

3/9/2016



Volume of a Solid



Yaomin Dong

Volume of a Solid

A Motivating Example for Modules 1 and 2

Project Description

This project demonstrates the following concepts in integral calculus:

1. Definition of volume.
2. Calculation of volume by integral.
3. Computer Aided Design (CAD).
4. Parametric design of solid.
5. Determination of volume in CAD.
6. Compare results in #2 and #5.

Project description.

Find the volume of a solid obtained by rotating the area bounded by

$$y = \sqrt[3]{x},$$

$$x = 8,$$

and

$$y = 0$$

about x-axis using integration and CAD techniques, and compare the results.

Solution:

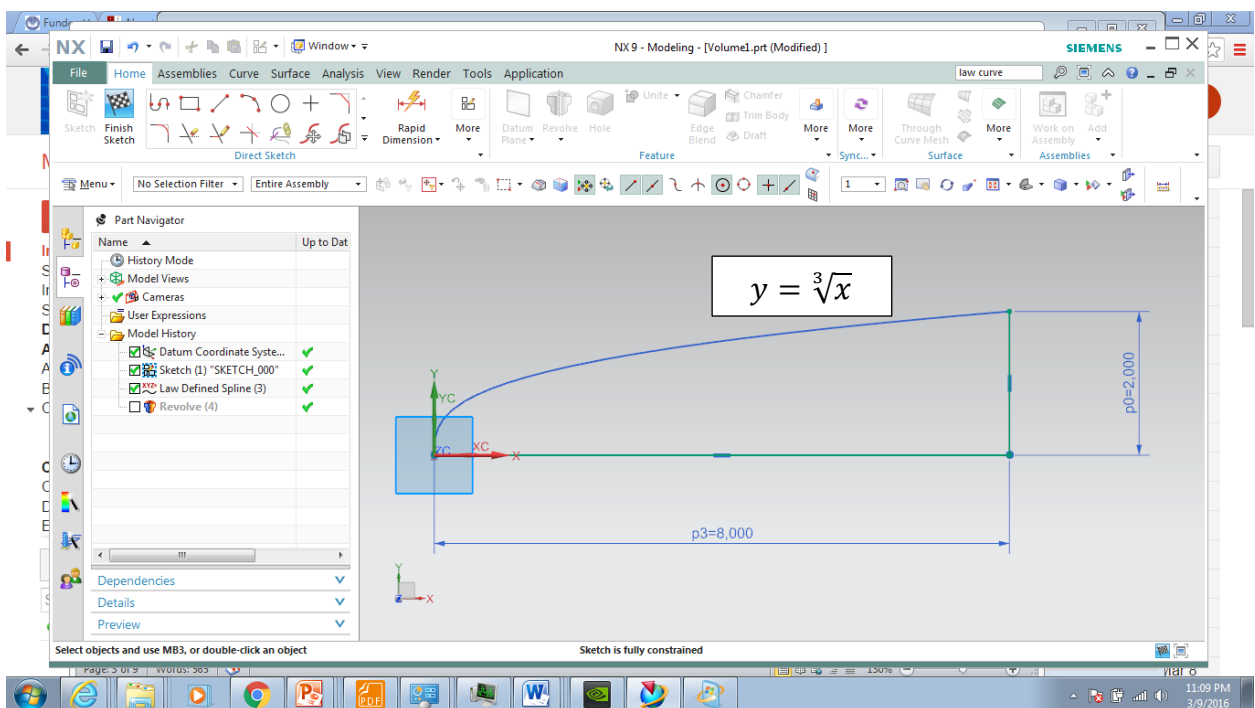
(1) By Integration

The area of cross section of the solid through x is

$$A(x) = \pi y^2 = \pi(\sqrt[3]{x})^2 = \pi x^{2/3} \quad (1)$$

And the volume is

$$V = \int_0^8 A(x) dx = \int_0^8 \pi x^{2/3} dx = \frac{96\pi}{5} \quad (2)$$



(2) By CAD

Define the parametric expressions:

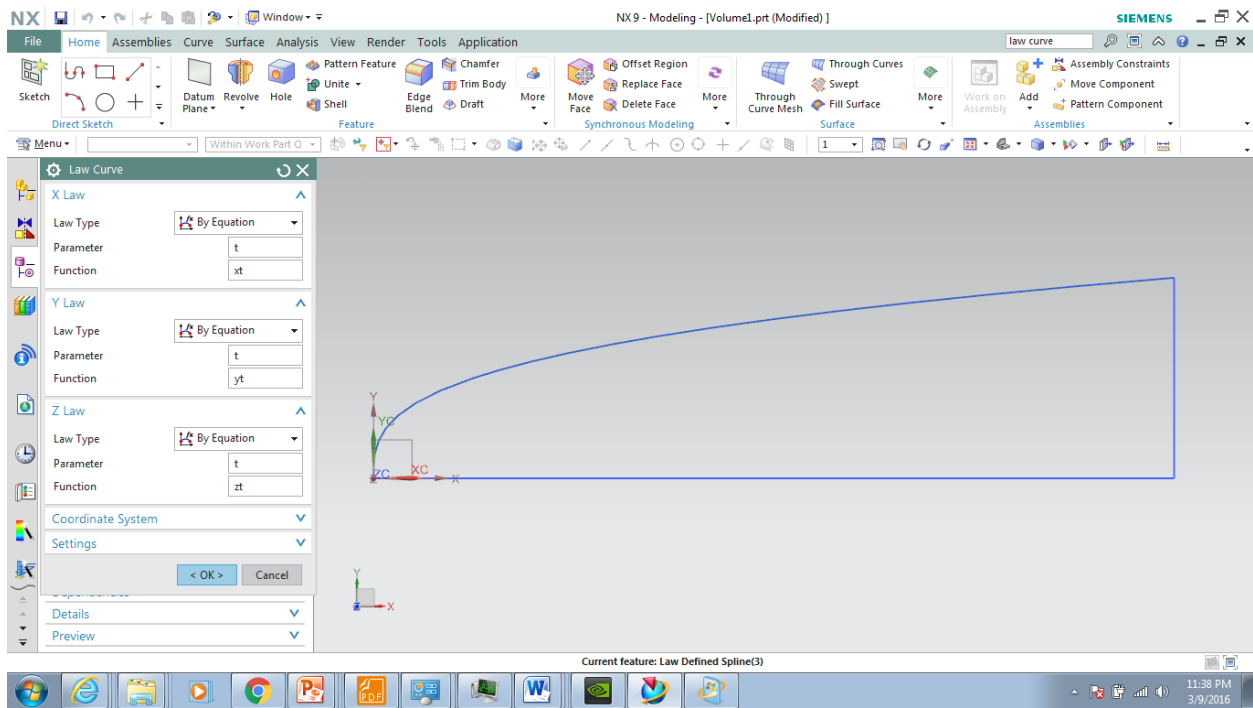
The screenshot displays the Siemens NX software interface. The 'Expressions' dialog box is open, showing a table of listed expressions for a Law Defined Spline(3) curve. The table has columns for Name, Formula, Value, Units, Type, Up to Date, and Comment. The expressions are:

Name	Formula	Value	Units	Type	Up to Date	Comment
t (Law Defined Spline(3) X...	0	0	in	Num...	✓	
xt (Law Defined Spline(3) X...	yt^3	0	in^3	Num...	✓	
yt (Law Defined Spline(3) Y...	2*t	0	in	Num...	✓	
zt (Law Defined Spline(3) Z...	0	0	in	Num...	✓	

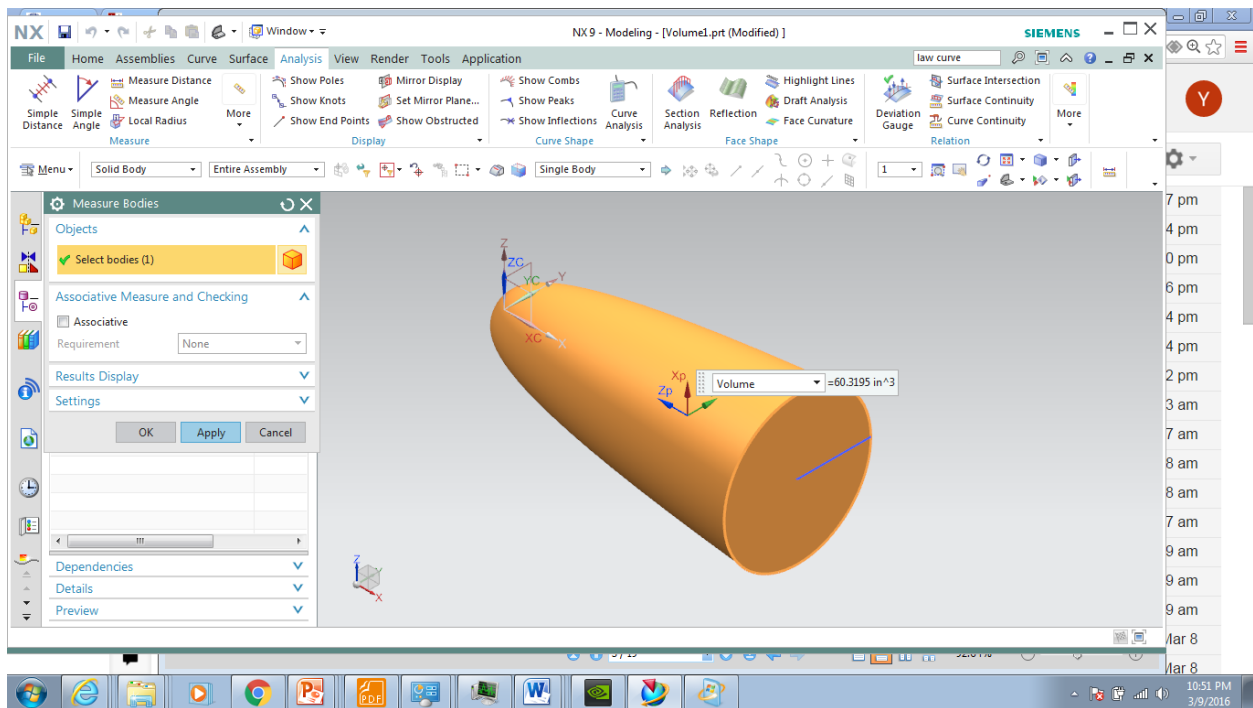
The dialog box also shows a 'Formula' field with a function icon $f(x)$ and buttons for 'OK', 'Apply', and 'Cancel'. Below the dialog box, a 2D coordinate system is shown with a blue curve. The horizontal axis is labeled 'p3=8,000' and the vertical axis is labeled 'p0=2,000'. The origin is marked with 'YC' and 'XC'.

Choose expression to edit, enter new expression, or select feature to edit parameters

Create the law curves in CAD using equations:



Revolve the region about x-axis to create the solid:



Finally, using the CAD built-in function, the volume can be obtained.

(3) Comparison of results from integration and CAD