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Classic Solid CAD Models of the Vocal Folds

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Abstract

Finite Element Modeling (FEM) of the human laryngeal system is dependent on accurate models of the geometry. Using standard models for verification of method is key to moving the field forward. Presented are three classic FEM vocal fold models as CAD files so that the models can be quickly imported into a finite element software package.

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Keywords: laryngeal cartilage, CAD model, MRI, thyroid, cricoid, arytenoid.

1. Introduction

A review of 19 studies was undertaken to compare computational vocal fold modeling practices (Cook, 2009). Within the review, modeling information (e.g., model geometry, modeling assumptions, modeling approaches, material property values, numerical techniques applied, boundary conditions) was recorded. This data-based review revealed both strengths and weaknesses in the literature. One key finding was concerning the geometry used. All reviewed studies presented a pictorial representation of the vocal fold geometry. However, approximately 47% did not include sufficient information for independent replication of the model geometry.

In order to advance the voice science field with the use of Finite Element Modeling (FEM), common models and standards are needed for comparison of new techniques. The purpose of this report is to provide the computer solid models (CAD) created from three classic FEM reports of the vocal folds.

2. Three Classic Models

Three models of the vocal folds, as described in the literature were made into solid CAD geometries for importing into CAD or FEM software packages: [1] Titze and Talkin (1979), which has been the basis for numerous subsequent computational studies (e.g., Alipour et al., 2000; Alipour and Scherer, 2000; Gunter, 2003), shown in Figure 1; [2] Scherer et al. (2001), which has similarly been the basis for numerous computational and experimental studies (Scherer et al., 2001; Thomson et al., 2005; Drechsel and Thomson, 2008) and has been often named the M5 model, shown in Figure 2; and [3] one of the variations of the Titze and Talkin model (Alipour et al., 2000; Alipour and Scherer, 2000), shown in Figure 3. These geometric models were created in CAD software and saved output as STEP files.

3. Data files

3.1 Files

Two sets of files are presented (Table I). First, the Titze and Talkin, Scherer, and Alipour model were compressed in a single 'zip' file (VocalFoldCAD.stp.zip). The two versions of the Titze and Talkin, and the Scherer models were created with the same geometry but with different steps in the CAD software, so they may mesh somewhat differently in FEM software, depending on the CAD lines. The second set of files use Windows Media Video illustrating the shapes of the models with a rotating movie of the shapes; these were compressed in a 'zip' file called VocalFoldCad.wmv.zip.

3.2 Reading Files

The format of the files is a CAD format STEP (stp) file. While there are many CAD formats, STEP files are the international standard for computer-interpretable representation and exchange of product manufacturing information (ISO 10303, for a good summary, go here: http://www.mel.nist.gov/msidlibrary/doc/jcise1.pdf). Commercial CAD programs will be able to import these files. There are also free, open source, CAD programs which can open and visualize the STEP files (e.g., FreeCAD was used in making the figures above and the media visualizations of the files, http://sourceforge.net/apps/mediawiki/free-cad/index.php).

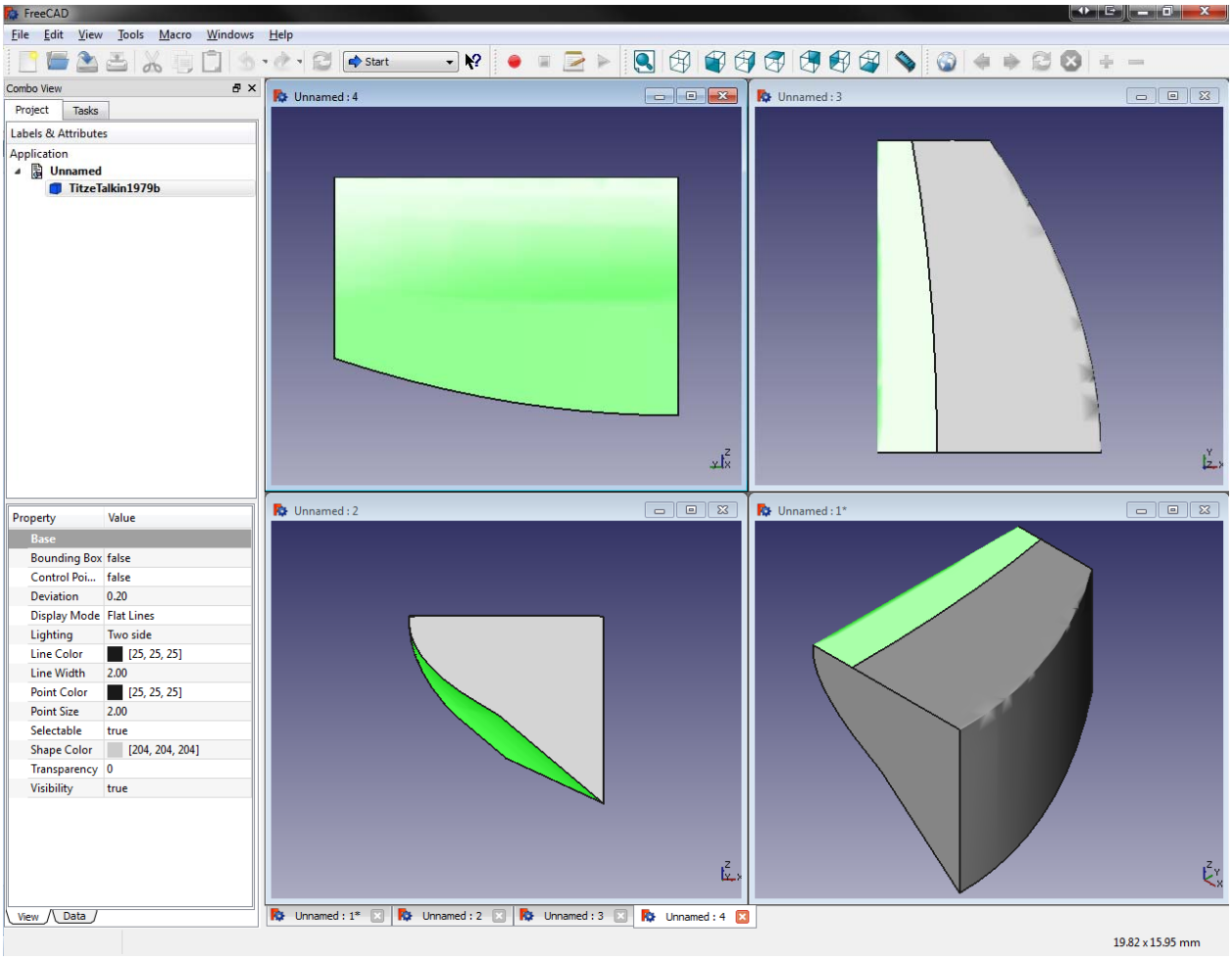

Figure 1. Four views of the Titze and Talkin (1979) model. Top left, view from the medial direction. Top right, superior view looking down on the vocal folds. Bottom left, posterior view near the arytenoid cartilage. Bottom right, axonometric view.

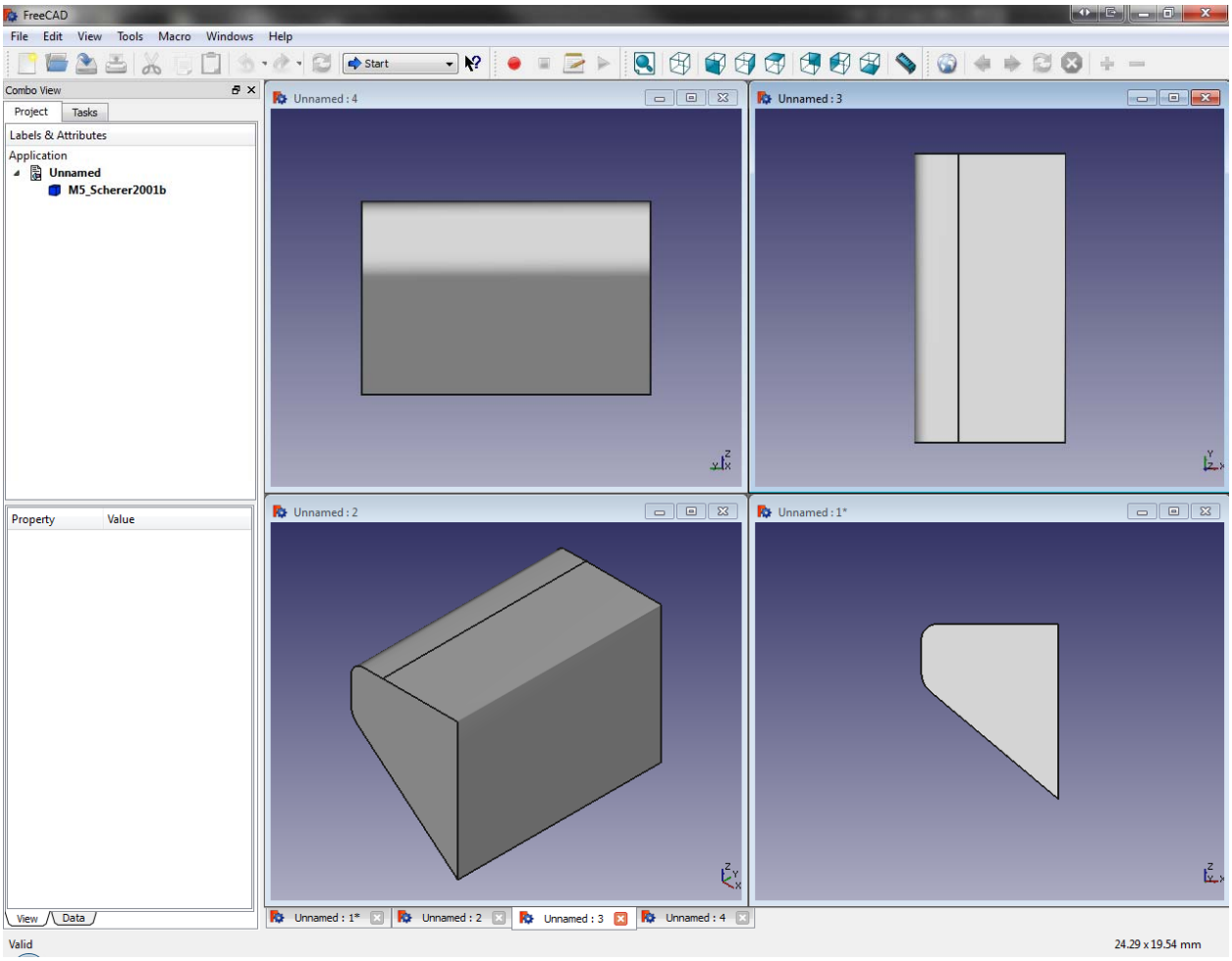

Figure 2. Four views of the Scherer et al. (2001) M5 model. Top left, view from the medial direction. Top right, superior view looking down on the vocal folds. Bottom left, posterior view near the arytenoid cartilage. Bottom right, axonometric view.

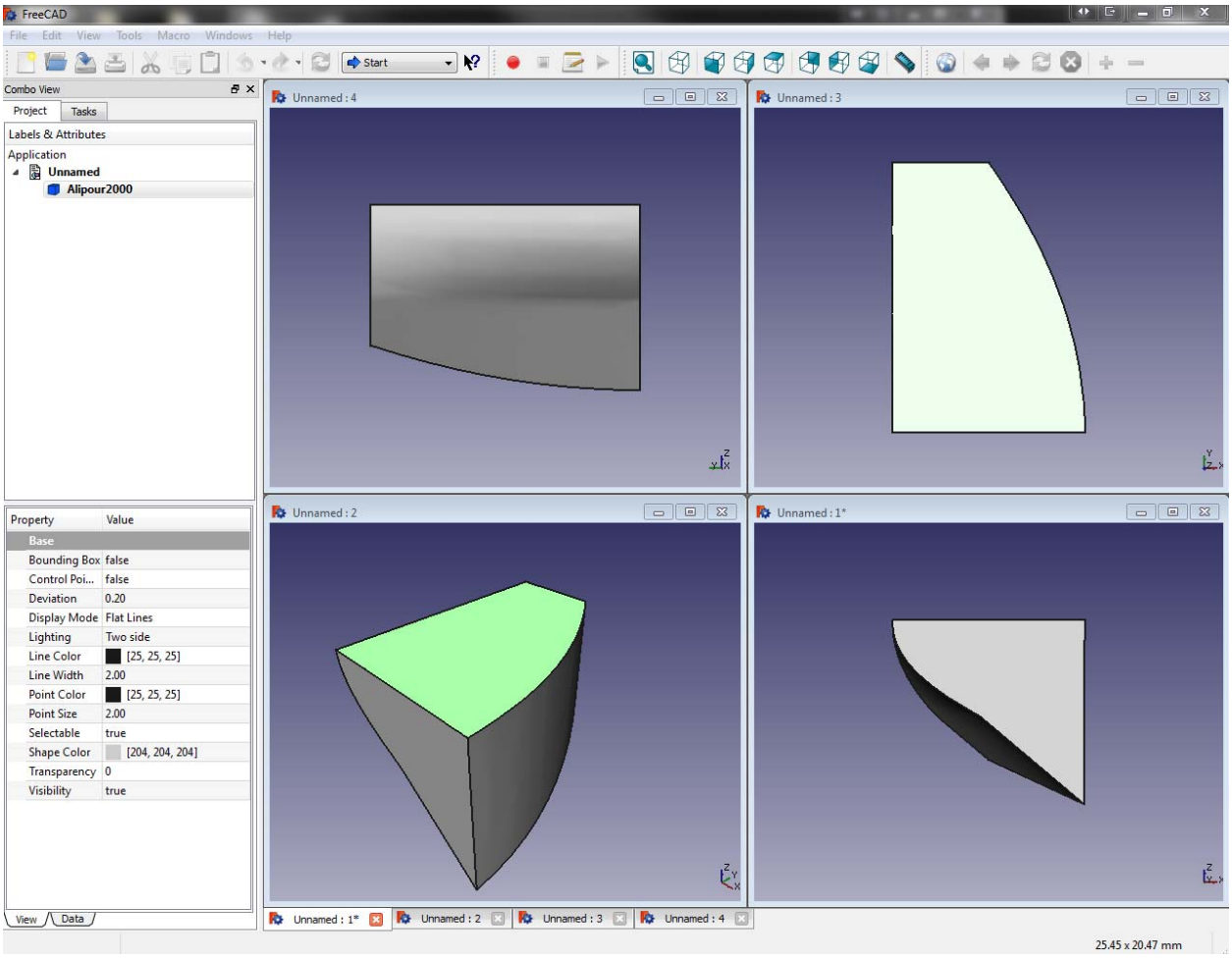

Figure 3. Four views of the Alipour et al. (2000) model. Top left, view from the medial direction. Top right, superior view looking down on the vocal folds. Bottom left, posterior view near the arytenoid cartilage. Bottom right, axonometric view.

Table I. Accompanying files.

Model	Version 1	Version 2	Media
Titze and Talkin	TitzeTalkin1979.stp	TitzeTalkin1979b.stp	TitzeTalkin1979.wmv
Scherer (M5)	M5-Scherer2001.stp	M5-Scherer2001b.stp	M5-Scherer2001.wmv
Alipour	Alipour2000.stp	-NA-	Alipour2000.wmv

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Use Agreement

The scripts, images and text are open to use by the public as a service and part of the National Resource of Laryngeal Data (supported by the National Institute of Deafness and other Communicative Disorders). However, we ask the reader to respect the time and effort put into this manuscript and research.

If the text, images, or included scripts are used, the user agrees to reference this document, the NRLD, and the source of the original data. We also suggest that the user contact the original contributors of the data and give them the right of refusal to (1) participate on papers using the data and (2) have their supporting project acknowledged. The user agrees to freely share with the NLDR any extension software build on the data contained.

Revisions

1.0 Eric Hunter: Main document (April 2012); models constructed by Scott Thomson.
2.0 Laura Hunter: imported into new template, technical writing review (April 2015)