From the Editor

Musical Instrument Ergonomics

David Nabb's interview of Maarten Visser[1] on page 159 of this issue and Brenda Wristen's article on the 7/8ths keyboard[2] from the March issue are two recent examples of articles on musical instrument ergonomics. Ergonomics, literally the study of work, is defined as "the applied science of equipment design intended to maximize productivity by reducing operator fatigue and discomfort."[3] When I was an undergraduate student at Tufts University in the 1970s, my engineering roommate studied "human factors engineering" (but never applied it to music, as far as I know). In 2006, a Google search for "ergonomic musical instruments" yields over 1 million websites; a search for "musical instruments" yields 16 million websites.

The design of musical instruments must, of course, find the proper balance among a number of factors. Most important is the sound production, which is the *raison d'etre* of any musical instrument. However, each musical instrument also must be not too difficult to play, relatively durable, and more or less affordable. We can all think of examples of instruments that we don't see or hear very often due to one or more of these factors. Those of us in performing arts medicine are particularly concerned about how easy or difficult an instrument is to play. Published studies suggest that some instruments are associated with a higher risk of injury than others.[4,5] While instrument design is only one contributing factor in the overall risk for performance-related injury, it is one that we (theoretically) have control over. Why are musical instrument designs so slow to change?

Musical instrument design has evolved over time, and that is part of the problem we now face. In most cases, the designers of those instruments were men (rather than women) who lived and worked a few decades to a few centuries ago, mainly in Europe. They were likely to design instruments that they could use and that would be favored by the majority of musicians back then, who were mostly male. Today, musicians comprise a more diverse group with far more women, relatively fewer persons of European descent, and more persons with various physical disabilities. Nonetheless, we still play instruments that were designed for a fairly homogeneous group of performers. Furthermore, we have more options in instrument design today thanks to the advancement of technology.

In general, the interface between musician and instrument involves two activities. The musician must manage the spatial relationship between him- or herself and the instrument (either supporting the instrument or simply positioning him- or herself in order to play efficiently) and simultaneously manipulate the instrument to produce a variety of sounds. Both activities are amenable to an ergonomic approach. In the next few paragraphs I'll briefly review the major instrument families and discuss how ergonomics can apply to each.

The piano is not held by the pianist, but it is important for the pianist to be positioned properly at the keyboard. The adjustable bench (when available) is a significant help in this regard. As mentioned earlier, it is possible—and for some pianists, advantageous—to decrease the width of the keys. Key width is one example of a metric developed by men for men. Just as the Women's National Basketball Association uses a slightly (3.4%) smaller basketball, women (and some men) with smaller hands have reported that they find it easier to play a piano with narrower keys. The two common sizes are 7/8 and 15/16, which are 12.5% and 6.25% narrower than the standard, respectively. The benefits extend to playing bigger chord intervals and playing crossover/crossunder passages as well as a shorter reach for very low and very high notes. I was unable to find any references to narrower key width on the organ or other keyboard instruments in my web searches.

Modifications of string instruments have been mainly in the category of alternative shapes of the instrument body. These modifications can range from a "beveled" edge of a guitar body (where the right forearm rests on the instrument) to the "ergonomic violin,"[6] which hardly looks like a violin at all. Several viola designs have removed part of the body of the instrument so as to make it easier to play in the higher positions. Various websites have information on ergonomic cellos and other string instruments. Not to be neglected is the importance of the chair on which cellists, harpists, guitarists, and other string players sit.

Woodwind instruments have been improved by several ergonomic changes. In the category of instrument support, the use of a neck strap or a support post is possible with the clarinet, flute, and other woodwinds. The shape of the flute has been changed to address some

of the difficulty of holding the instrument out to the side: a 30° angle between the mouthpiece and keys allows the flutist's neck to stay in a neutral position without significant abduction of the right shoulder. (A 150° bend accomplishes the same thing while effectively shortening the length of the entire instrument for those with short arms.) Perhaps some of the most common modifications of modern instruments are the extensions that can be added to various keys on the flute and other woodwinds, allowing the shorter fingers to reach their respective keys more easily.

Brass instruments are associated with the lowest rates of performance-related injury in the studies cited above, but some ergonomic modifications have been developed for these instruments. The interview of Maarten Visser in this issue has a picture of a support post for a trumpeter with a disability, and a four-valve trumpet with the valves arrayed in an arc rather than in a plane is commercially available.[7] When I was playing the trumpet and baritone horn in high school, we used fiberglass mouthpieces for cold weather performances outdoors—the Veterans Day parade was often held in near-freezing temperatures in Maine. Tone quality was suboptimal but adequate under the circumstances.

Percussion ergonomics may be the least studied area among the instrument families, even though percussionists have an injury rate in the middle of the instrument range.[4] Again, the chair or stool that a percussionist uses when sitting is a very important piece of equipment. Arranging the drum set so that each instrument is within easy reach is a combination of art and science. Consumers today can buy a variety of tools and kitchen utensils with ergonomic handles—should we be testing alternative handle designs for the sticks and mallets that percussionists use?

Given all of these possible improvements to instrument design that have the potential to decrease the rates of performance-related injuries, why have so few been adopted widely? First, much of the potential has yet to be proven, and performing arts medicine specialists would do well to undertake studies to determine which ones are truly of benefit. At the same time, it's obvious that there is some resistance to change with a nearly Darwinian approach to success. This is a common human trait, but it will be essential for performers, teachers, and health care professionals to support the use of ergonomic instruments whenever it makes sense for an individual performer.

Finally, we should all remember that some of us have physical disabilities that make playing a "regular" instrument impossible. Instrument modification can help expand the world of music to a larger number of people with varying abilities. And keep in mind that there are only two kinds of people in the world: those with "different abilities" and those who are "TAB" (temporarily able bodied).

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