Organbuilders and research: A clarification

Francesco Ruffatti and Judit Angster

The following is a response to the article "Organbuilders and research: Another point of view," by John M. Nolte (The Diapason, July 2010, pp. 20–21), which was itself in response to the article "Organbuilders and research: Two points of view," by Francesco Ruffatti and Judit Angster (The Diapason, January 2010, pp. 24–27).

I found the article in the July issue (pages 20–21) written by my colleague John M. Nolte very interesting and informative. We are probably of the same age: I too have been involved in organbuilding for well over 40 years. Having said that, I should also say that I do not really believe that longevity in organbuilding practice is what counts the most: one can repeat the same mistakes for decades, and at the same time a bright young organbuilder can find innovative ways quickly. Experience plays a role, but it is the personal attitude that makes the real difference. In any case, we both seem to be curious enough to try to get to the bottom of organbuilding issues. For this reason, I have chosen to be involved in research, and have been lucky enough to find the connection, during the last ten years, with the very respected and reputable Fraunhofer Institut für Bauphysik in Stuttgart.

Having practiced both open-toe and closed-toe voicing for quite some time, going through a variety of organbuilding "trends," and having come in the end to some empirical conclusions, I was always curious to find out why I was considering one method better than the other for certain applications. Specifically, I have no problem in stating that under "average conditions"—let us say at around 3 inches of wind—I obtain better results with open-toe voicing on principals and flutes, and better results with closed-toe voicing on strings. If I have to raise the pressure further, to increase the sound energy at its source (sometimes you have to, especially in poor acoustics), I find it easier to control principals and flutes if I voice them with open toes. "Better results" are always subjective, of course, and personal taste plays an important role, as I stated in my original article.

Dr. Angster, Dr. Miklos, and other scientists—all top names in organ acoustics—have explained to me not only the Bernoulli formula, which in the end is not so complicated, but a number of other theories and esoteric formulas. I tend to be "practical," like many organbuilders, and will not deny having been taken by surprise in seeing how variable the scenario can be in toe wind pressure values, after boring holes and applying pressure sensors to the sides of the pipe feet.

In a perfect world, one could put each stop on its own wind pressure in order to compensate for open or closed toe, in order to obtain, as Mr. Nolte suggests, equal wind pressure at the languid, which is not an easy thing to actually measure, unless you bore holes at the toes as we did during the research. In the real world, when you are voicing a chest of pipes in a Swell division containing principals, flutes, strings and reeds, then you have fewer choices. This is where a practical comparison of the two methods, given equal windchest pressure, becomes meaningful. While I respect Mr. Nolte's idea, the choice that we made in establishing a research procedure was different, as Dr. Judit Angster explains well in her section of this article. I will never say that "my way is the only way," and I would ask for the benefit of the doubt from others as well.

The issue of the so-called "wind noise" is, in my opinion, the key to, not a side aspect of, the whole matter. I have been told that what causes turbulence—and noise as one of the results—is a sudden restriction in the air flow. In other words, if we restrict the maximum flow from the diameter of the windchest hole, by closing the pipe toe, turbulent conditions are created. The "open toe" is so open that it looks exaggerated: this is not done to make sure that enough wind gets into the pipe, but rather to avoid as much as possible a restriction in the flow. The shape of the pipe tip may have some influence in the noise, but the real issue does not change. Actually, by looking at photo 2 of Mr. Nolte's article, it seems to me that the hole with the countersink, which he refers to as "quiet toe-hole," seems to direct the flow inwards, towards the center of the flow, thus potentially creating the opposite of what a "diffuser" would do. A diffuser is a device that is aimed at reducing turbulence from flow restrictions. On this matter, we have some interesting results from previous research on wind supply.

If noise is created, at equal windchest pressure conditions, Mr. Nolte agrees with me that by reducing the wind flow at the lower lip, which is the only way to control volume in an open-toe flue pipe, the wind noise is reduced as well. I take this as a strong indication of the validity of the open-toe system for the "classical stops," where it is not as desirable to nick the languids. For the strings, the matter is different, and the need to reduce the pressure in the toe is linked to the need for keeping the mouth cutup to reasonable levels in spite of the smaller relative diameter of the pipes, to preserve clarity. Nicking is, for these pipes, a normal condition (except in rare occasions—for example, the "Violetta" by Callido).

Voicing is very personal, and tastes are different. I am sure that Mr. Nolte does a fine job with voicing, given his experience, regardless of the method. As to wooden pipes, I am happy to hear that he has done research on this aspect as well. We are doing the same, possibly with some different objectives: not only to find better transitions, but also, for example, to speed up the speech on very large 16′ open wood pipes. I will read Mr. Nolte's reprint when it becomes available, as well as the description of his all-wood practice organ. I sincerely wish him the best of luck in his efforts. After all, we are all in the same boat, and all for the same reason: we all love the work that we do.

—Francesco Ruffatti

In my contribution to the article, I tried to release information about our current research project on organ pipe voicing and scaling. Within this context, I mentioned our investigation on open and controlled toe voicing, as one example of the ongoing research. Unfortunately, the goal of this experiment was not formulated clearly; therefore I have to accept Mr. Nolte's ironic criticism as justified.

Certainly, the group of scientists and I, who have been working together for several years on organ pipe research, know very well that "the velocity of air at the flue is determined by the pressure in the foot of the pipe just below the languid" and that "in every case, the voicing pressure is lower than the windchest pressure." But we also know that not only "the velocity at the flue" "matters for pipe speech," as Mr. Nolte states. A more important factor for the speech is the velocity at the upper lip, and that velocity depends also on other parameters. The air jet emerging from the flue must obey the physical law of momentum conservation; therefore its maximal velocity V at a distance y from the flue can be given as $V(y) \approx U_B (d/y)^{1/2}$, where U_B is the Bernoulli-velocity and d is the width of the flue. The air jet is directed usually slightly outside; therefore it hits the upper lip at a velocity that is lower than its maximal velocity. The direction of the jet depends on the relative position of the languid and lower lip. The task of the voicer is to find the optimal adjustment of the mouth area to ensure the required loudness and speech of the pipe. From the standpoint of science, the voicer adjusts only two physical quantities: the air volume through the flue and the velocity at the upper lip. In the case of a constant windchest pressure, the air volume is adjusted for closed-toe pipes both at the toe and at the flue; in the case of open-toe pipes, it is adjusted only by means of regulating the flue width. The velocity at the upper lip depends on several parameters: the Bernoulli-velocity (which depends on the foot pressure), the width of the flue, the cutup, the positions of lower lip, languid, and upper lip, etc. The essence of the art of voicing is to find the optimal adjustment of these parameters only by listening to the sound.

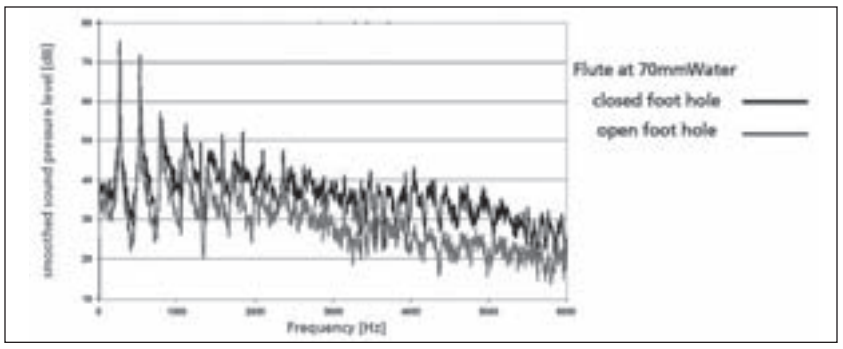

Figure 5. Sound spectra of the stationary sound of two identical flute pipes voiced by closed-toe and by open-toe methods

The velocity profile of the air jet depends also on other parameters like the profile and angle of the languid, nicking, etc. In order to get more information about the properties of the air jet, the free outflow from the flue of metal organ pipes and edge tone generation at the upper lip was the subject of a three-year Ph.D. project at the Fraunhofer IBP, which will be completed this year.

If two identical pipes are placed on the same windchest, one with open toe and the other with closed toe, it is possible to get the same velocities at the upper lips by reducing the flue width of the pipe with open toe. This opportunity has led us to the idea of voicing the two pipes on the same windchest pressure, to the same volume of sound. Thus the goal of the investigation was to voice the pipe with open toe and the pipe with closed toe to the same loudness and then compare their steady spectra and attack transients. Preliminary results of this investigation were presented in our article.

For us scientists, it was astonishing to witness how similar the achieved sound was from both types of pipes. Steady spectra and attack transients, measured by our special method, were very similar. The only easily measurable difference was the lower wind noise level on the pipe voiced with open toe at 70 mm water column pressure.

In a closed-toe pipe, the foot pressure may be significantly lower than the pressure in the groove. This pressure difference accelerates the flow through the smaller cross-section of the foot hole. The cross-section of the foot will then suddenly become much wider and the flow velocity will decelerate. This acceleration/deceleration process can generate noise and pressure fluctuations. With open toe, neither pressure difference nor sudden velocity changes occur. As the measurement results in Figure 5 of our original article show, the wind noise level in the pipe sound is lower in the case of voicing with an open pipe foot.

The common research with voicers has proven that good speech and steady sound can be achieved by both voicing methods. The voicer should decide which method he prefers; this is a question of taste and experience, not of science.

—Judit Angster