

# Cost Analysis and Design of Wind Turbine Blades

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## Research Project Goals:

- ❑ Develop MATLAB code based on the existing tool NuMAD (Numerical Manufacturing and Design Tool) to generate a macro for a wind turbine blade which can then be used for cost analysis of the blade.
- ❑ Collaborate with researchers from University of Massachusetts Lowell for developing an Excel based tool that uses the UT Dallas macro for wind turbine blade for detailed cost analysis.
- ❑ Perform cost comparisons of this data with the data from previous studies on existing wind turbine blades to validate the model.

## Research Project Overview:

- ❑ Motivation:
  - One of the primary driving factors behind any engineering design is cost, and this is particularly true for renewable energy systems.
  - The detailed analysis of costs, calculation of material costs, mold costs, labor costs, etc. provides a good basis for financial control. At the research level, it can help in providing valuable data to the designers to make relevant changes to reduce the overall cost of the product.
- ❑ Design:
  - A wind turbine blade design consists of different stations (figure 1) when we traverse longitudinally along the blade.
  - When traversing along the curved perimeter of the blade, the outline shape is divided into individual points called DPs (Division points) (figure 2).
  - Since a wind turbine blade is comprised of several materials laid up in the form of layers in a mold when manufacturing, these design considerations are important for understanding the details like length (using stations), breadth (using DPs), thickness, area, etc. cost analysis.
  - The DP, station, number of layers, etc. information could already be extracted from NuMAD, a MATLAB based design tool developed by Sandia National Laboratories and this data needed to be processed and give an output of details of every single layer of the blade.

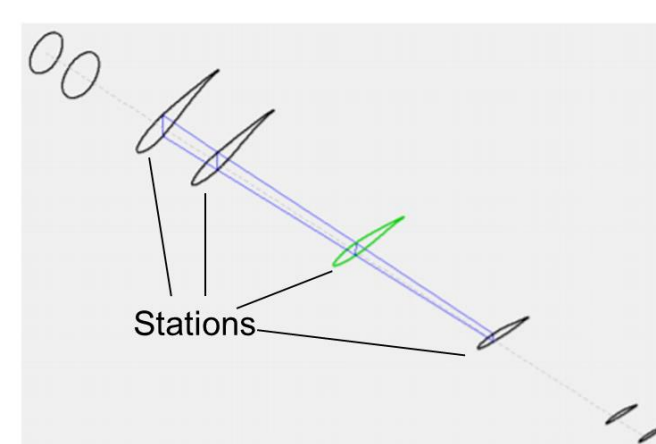
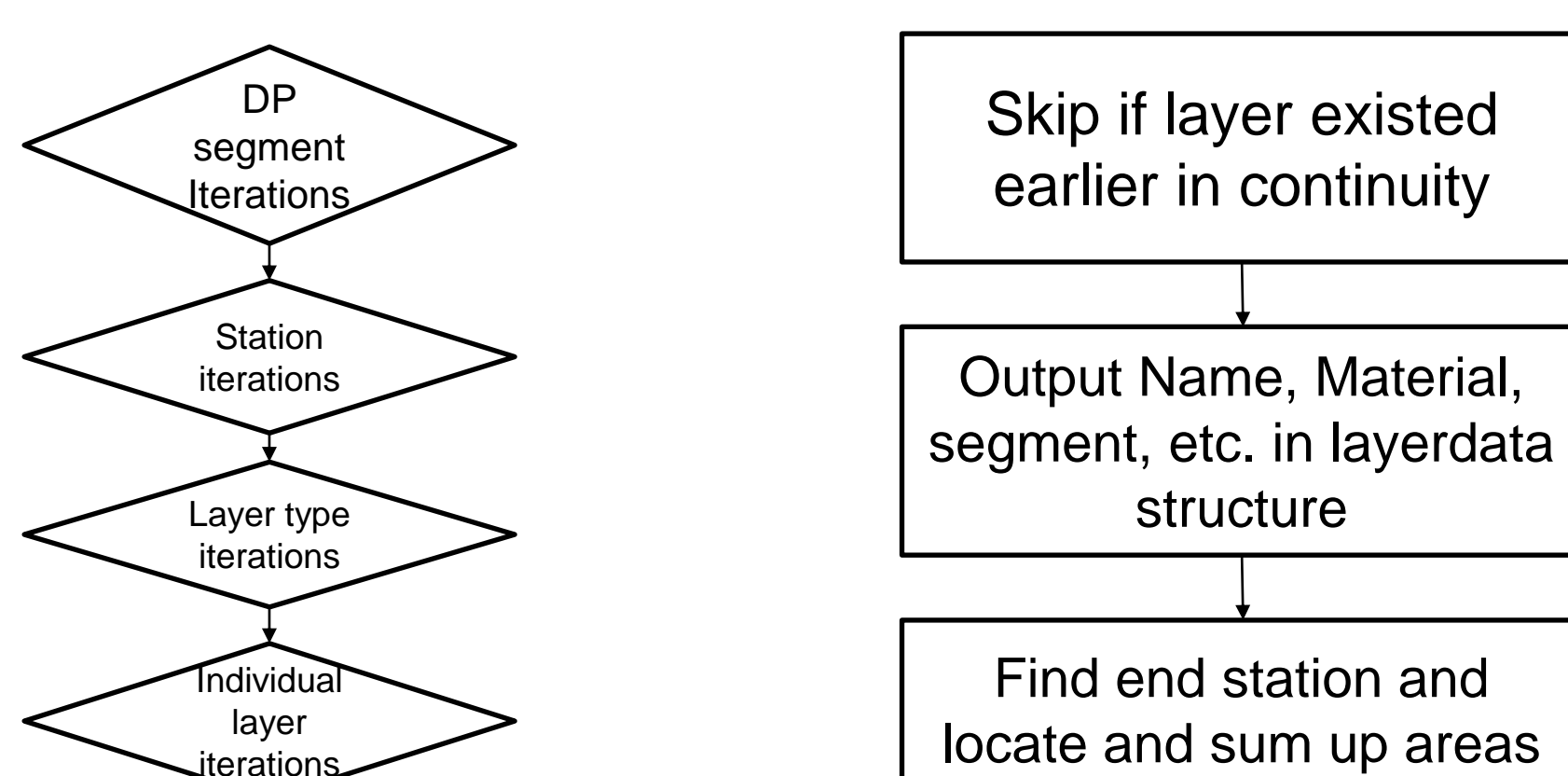


Figure 1: Stations



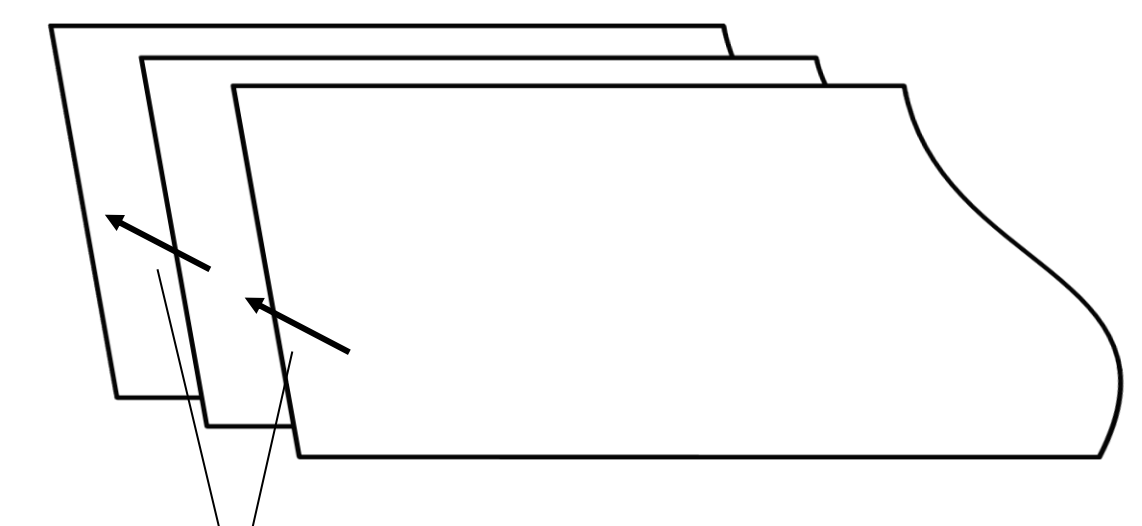
Figure 2: Division points (DP)

❑ The MATLAB code developed for this research project followed the following algorithm to calculate the length, area, material type and number of layers for each wind turbine blade:

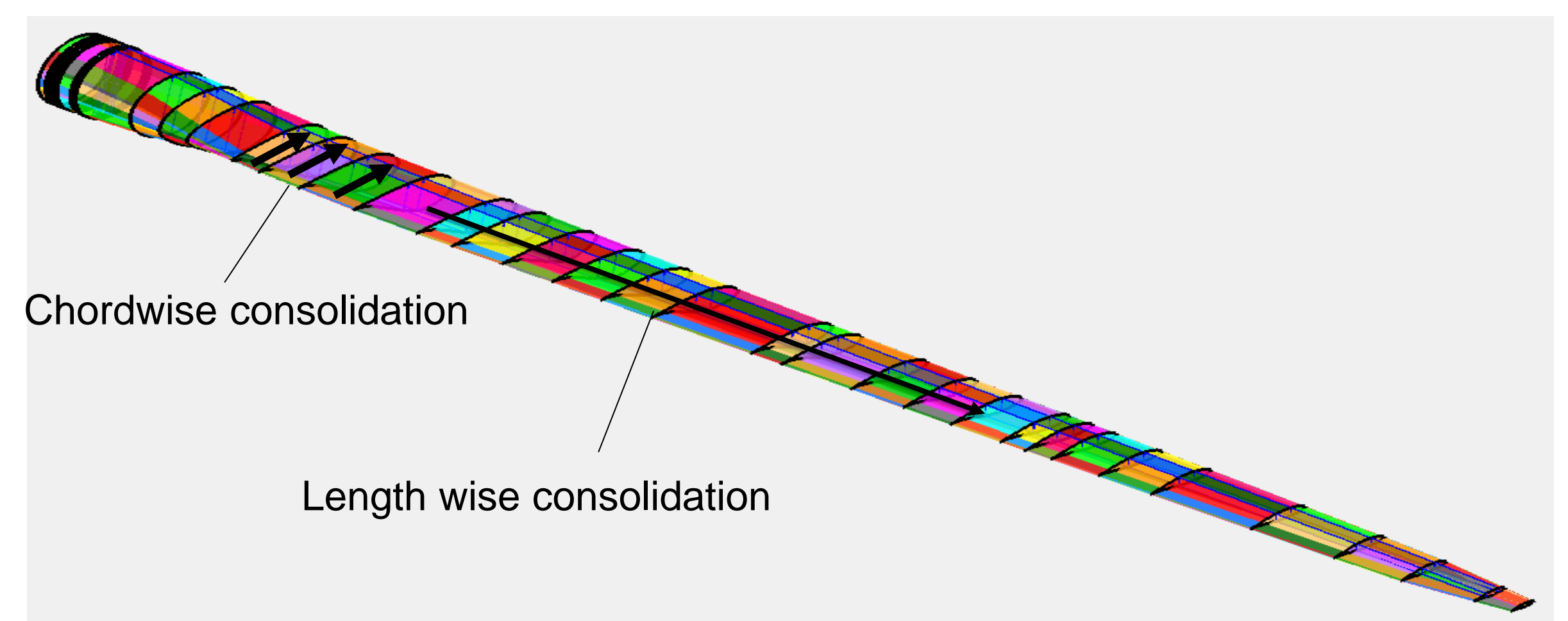


## Research Project Results:

- ❑ The MATLAB based cost tool that was developed could also perform the consolidations shown in the pictures below.
- ❑ The code successfully gave the following details of every single layer going into the design of the wind turbine blade in form of an excel sheet:
  - Name of consolidated panels
  - Material
  - Thickness
  - Start station
  - End station
  - Area
- ❑ This output was put into the excel tool developed by researchers from University of Massachusetts Lowell which was then used for performing cost analysis of existing wind turbine blades and compare it with previous cost analysis.



Consolidation of a stack of layers with similar properties



NuMAD model of wind turbine blade

## Project Conclusions/Outcomes:

- ❑ The successful development of this tool and further comparison of data with existing studies tells us important information about cost distribution when manufacturing a wind turbine blade.
- ❑ Since the tool is generalized and input data is based on NuMAD, blade designers can predict the cost of any blade within seconds and then move on to study the output data from the tool for a detailed analysis.
- ❑ This analysis can not only help estimate the cost of the blade, but also help the designers in performing specific changes to decrease the overall cost.
- ❑ UTD researchers can use this tool to optimize designs for future, novel wind turbine rotor concepts.