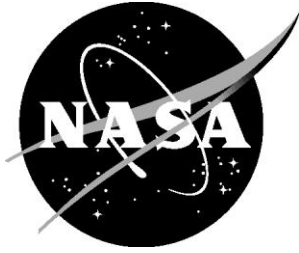


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Loft v4.0: An Updated Automated Mesh Generator for Stiffened-Shell Aerospace Vehicles

*Lloyd B. Eldred
Langley Research Center, Hampton, Virginia*

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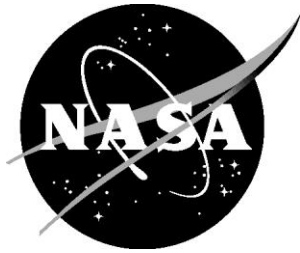
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Space Administration

Langley Research Center
Hampton, Virginia 23681-2199

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Abstract

Loft is an automated parametric mesh generation code that is designed to model stiffened-panel aerospace vehicle structures. After more than 20 years of in-house use and development, the program was released to the public in 2023. Since that release, significant additional features have been added, including new object types, new airfoil shapes, program flow control options, additional options for selecting parts of models, and support for creating boundary conditions, loads, and rigid element stitching from within the code. These additions address previous limitations of the code and significantly expand its application and usefulness.

This memorandum is presented in two parts. The first part contains a technical paper with a brief overview of the code and its applications and a more lengthy discussion of the program's new features. Part two of the memorandum is the updated program user manual. The manual includes in-depth tutorials that use the new features and a complete command reference.

Introduction

Loft is a tool that enables rapid creation of finite element models of aerospace components and vehicles suitable for conceptual and preliminary design studies. Its parametric modeling capabilities enable generation of many variations of a design for exploration of a design space and identification of regions of that space that are worthy of more refined design effort. Over the past 25 years, *Loft* has been used to model parts of a wide variety of aerospace systems, including the Next Generation Launch Technology (NGLT) wing, the payload fairing for the Ares V and the Space Launch System (SLS), the Low Boom Flight Demonstrator (LBFD/X-59), Human Landing System (HLS) reference landers, horizontal takeoff two-stage-to-orbit (TSTO) systems, and planetary atmosphere entry backshells.

Loft's manual was first published in 2011 [1]. The program itself was released for free public use via software.nasa.gov in 2023. Simultaneously, a NASA Technical Memorandum was released [2] with an overview of the code capabilities and a complete updated users' manual. A conference paper and presentation [3] were written to describe applications and scenarios where *Loft* would be useful. Two workshop presentations [4,5] described the uses of the program and the incorporation of *Loft* into a high-fidelity, low-maturity, design environment that is being created at NASA. This memorandum briefly summarizes the previous publications, describes the updated features of the program since its initial release, and includes an updated users' manual for the current features of the code.

The updated, version 4.0, *Loft* program is available for free via a request at software.nasa.gov. It comes packaged with this manual and all of the example files and small utility programs discussed in this document.

Program Overview

Loft is a finite element model (FEM) creation tool that takes a descriptive text file as input and generates a structural mesh in a wide variety of output formats, including NASTRAN, TecPlot, Virtual Reality Modeling Language (VRML, now a subset of the X3D format), and Stereo Lithography (STL). Figure 1 illustrates

an eleven-line input file and two views of the finite element mesh that is produced by *Loft* from that input file.

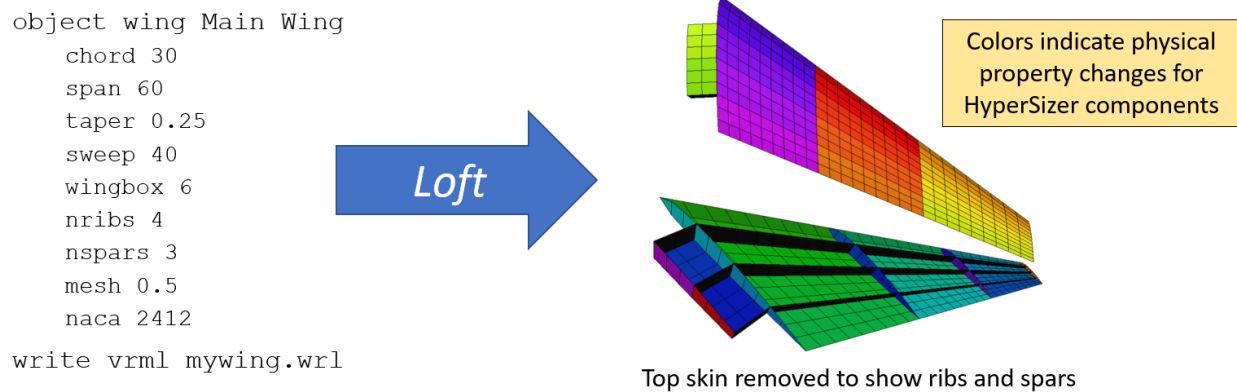


Figure 1. Example Loft input and output

Loft has a powerful variable and math capability that adds to the program's inherent parametric nature. Users can specify meaningful variable names with values. Math support includes addition, subtraction, multiplication, and division as well as trigonometric and hyperbolic functions, log, exponential, square and cube roots, absolute value, and truncation. Figure 2 illustrates the use of variables and math to generate a spherical tank model of a desired volume. Certainly, the calculation for the radius (or the value of pi) could be performed outside of the input file and specified without the use of any variables. But, the variables add clarity and readability to the input and allow the user to quickly generate a family of models with different volumes by changing the value of the volume variable and the output filename.

```

# Example use of variables & math to create a
# FEA model of a sphere with a specified volume
define volume 10.0
define piover2 0.0 %acos
define pi $piover2 * 2.0
define radius $volume * 3.0 / 4.0 / $pi %cbrt
list variables
#
object dome sphere top
  curvel cir
  cl_xscale $radius
  cl_yscale $radius
  length -1.0 * $radius
  nodes_axial 30
  nodes_circ 150
object dome sphere bottom
  length $radius
  nodes_axial 30
write vrml sphere.vrml

```

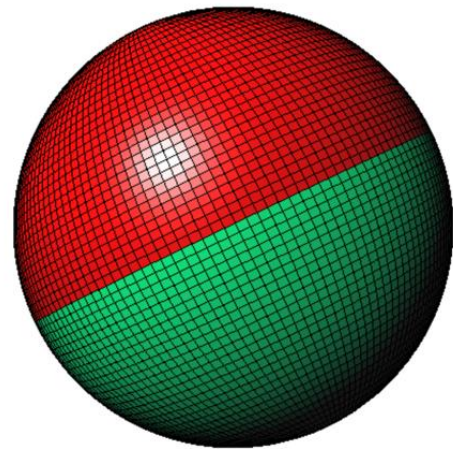


Figure 2. Variables and Math in Loft