests prevent those pipes from being “borrowed” to other manuals for convenience and can be hard to make quick and responsive.

Gawthrop Organworks windchests feature an independent valve and chamber arrangement for every pipe. In this arrangement, a single electrically operated valve (A) allows the pressurized air to enter a special cylindrical expansion chamber (B). This chamber creates the “air cushion” effect of a slider windchest, improving the speech characteristics of the organ pipes by absorbing the sudden “wind shock” created by the opening valve. Unlike a slider chest however, every note is completely independent of the others, allowing any rank of pipes to be made available on any manual at any pitch which is musically useful.

Should a note malfunction due to age or damage, maintenance is simplicity itself. Removing a handful of bolts will suffice to remove the entire action from the windchest, one half-rank at a time. This allows effortless access to all the moving parts, attached to a single valve board which can be easily removed from the organ if need be. We take the additional step of furnishing all of the wiring of these valve boards with plugs which can be disconnected and reconnected in seconds without tools.

A simplified cross-section of a Gawthrop Valve and Chamber windchest.
On the left, the pipe-valve is closed and therefore, the pipe is silent.
On the right, the valve is open, the chamber is pressurized and the pipe speaks.
ENVIRONMENTALLY RESPONSIBLE ORGANBUILDING

Environmental Issues are something most organ builders elect not to think much about. While it is undoubtedly easier to continue on in time-worn habits as though there are no consequences, we do not believe such an action is in keeping with our values, or those of our clients.

While the issues of environmentalism have been largely ignored in our field, a surprising number of problematic materials and practices have become commonplace.

EBONY

Ebony (D. Melanoxylon), is a dense African hardwood found mainly in Tanzania and Mozambique and has been the traditional material for the “black keys” of organ keyboards and other decorative elements for centuries.

Ebony is also an unfolding ecological catastrophe. High demand in both foreign and domestic markets have lead to massive, unsustainable and illegal logging of Ebony forests in Kenya and Tanzania. If current trends continue, supplies of harvestable Ebony in Tanzania will be entirely depleted in less than half a century.

Musical instrument makers, historically heavy users of Ebony, have largely turned a blind eye to the plight of this traditional material. While the manifest benefits of the material are undeniable and our firm has employed ebony in the past, we no longer feel its use is ethically appropriate.

IVORY

While Ebony is an unfolding environmental concern, Ivory has already taken its toll. Hundreds of thousands of elephants were illegally poached using the most inhumane methods imaginable, exclusively for their tusks during the ivory crisis of the 1970s, and for decades before. Countless extinctions and near-extinctions of various species of elephants owe their origins to the ivory trade all across the world.

While certified pre-ban ivory has recently become available on the market again in sufficient quantity for the manufacture of organ keyboards, much of this material, lacking provenance, was very likely illegally poached and we find its continued use in our industry morally dubious. At Gawthrop Organworks, we limit our interaction with ivory to the preservation and restoration of existing instruments which utilized it. On new instruments, we do not provide ivory keyboards at any price.

LEATHER

Besides lumber, the material most synonymous with organbuilding has always been leather. Its flexible, durable, air-tight qualities are legendary, and its use in our industry is effectively ubiquitous.

While not a catastrophe on the scale of ivory or ebony, the mounting environmental
impact of dumping and chemical runoff by the leather tanning industry (particularly in India) combined with the similarly increasing animal welfare concerns associated with the raising of leather stock of both sheep and calves is difficult to ignore.

Additionally, the history of leather in organ building includes episodes where several years of “bad leather” seriously compromised the longevity of pipe organs making extensive use of it.

Gawthrop Organworks has made a serious engineering goal of reducing the amount of leather used in our instruments to the bare minimum. As a result of these efforts, our organs frequently contain less than 10% of the leather used in other instruments of similar size, frequently less than ten square feet in an entire instrument. Our research in the area continues, and our ultimate goal remains the elimination of leather from our instruments altogether.

FINISHES

Until the second half of the twentieth century, the ubiquitous wood finish in organ building was Shellac. Shellac is a non-toxic, renewable natural material but historic organ builders chose it for less altruistic reasons. Even ranked against modern lacquers, polyurethane and polyester based finishes, shellac forms the most effective barrier against changes in airborne humidity of any wood finish available. That protection ultimately came at too high a price, and most organ builders today utilize less expensive and more user-friendly petroleum-based finishes.

The profusion of cheap petroleum-based finishes in organ building (and indeed in many other kinds of construction as well) represents not only a step backwards in quality, but a serious air quality hazard. Typical lacquers now used in organ building are invariably diluted in solvents given the HAP (Hazardous Air Pollutant) classification by the US Environmental Protection Agency. Even after the solvent has evaporated, such finishes continue to outgas volatile organic compounds, sometimes for years. These compounds have been linked to serious chronic health effects and regulations in many parts of Europe severely restrict their use in public spaces including places of worship.

We finish organ components exclusively with shellac. Consoles, which receive far more physical abuse require a finish which is more abrasion resistant. For this application, we use specially formulated non-toxic water-borne lacquer which meets stringent environmental standards.

We apply these finishes using state of the art spray systems, designed with HVLP (High Volume Low Pressure) technology, more commonly used in the demanding field of automotive finishing. This technology allows for greater than 50% reductions in wasted finish due to overspray and creates a finish with better surface characteristics.

We believe our finishing process is the most environmentally sound in the industry, while simultaneously providing critical protection for the wooden parts of the organ against harmful changes in atmospheric humidity.

‘Green’ Finish Credentials:

OTC & SCAQMD VOC COMPLIANT
No NMP, No Hydrazine
California Prop. 65 Compliant
LEED CREDIT CODES: EQ4.1, EQ4.2, EQ4.5

ENERGY EFFICIENCY

In most applications, ecological and financial concerns have largely pushed inefficient power supplies of linear design out of the marketplace. It is disappointing, in that context, to see how large a role is still played in the organ industry by shockingly inefficient linear power supplies, which can throw away as much as half the power they consume as waste heat. Gawthrop Organworks uses only highly efficient switched-mode power supplies. In addition to being dramatically more efficient, they have the additional advantage of not pouring waste heat into the organ chamber, where it can disrupt the tuning.
Every technical speciality has a language. The organ is cursed with several. As a discipline that evolved independently in many different countries over a span of many centuries, it collected any number of names for all of the various pieces, concepts and sounds in a half dozen different languages. When organbuilding became an international affair, those terms were all thrown into the mix together.

This guide is meant to help you through the language of the proposal, and is by no means comprehensive (the world lacks enough paper to print a comprehensive treatment of organ jargon); but our hope is that it will prove useful and educational.
ACTION

The action is the mechanism which translates the movements of the keys on an organ console to the opening of valves which permit wind to flow into the organ pipes. The earliest pipe organs used mechanical action to connect the keys directly to leather covered pallet valves with the long wooden bars or trackers (from which this action draws its nickname).

Unsurprisingly, the larger an organ becomes, the more physical resistance is offered by an instrument with mechanical action, which can make building and playing larger instruments in that style very challenging. Later developments included the tubular-pneumatic action where charges of air and vacuum were transmitted through long, small-diameter tubes from the console to the organ chamber. The increasing availability and reliability of electricity led to the development of the electro-pneumatic action, where the actions of the organist are transmitted by wire as electrical signals to a series of progressively larger valves in the organ, the first of which is set in motion by a small electro-magnet. The availability of increasing amounts of electrical current and more sophisticated control systems also made possible the electro-mechanical or direct-electric action, where each pipe in the organ stands over a dedicated electromagnetic valve, controlled by a complex switching system.

A great deal of ink has been spilt by the proponents and detractors of various kinds of actions over centuries of the craft. We consider this argument a fine example of the capacity of organ builders to have large arguments over comparatively small matters and we will not rehash the arguments here save for pointing out that any style of action, assuming it has been properly engineered, is perfectly capable of rendering all service music and most concert literature without difficulty. The differences between them are subtle, and lie almost entirely at the outside edges of the sorts of music we would expect to hear on a Sunday morning. As a consequence, we would suggest that the action plays a comparatively small role in determining the success of any given instrument in worship and that any organ builder who spends more effort on manufacturing or selling the action than the musical resources of an instrument has either taken their eye off the ball, or would prefer that you do so.

BELLOWS [See RESERVOIR]

BORROW

To make a rank of pipes available at more than one pitch, or on more than one manual.

A Borrow is similar to a coupler, except the effect is limited to a single rank, rather than an entire manual. This is made possible by the use of Unit Action. [See UNIT ACTION]

CELESTE [See UNDULANTS]

COMBINATION ACTION

When an organist wants certain sets of organ pipes to play from the keyboards, he turns them on and off with controls called Stops on the console. Sometimes these take the shape of tilting tablets above the keyboards, sometimes drawknobs off to the sides of the keyboards. Whatever the chosen methodology, the same problem presents itself: manipulating one or two controls quickly while playing can be challenging enough but larger changes involving many controls would require the organist to have either more hands, a trained assistant, or a robot.

The Combination Action is a robot, or rather a small computer which allows the organist to set and recall various combinations of control positions by pressing small round buttons called Pistons located strategically beneath the
keys of each keyboard on the console. Many instruments have pistons snuck in above the pedals as well, where the organist can surreptitiously thump them with an idle foot. When you see an organist playing along and suddenly several controls on the console move on their own, the console is not haunted. Rather, you have seen the organist use the combination action.

The modern combination action developed by Gawthrop Organworks routinely handles many thousands of memory levels, which may be set and retrieved by the organist at will. Unfortunately, many combination action systems still sold and installed today were engineered decades ago, when computer memory was still a precious and rare commodity. Consequently, they offer a mere handful of memory levels. We would highly recommend that any church commissioning a new organ insist on a combination action built on a more modern technological foundation, and capable of storing hundreds if not thousands of levels of memory.

**CONTROL SYSTEM**

All organs with electric actions require some form of control system to direct the electricity to the appropriate valves in response to the status of the controls and keyboards on the organ console. In the early days of electric actions, these were largely mechanical affairs, with magnets pushing bars full of tiny wires into contact with matching sets of wires some distance away. This trouble-prone arrangement has thankfully been supplanted by solid state circuits in new construction.

**CONSOLE**

The control center of the organ. Equal parts furniture, cockpit and remote control, the organ console is where the musician and the instrument meet. Consoles vary widely in style and size but they are easy to identify; just look for the keyboards. The most important thing to realize about consoles is that they are not part of the sound-producing section of a pipe organ. If you should ever want to impress a pipe organ builder you meet at a cocktail party (into which he has presumably wandered by mistake) just demonstrate your knowledge that the console doesn’t make any sound, and that there are more pipes in an organ than are visible in the case. These two small insights will, all by themselves, elevate your level of demonstrated pipe organ acumen well above the average.

**COUPLER**

A device which allows resources from one section of a pipe organ to be played elsewhere. For example, pipes from one of the manual keyboards to be played on another keyboard, or on the pedals.

**CRESCEUDO PEDAL**

A Crescendo Pedal looks very similar to an expression pedal [See EXPRESSION] but functions differently. When depressed, the crescendo pedal incrementally activates stops organized from softest to loudest, creating a musical crescendo. When retired, it reverses the sequence, creating a diminuendo. This is a 19th century invention, and some 19th and 20th century solo literature calls for it directly, but it is more often used by visiting substitute organists as a shortcut to selecting stops on an unfamiliar instrument.

**DIVISION**

An organ is typically divided into sections called Divisions. Typically (though not always) each division corresponds to a keyboard on the organ console.

**CIPHER / CYpher**

A pipe which speaks when it isn’t supposed to. Typically this is the result of a mechanical failure of some kind. Cyphers come in various levels of severity, from the barely audible Whisper Cypher (which can be very difficult to find) to Full Cyphers of pipes designed to be heard over the rest of the organ combined. If you are fortunate enough to work on pipe
organs for a living, you will eventually have the opportunity to experience a Grand Cypher or Sforzocalypse, where hundreds of notes of many different ranks play simultaneously, as though the organist had turned on every stop available, then laid a phonebook across the keyboard. Even in modest sized instruments, such an event can be profoundly impressive.

Cipher and Cypher are alternate spellings of the same word, and while both are technically correct, we typically use the European “Cypher” in order to appear maximally sophisticated and erudite.

**Diapason / Principal**

The most idiomatic sound in the organ is that made by the Diapason or Principal scaled pipes. Mid-way between Strings and Flutes in their harmonic development, it is (not coincidentally) the class of pipes most similar to the human voice in volume and timbre. [See Overtones, Scaling]

**Drawknob / Drawstop**

[See STOP]

**Dummy**

A pipe, usually visible in an organ case, which is not designed to speak. The visual demands of symmetry and architecture often demand pipes for use in organ cases which have proportions not needed in the organ. Consequently, many case pipes are not actually capable of speaking, and are purely decorative. Many cases have a mix of decorative and speaking pipes, not always clearly marked. Consequently most experienced organ tuners have at least one story of having attempted to tune dummy pipes, without success. [See Voicing, Flue Pipe: Anatomy]

**Expression**

One of the musical limitations of organ pipes is that any given pipe can only play at one level of loudness. While an organist can create changes in loudness by turning stops on and off, these changes are quite abrupt and often effect the kind of sound involved, not just the amount of sound.

To affect truly gradual changes or to finely control the volume of any given rank of pipes requires a different approach; the pipes are placed in an enclosure and the front of the enclosure is made with louvres or shades which can be gradually opened and closed by a the organist using a foot control a bit like an accelerator pedal. With these shades closed, the pipes are effectively in a closed box, and their volume is greatly reduced. With the shades open, the pipes sound almost as they would if they were not enclosed at all.
Flue Pipe

At a fundamental level, flue pipes are pretty simple. The basic concepts that make them work are no different from a slide whistle or a pan pipe. Such were probably the first musical instruments humans made besides drums.

Wind enters a flue pipe through a hole in the toe and is formed into a thin sheet of air by the small gap between the lower lip and the languid called the windway. That sheet of air moves upwards to pass over the upper lip. Fluid dynamic forces set up a cycle where this wind sheet oscillates forward and back, sending waves of pressure up the body of the pipe which we hear as sound.

From this rather humble behavior, most of the widely varied tonal effects of the organ are created. Many different alterations can change the tone of a flue pipe, variations of scaling, material, the treatment of the lips and languid, the addition or absence of ears, caps at the end of the body, plates or dowels placed in front of the languid, and a thousand other factors too numerous to name.

Flue pipes can sound like whistles, distant sets of orchestral strings, and echoes of the human voice itself.

Flutes typically cannot sound like brass instruments, clarinets and oboes; that job usually goes to the reed pipes.

(See VOICING, REED PIPES)

Flute

Broadly speaking, the flute pipes of the organ tend to have the largest scales and the least harmonic development. That description makes them sound more bland than they are; good pipework and voicing can produce an astonishing array of distinctive flute tones. Flutes are a class of pipes frequently made of wood, and this too contributes to their endless variety.

Foot

An approximate unit of measure, to indicate the pitch of a rank of pipes. The basic pitch of the bottom C key of an organ keyboard is made by a pipe approximately eight feet in length. A rank which begins at that pitch is said to be an “eight foot” rank. A rank an octave higher starts on a pipe approximately half that length, and is a “four foot” rank and so on.

Harmonic

Harmonic Length

Harmonic length is a term usually used to refer to a technique where the resonators of
a reed pipe are made at approximately twice the typical length, but tuned to their normal pitch. This treatment can greatly increase the volume and harmonic development of a reed pipe. In very high pitched pipes, where the resonators are very small, it can also make their manufacture and tuning easier.

The corollary of this technique in flue pipes is to produce them at nearly double the desired length and pierce a hole in them at approximately the point where a normal pipe would have ended. The hole forces the pipe to speak a pitch higher than the length would normally suggest and the additional length tends to focus and intensify the sound. Making pipes in this style is expensive, and voicing them can be challenging, so it is a technique usually reserved for special stops, most notably the Harmonic Flute.

**LANGUID, LIP (UPPER/LOWER)**

[See FLUE PIPE: ANATOMY]

**MANUAL**

Manuals are simply the musical keyboards on the organ console. They are called Manuals or Manual Keyboards to differentiate them from the keyboard made for the feet: the Pedal Keyboard or Pedalboard.

**MIXTURE**

Mixtures are a special kind of stop. They are not designed to be played by themselves, but on top of another rank (typically, a Diapason of eight foot pitch). Unlike an ordinary rank, a mixture has several pipes for every note on the keyboard. These pipes are tuned to the overtones of the rank the mixture is designed to complement. [See OVERTONES]

**OPEN TOE**

Open Toe, or Open Toe Voicing is a style of voicing organ pipes where the hole in the bottom of the pipe is left quite large, resulting in high pressure and low turbulence in the foot. This is typically accompanied by a very thin windway. This style of voicing is popular among builders of historic instruments, in some part because it secures surprising volume levels from very modest wind pressures. [See VOICING, FLUE PIPE: ANATOMY]

**OPUS NUMBER / OPUS LIST**

An opus number is a glamorized serial number for an organ. Organs from a single builder are numbered sequentially for ease of reference and historical clarity. The practice of using the word “Opus” (a Latin word meaning simply “work”) is cribbed from the conventions of classical music composition. As follows intuitively, an Opus List is simply a list of organs completed by a firm. While conventions vary, typically only new or very substantially altered instruments will receive an opus number. Instruments which have been restored or renovated are typically held to be the work of the original builder, and keep their original opus number on their nameplates.

If this sounds to you like a system which could needlessly make working out the actual history of an instrument confusing and difficult, you have understood perfectly.

**OVERTONE**

When the air in an organ pipe (or other resonator) begins to oscillate, a whole complex spectrum of different frequencies is generated. The most prominent of these, which we think of as being the “Note” is called the fundamental frequency, and is determined primarily by the length of the pipe in question. Complex interactions of shape, material, wind pressure and aperture all play a role in producing a host of other higher frequencies which color the sound. These other frequencies, or overtones, are most of what we hear as timbre and are the way we discern the differences between similar musical instruments, even though they may be playing the same note.

Overtones fall into two categories:

- **Harmonic Overtones** are frequencies which have a strong mathematical relationship to the
fundamental. The human brain is exceptionally good at teasing out these relationships, and the presence of harmonic overtones often makes it easier to hear and identify the fundamental pitch underneath.

Non-Harmonic Overtones are frequencies which have much weaker mathematical relationships to the fundamental. These can make identifying the pitch more difficult, especially when many notes are heard at once. The slightly sour tangy sound of chimes is a result of the abundance of non-harmonic overtones.

Harmonic Development is a term used to characterize how prominent the role of overtones is in the sound of a given pipe. A pipe with a greater prominence of overtones is said to have a greater harmonic development. As with salt, overtones can enhance the flavor of what’s underneath, but too much harmonic development can also obscure or even overpower that same flavor.

**PISTON**

Pistons are buttons used to control various features on the organ console (most commonly the Combination Action). Thumb pistons are typically small round* buttons, located underneath the keys of the keyboards, facing out. Thumb pistons (you will be unsurprised to learn) are most frequently activated by an organists’ thumbs, allowing them to keep their other four fingers busy on the keyboard while activating the control surreptitiously.

There are also pistons on the pedal keyboard, accessible to the feet. These are called Toe Pistons.

*While most organ pistons are round, at least one French-Canadian firm routinely installs square ones. Our research has not uncovered whether the rationale for this decision is a perverse pleasure at the pain an organist experiences when catching their fingertips on the corners, or whether French-Canadian organists are routinely equipped with rectangular fingertips.*

**PRINCIPAL CHORUS**

A group of Diapason ranks of ascending pitch, designed to be used together, forming a single cohesive sound. Typically, a Principal Chorus will begin with an 8’ Diapason, and add a series of stops tuned to the overtones of that rank. (See Overtones, Mixture)

**RANK**

A set of pipes scaled and voiced alike, most often one for each note of the keyboard. In some cases a rank may have more pipes than there are keys on the keyboard in order to allow them to be used transposed into different positions. (See BORROW, STOP, UNIT ACTION)

**REED PIPE**

Reed pipes generate sound in rapid powerful pulses created by the motion of a brass reed or tongue. While they may sound brassy, reed pipes operate under similar principals to their orchestral namesakes, and some of the same terminology applies.

Wind enters through the Boot, which, being sealed around the block, pressurizes rapidly. This air begins to escape under the precisely curved tongue and into the resonator. This begins a pulse which ends only when the low pressure area created under the tongue by the movement of the air pulls it flat against the shallot, blocking the flow. With no moving air, the low pressure under the tongue dissipates, and it springs back outward beginning the cycle again.

The frequency of this cycle is determined by an interplay between the length of the resonator, and the length of tongue left free to vibrate, which can be controlled by moving the tuning wire.

**RELEAY** (See CONTROL SYSTEM)

**RESERVOIR**

The pressure of the air in a pipe organ must be precisely controlled, and large reserves of air at that predictable pressure must be made available to meet the rapidly-changing wind demands of the organ. Both of these goals are
met by reservoirs.
While many different designs exist, the basic elements are always there: a large box holds air at the desired pressure. This is connected to a valve which allows higher pressure air from the blower to flow in and replace the air which leaves the organ when it is played. Typically, the pressure in the box is balanced against springs or weights to operate the valve. This centuries old active feedback system regulates the pressure in the reservoir with astonishing precision and speed.

**Resonator** (See Reed Pipe: Anatomy)

**Scale / Scaling**
Scaling is the relationship of an organ pipe’s diameter to its length. Broadly speaking, the scale of a pipe goes a long way to determining its timbre, with larger diameters tending to sound more like flutes (producing few overtones) and smaller diameters tending to sound more like strings (producing maximum overtones). (See overtones, flute, diapason, string.)

**Shallot** (See Reed Pipe: Anatomy)

**String**
The keen and incisive sounds of the flue pipes come from Strings. These are the pipes of the smallest scales and greatest harmonic development. Individually, they are valuable as a solo voice or to add an edge to an ensemble sound.

In modern practice they are more often arranged in pairs or ensembles of undulants. In this configuration the sound of strings is ostensibly imitative of their orchestral namesake, though it must be admitted that even in ideal conditions the resemblance is only a passing one.

Strings are easily the most difficult flue pipes to voice effectively, and the lack of good string voicing has made the inclusion of real string tone a rare feature in the second half of the twentieth century, their place being taken by slightly anorexic diapasons, tuned as undulants and named after the genuine article.

**Straight Action / Design**
Broadly speaking, when a rank is only available on one keyboard and at one pitch, without any borrowing or other unit action funny business, it is said to be straight. “Straight” terminology, whether it be in reference to actions, ranks, or organs overall is generally taken to mean the opposite of “unit”, where pipes sitting above independent valves can be made available in several different locations in the same organ.

**Stop**
Stops are the controls that activate certain ranks of pipes. If the mechanism of the action allows it, a rank of pipes may well have more than one stop, for example, on different keyboards, or transposed up or down an octave.

**Swell Shades** (See Expression)

**Switching System**
(See Control System)

**Toe** (See Flue Pipe: Anatomy)

**Toe Hole**
The small hole, usually chamfered, that an organ pipe sits on. It is used to conduct wind into the pipe, causing it to sound.

**Toe Piston** (See Piston)

**Tongue** (See Reed Pipe: Anatomy)

**Tremulant**
A Tremulant is a device which rhythmically pulses the wind pressure within a section of the organ, causing the sound of the pipes to oscillate. The effect is a similar to a singer’s vibrato.
UNDULANT
An undulant is rank of pipes intentionally kept very slightly out of tune. These ranks are designed to be paired with a similar or identical rank in which is in perfect tune, to generate a warm and complex interplay of sound, reminiscent of an orchestral string section.

UNIFICATION / UNIFIED UNIT / UNIT ACTION
A unit action is one where every pipe can be made to speak independently of the others. A rank so treated can be used at multiple pitches, or on multiple keyboards without any mechanical dependence on other ranks in the same division. A single rank placed on such an action in an organ of otherwise straight design is said to be “unified”.

VOICING
While there is craftsmanship at many stages of building a pipe organ, it could be argued that the only aspect which truly achieves the status of fine art is voicing.

Pipes, freshly made, have been brought only to the point where they make a sound. The shaping of the sound, both of individual pipes and whole ensembles, is voicing.

It is through this physical manipulation of the pipework that all of the color and personality is given to organ pipes. The process requires talent in both hands and ears, and while you could spend many years just learning how to make pipes give you what to want, the real magic lies in learning what to want. As any voicer will tell you, that is the work of a lifetime.
Colophon

Body text in this document has been set in Pollen, a typeface designed by Eduardo Berliner and a recipient of the ISTD Premier Award. Headlines are set in Apolline, a typeface by Jean Francois Porchez and captions in Cora by Bart Blubaugh.

As we ourselves are modern practitioners of an ancient art form, it gives us pleasure to typeset our words in young and vital typefaces designed by modern craftsmen.