

# SolidWorks and SolidWorks Sustainability

Marie Planchard  
Director of World Education Markets



# Welcome Kentucky Teachers – SolidWorks is already here

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## [Product Design Engineer](#)

Big Ass Fans - Lexington, KY


modeling software; **SolidWorks** preferred. • Ability to handle multiple tasks, set priorities and meet schedule...

[www.beyond.com](http://www.beyond.com) - June 16 - [Save this job](#) 

## [Mechanical Designer, Structural Engineer, Document Control](#)

B Rowland Technical Staffing - Louisville, KY

drafting, **SolidWorks** CAD, and Bill of Materials development. The work will be performed on CAD and on the shop floor...

[www.careerbuilder.com](http://www.careerbuilder.com) - June 16 - [Save this job](#) 

## [Design and Development Engineer](#)

JobTarget - Bowling Green, KY - Holley, NY

a plus. Experience in ProE Wildfire and/or **Solidworks**, Approx. 2000 hrs. Broad knowledge in different materials for manufacturing...

[www.jobtarget.com](http://www.jobtarget.com) - June 15 - [Save this job](#) 

## [Plastics Mechanical Engineer](#)

EngineeringClassifieds - Bowling Green, KY - New Orleans, LA - \$80000 - 90000 per year

Must have experience with several of the following: **Solidworks**, Adobe3D, CAD and or Auto CAD plus the ability to understand RF and Electronic circuits...

[www.engineeringclassifieds.com](http://www.engineeringclassifieds.com) - June 15 - [Save this job](#) 

# What is CAD?

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- Computer Aided Drafting/Design
- But that is only the words that make it an acronym
- Here is a little hint:



# What is CAD?

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- How are these similar

English

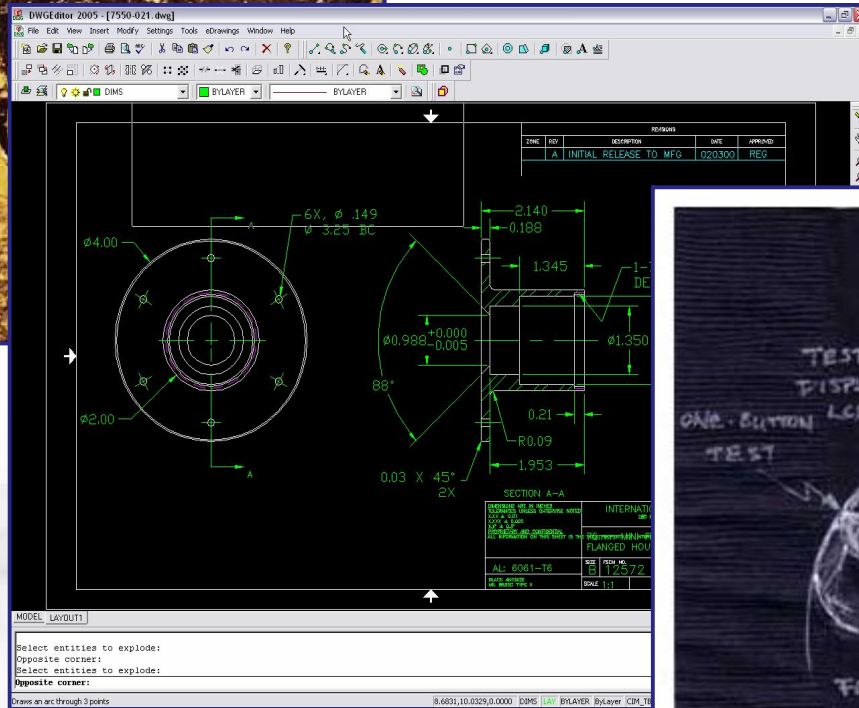
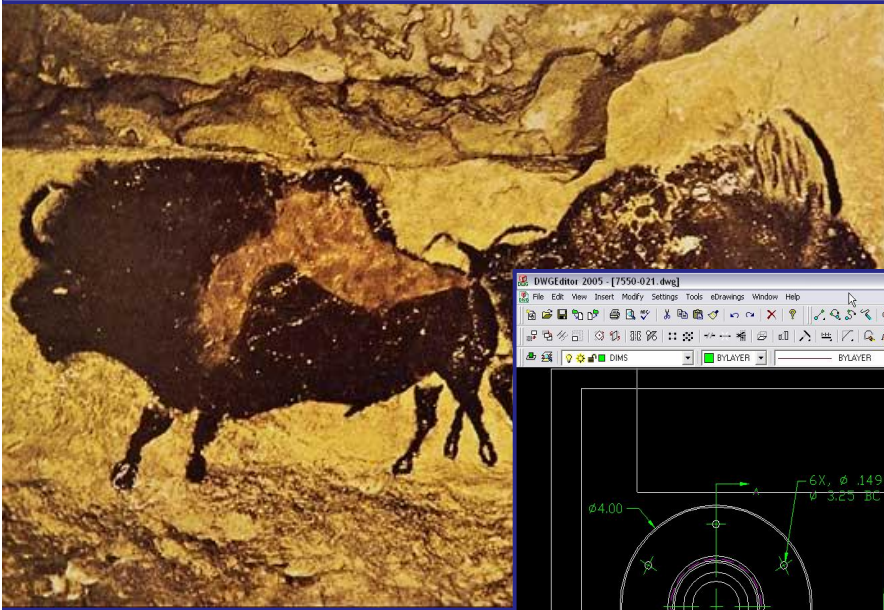
Newspapers

Television

CAD

email

# How are these similar?



Miles Hammond, Scott Gales

# What is SolidWorks?

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- Is SolidWorks CAD too?

# What is CAD?

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- Computer Aided Design
- But that is only the words that make it an acronym
- Here is a little hint:



# What is CAD?

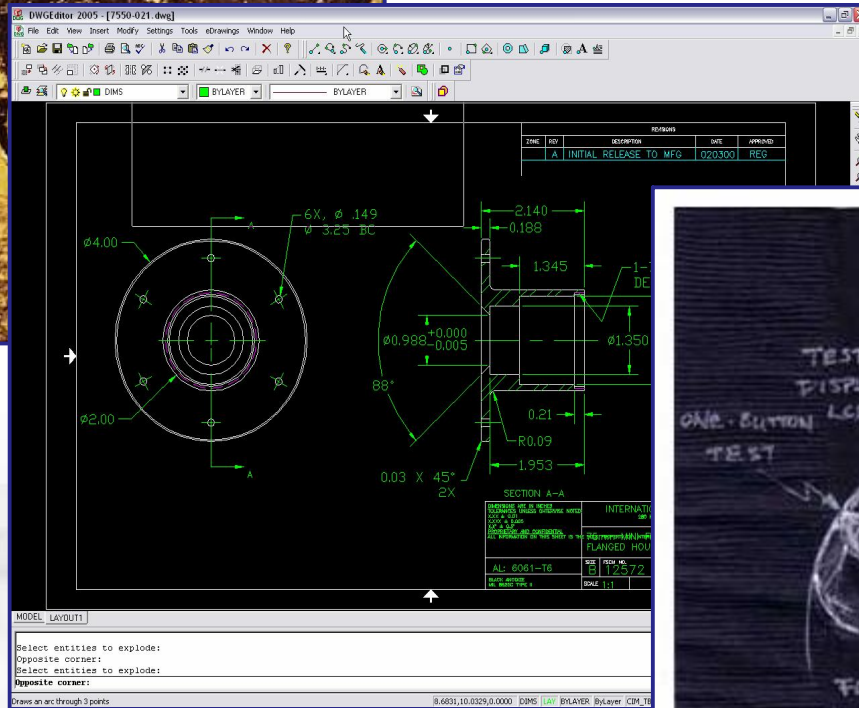
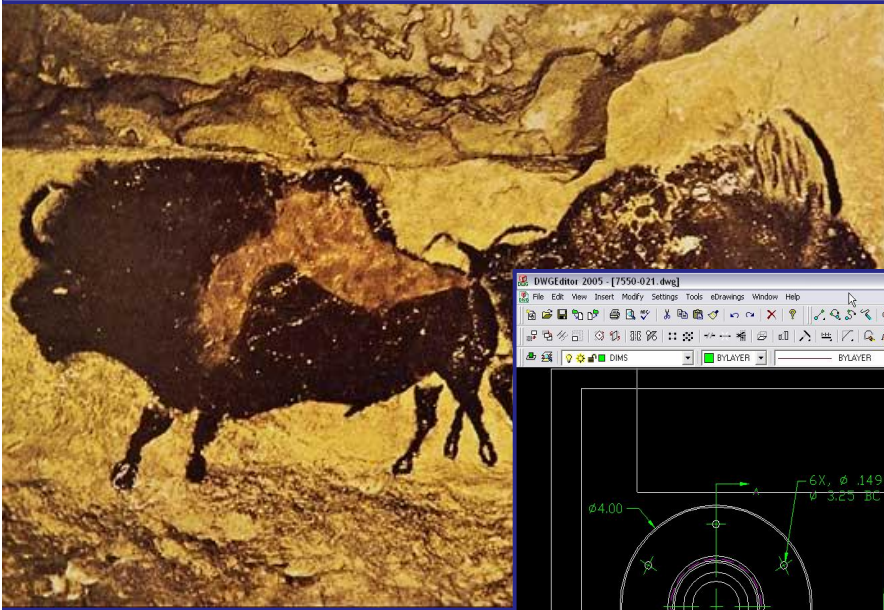
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- How are these similar

English  
Newspapers  
Television  
CAD  
email



# How are these similar?



Miles Hammond, Scott Gales

# What is SolidWorks?

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- Is SolidWorks CAD too?

# Our Customers Design Everything



# Innovative Solutions For Educators

SolidWorks Education



Student Access



Tutorials & Curriculum



Sustainability



SolidWorks Community



Training Support, & Resources



Industry Certification

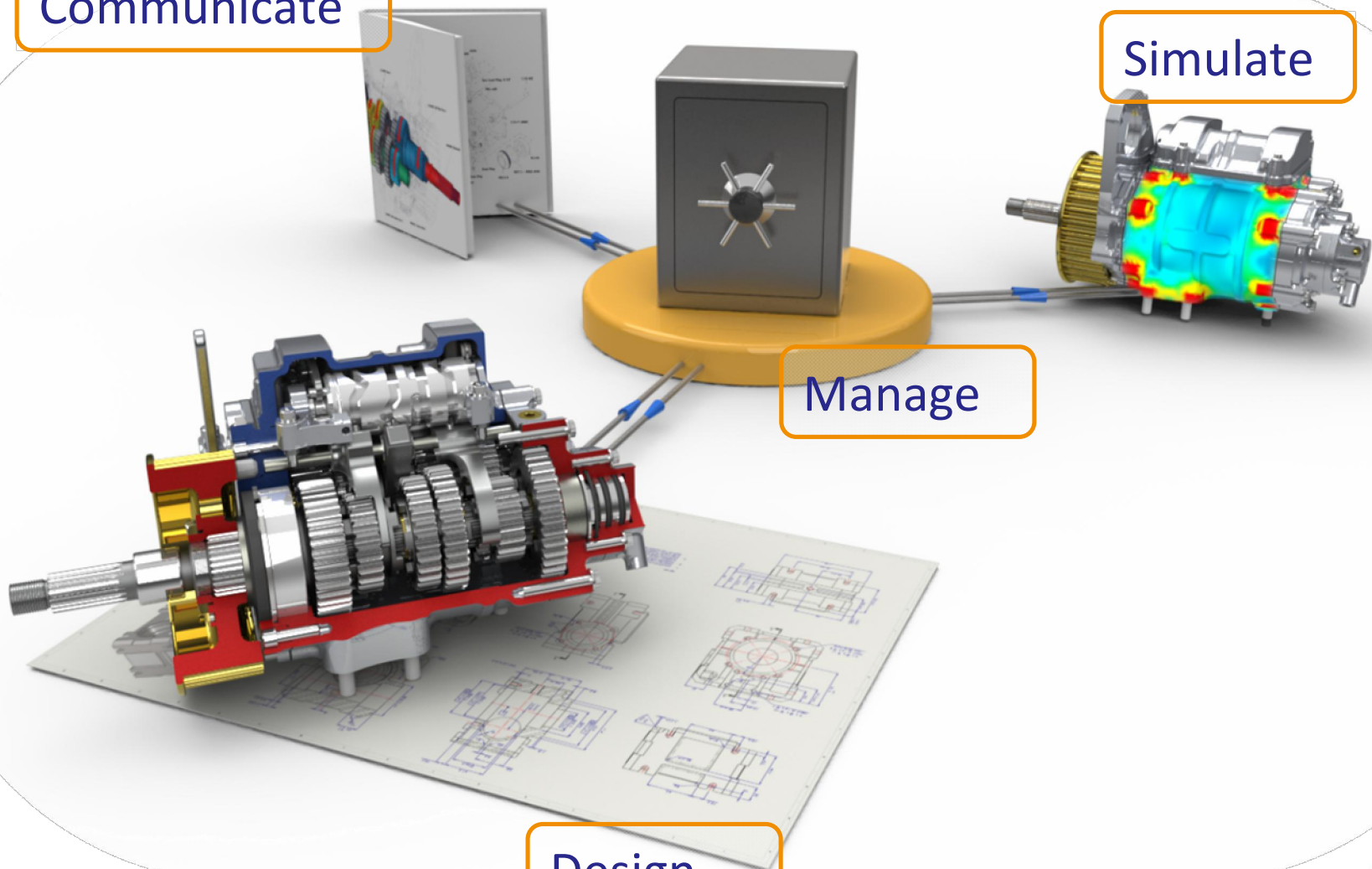
# Intuitive Solutions For Every Stage of Design

Communicate

Simulate

Manage

Design



# SolidWorks makes math and science relevant

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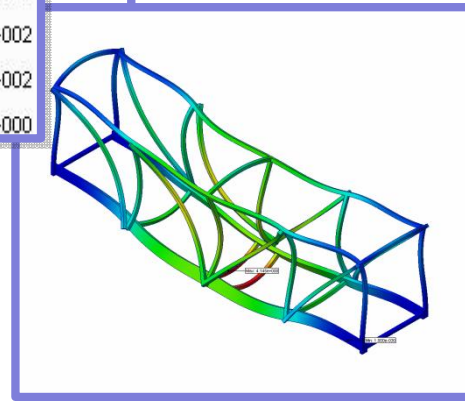
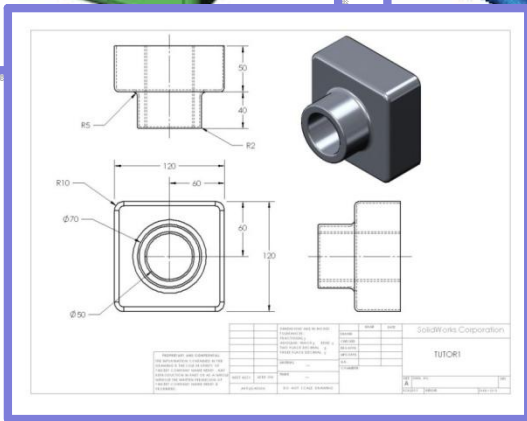
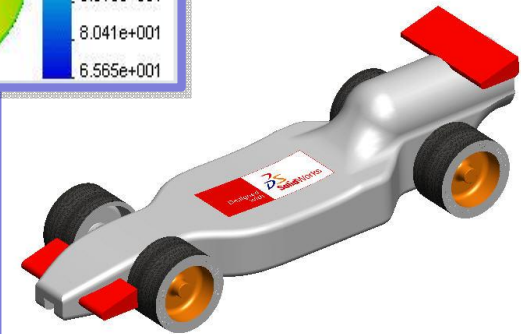
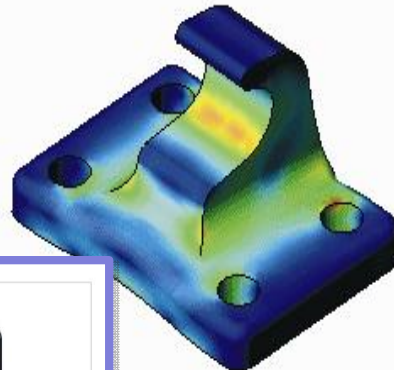
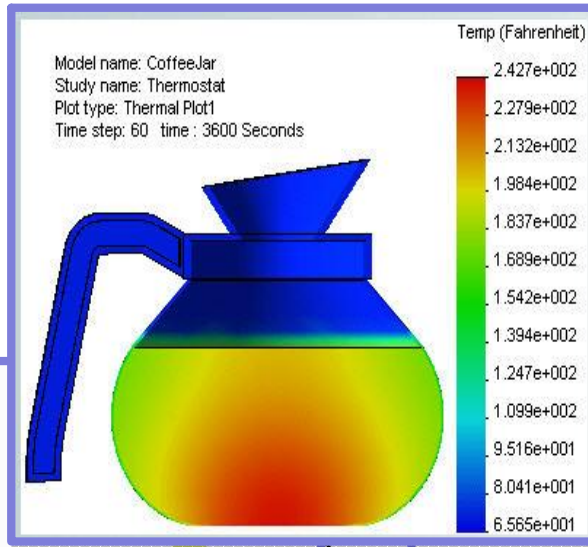
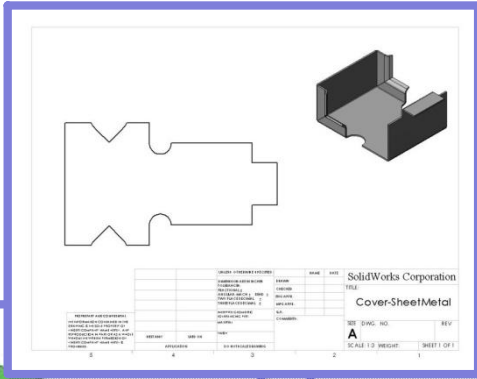
## Math and Science

- Geometry, Algebra and Calculus
- Physics, Chemistry and Environmental Science
- Biology – medical products

## Communication Skills

- Work as a team
- Describe a problem, formula solutions
- Enhance oral and written technology skills
- Accept failure and try again to make it better

# Tutorials and Curriculum



# Intuitive Solutions For To Empower Your Students

Sustainability





# What is Sustainable Engineering?

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- **Sustainable engineering** is the integration of **social, environmental, and economic** conditions into a product or process
- Soon all design will be **Sustainable Design**
- **SolidWorks Sustainability** allows students to be environmentally conscious about their designs
- Successful products are developed by integrating **Life Cycle Assessment (LCA)** directly into engineering design process

## Life Cycle Assessment - LCA

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- A method to quantitatively assess the **environmental impact** of a product throughout its entire lifecycle, from the procurement of the raw materials, through the production, distribution, use, disposal and recycling of that product.

# LCA – Life Cycle Assessment

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- **Raw Material Extraction**

- Planting, growing, and harvesting of trees
- Mining of raw ore (example: bauxite)
- Drilling and pumping of oil

- **Material Processing** - The processing of raw materials into engineered materials

- Oil into Plastic
- Iron into Steel
- Bauxite into Aluminum

- **Part Manufacturing** - Processing of material into finished parts

- Injection molding
- Milling and Turning
- Casting
- Stamping

## LCA – Life Cycle Assessment

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- **Assembly** – Assemble all of the finished parts to create the final product
- **Product Use** – End consumer uses product for intended lifespan of product
- **End of Life** – Once the product reaches the end of its useful life, how is it disposed of
  - Landfill
  - Recycled
  - Incinerated

## Life Cycle Assessment Key Elements

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- **Identify and quantify the environmental loads involved**
  - the energy and raw materials consumed
  - the emissions and wastes generated
- **Evaluate the potential environmental impacts of these loads**
- **Assess the options available for reducing these environmental impacts**

# Environmental Impact Factors

**Carbon Footprint**



**Total Energy**



**Air Acidification**

**Water Eutrophication**

# What is Carbon Footprint?

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- **Carbon Dioxide CO<sub>2</sub> and other gasses which result from the burning of fossil fuels accumulate in the atmosphere which in turn increases the earth's average temperature in kilograms (kg).**
- **Carbon footprint acts as a proxy for the larger impact factor referred to as Global Warming Potential (GWP).**
- **Global Warming is responsible for the loss of glaciers, extinction of species, more extreme weather, and other environmental problems.**



# What is Total Energy Consumed?

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- **Measure of the non-renewable energy sources associated with the part's lifecycle in mega joules (MJ). Impact includes:**
  - upstream energy required to obtain and process these fuels
  - embodied energy of materials which would be released if burned
  - electricity or fuels used during the product's lifecycle
  - Transportation?
- **Efficiencies in energy conversion (e.g. power, heat, steam) are taken into account.**





# What is Air Acidification?

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- **Sulfur Dioxide SO<sub>2</sub>, Nitrous Oxides NO<sub>x</sub> and other acidic emissions to air that result in acid rain.**
- **Makes the land and water toxic for plants and aquatic life.**
- **Slowly dissolves manmade building materials such as concrete.**
- **Measured in units of kilograms Sulfur Dioxide equivalent (SO<sub>2</sub>e)**



# What is Water Eutrophication?

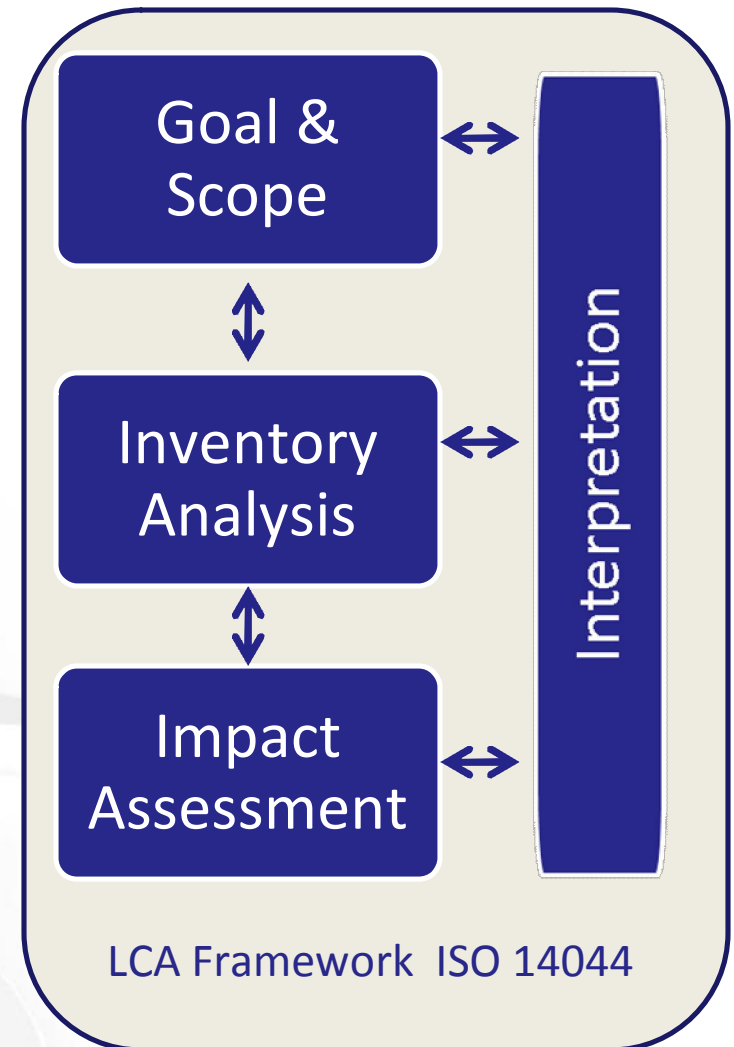
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- **Over abundance of nutrients added to a water ecosystem.**
- **Nitrogen (N) and Phosphorous ( $\text{PO}_4$ ) from waste water and agricultural fertilizers cause an overabundance of algae to bloom, which depletes the water of oxygen and results in the death of plant and animal life.**
- **Measured in kilograms Phosphate equivalent ( $\text{PO}_4\text{e}$ ).**



# References

- **Underlying LCA Technology: PE International**
  - 20 years of LCA experience
  - LCA international database
  - GaBi 4 - leading software application for product sustainability
  - [www.pe-international.com](http://www.pe-international.com)
- **International LCA Standards**
  - Environmental Management Life Cycle Assessment Principles and Framework ISO 14040/44  
[www.iso.org](http://www.iso.org)
- **US EPA LCA Resources**
  - <http://www.epa.gov/nrmrl/lcaccess/>



# Why SolidWorks Sustainability?

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## Soon all design will be Sustainable Design

- **More consumers want “greener” products**
- **New and unfamiliar challenge for businesses**
- **Sustainable design is a strategy for success**
- **SolidWorks Sustainability**
  - Easy to use and to understand
  - Reduces the environmental impact of product designs
  - Communicates effectively through reports and graphic display
  - SolidWorks SustainabilityXpress<sup>1</sup> is available to EVERY SolidWorks user at no cost

# Why SolidWorks Sustainability in the classroom?

**Find Similar Material**

| Materials | Specific Heat | Density | Elastic Modulus | Shear Modulus | Thermal Condu... |
|-----------|---------------|---------|-----------------|---------------|------------------|
| ABS PC    | 1900          | 1070    | 2.41e+009       | 0.622e+008    | 0.2618           |

| Property   | Cond... | Value      | Units     |
|--|---------|------------|-----------|
| <input checked="" type="checkbox"/> Material Class   | =       | Plastics   |           |
| <input type="checkbox"/> Specific Heat               | -any-   | 1900       | 1/(kg*°K) |
| <input type="checkbox"/> Density                     | -any-   | 1070       | kg/m^3    |
| <input type="checkbox"/> Elastic Modulus             | -any-   | 2.41e+009  | N/m^2     |
| <input type="checkbox"/> Shear Modulus               | -any-   | 0.622e+008 | N/m^2     |
| <input type="checkbox"/> Thermal Condu...            | -any-   | 0.2618     | W/(m*°K)  |
| <input type="checkbox"/> Poissons Ratio              | -any-   | 0.3897     |           |
| <input checked="" type="checkbox"/> Tensile Strength | -any-   | 4e+007     | N/m^2     |

Select search criteria. Set the condition(s) and value(s)

Find Similar

**Environmental Impact**

Carbon Energy Air Water Manufacturing Process: Injection Molding

Selected original: 0.2618 kg Selected original: 0.0001 kg Selected original: 0.0022 kg Selected original: 0.0001 kg

Accept Edit Cancel

**Material**

Class: Plastics  
Name: ABS PC  
Weight: 0.01 kg  
Find Similar Set Material

**Manufacturing**

Process: Injection Molding  
Region: Asia

**Use**

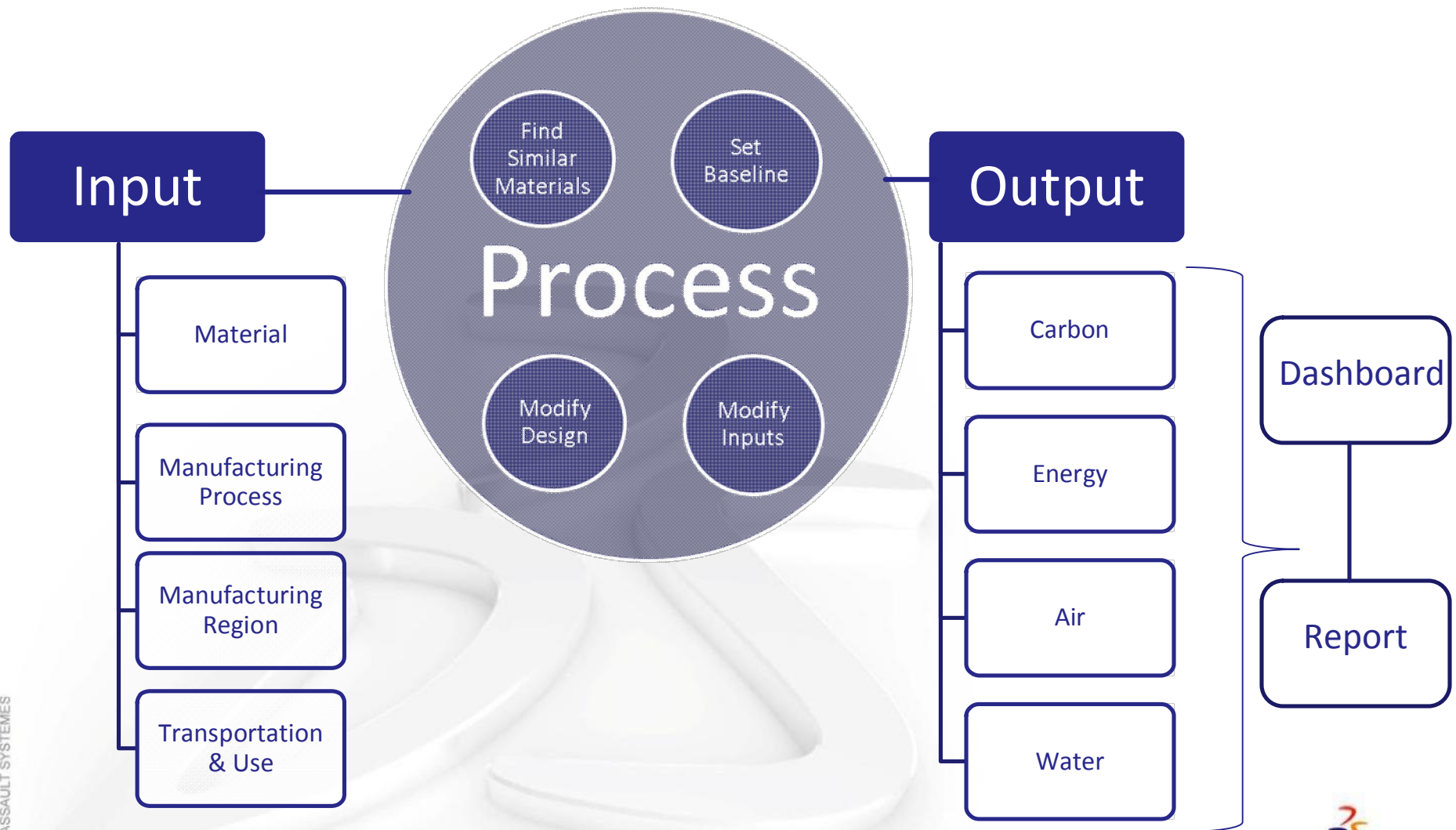
Region: North America

**Environmental Impact**

Material  Manufacturing  Use Regions  End Of Life

Carbon: Current 0.29 kg, Baseline 0.23 kg  
Energy: Current 4.03 kJ, Baseline 3.00 kJ  
Air: Current 0.00 kg, Baseline 0.00 kg  
Water: Current 0.00 kg, Baseline 0.00 kg

# SolidWorks Sustainability Methodology



# Input Material Class and Material Name

- **Material Class and Name Hierarchy**

| Material Class  |                      | Material Name                   |   |
|-----------------|----------------------|---------------------------------|---|
|                 |                      | Material Class: <b>Plastics</b> |   |
| Steel           | Plastics             | ABS PC                          | Acrylonitrile Butadiene Styrene<br>Polycarbonate                            |
| Iron            | Other Metals         | Acrylic                         |   |
| Aluminum Alloys | Other non-metals     | Delrin® 2700<br>NC010           | <b>Polyoxymethylene</b> (POM, polyacetal or polyformaldehyde) mfg by Dupont |
| Copper Alloys   | Generic Glass Fibers | Nylon 101                       |   |
| Titanium Alloys | Carbon Fibers        | PE High Density                 | Polyethylene  |
| Zinc Alloys     | Silicons             | PVC Rigid                       | Polyvinyl Chloride  |
| Other Alloys    | Woods                | And many more                   |   |

# Input Manufacturing Process

Available manufacturing depends on material class

|                       | Class: Aluminum Alloys |                                   |                       | Class: Plastics  |  |
|-----------------------|------------------------|-----------------------------------|-----------------------|------------------|--|
| Manufacturing Process | Die Casted             | Sand Casted                       | Manufacturing Process | Injection Molded |  |
|                       | Extrusion              | Stamped/<br>Formed Sheet<br>Metal |                       | Extrusion        |  |
|                       | Forged                 | Machined Sand<br>Casted           |                       |                  |  |
|                       | Milled                 | Turned                            |                       |                  |  |



# Input Manufacturing Region

- **Each region produces energy by different method combinations. Impact of a kWh is different for each region. Example methods include:**
  - Fossil Fuels
  - Nuclear
  - Hydro-electric
- **Determines the resources consumed by manufacturing processes in that region**
- **Region Choices**
  - Asia
  - Europe
  - North America
  - Japan



# Input Transportation and Use Region

- **Determines the energy sources consumed during the product's use phase (if applicable) and the destination for the product at its end-of-life.**
  - Asia
  - Europe
  - North America
  - Japan
- **Estimates the environmental impacts associated with transporting the product from its manufacturing location to its use location.**

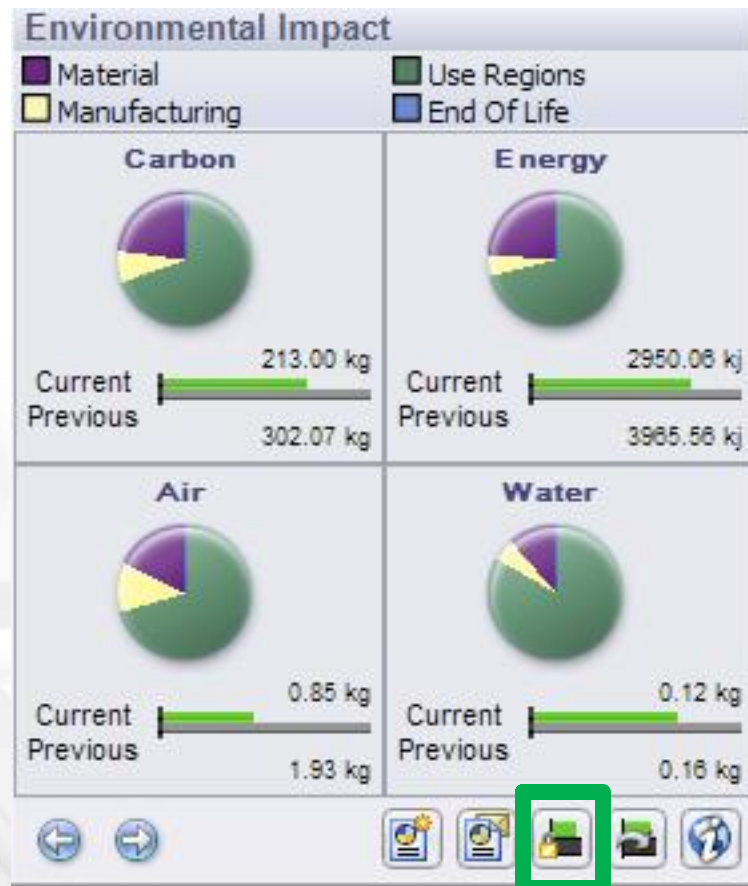
| Manufacturing   |        |
|---|--------|
| Process:  | Milled |
| Region:   | Asia   |
|  |        |

| Use  |               |
|--|---------------|
| Region:  | North America |
|  |               |

# SolidWorks Calculates Environmental Impact

- **Parameters**
  - Carbon Footprint
  - Air Acidification
  - Water Eutrophication
  - Energy Consumed
- **Factor Percentage**
  - Material
  - Manufacturing
  - Use Regions
  - End of Life
- **Set Baseline**



# Find Similar Materials based on Material Properties

- Thermal Expansion
- Specific Heat
- Density
- Elastic Modulus
- Shear Modulus
- Thermal Conductivity
- Poisson's Ratio
- Tensile Strength
- Yield Strength

The screenshot displays the SolidWorks interface. At the top, a table lists material properties for '1060 Alloy':

| Property          | Value       | Units    |
|-------------------|-------------|----------|
| Thermal Expans... | 2.4e-005    | K        |
| Specific Heat     | 900         | J/(kg*K) |
| Density           | 2700        | kg/m^3   |
| Elastic Modulus   | 6.9e+010    | N/m^2    |
| Shear Modulus     | 2.7e+010    | N/m^2    |
| Thermal Condu...  | 200         | W/(m*K)  |
| Poissons Ratio    | 0.33        |          |
| Tensile Strength  | 6.89356e+00 | N/m^2    |
| Yield Strength    | 2.75742e+00 | N/m^2    |

Below this is the 'Environmental Impact' section, which includes four pie charts for Carbon, Energy, Air, and Water. Each chart shows a 'Selected' portion and an 'Original' value:

- Carbon: Selected 0.78kg, Original 0.78kg
- Energy: Selected 9.95kJ, Original 9.95kJ
- Air: Selected 0.0046kg, Original 0.0046kg
- Water: Selected 0.00027kg, Original 0.00027kg

The 'Manufacturing Process' is set to 'Stamped/Formed Sheetmetal'. A 'Find Similar' button is visible in the top right of the material properties window.

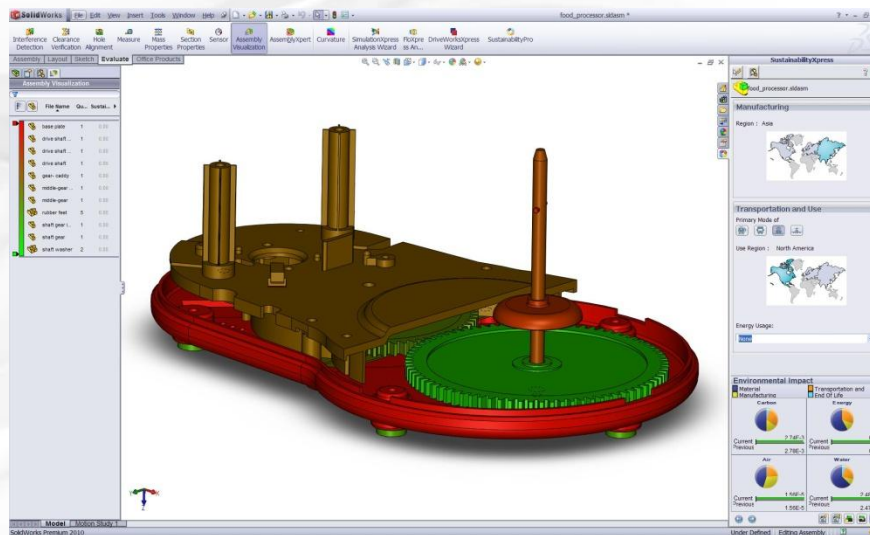
# Definitions of Material Properties

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- **Thermal Expansion** - the change in length per unit length per one degree change in temperature (change in normal strain per unit temperature) (K)
- **Specific Heat** - quantity of heat needed to raise the temperature of a unit mass of the material by one degree of temperature. (J/kg K)
- **Density** - Mass per unit volume. (kg/m<sup>3</sup>)
- **Elastic Modulus** (Young's Modulus) - ratio between the stress and the associated strain in a specified direction (N/m<sup>2</sup>)
- **Shear Modulus** (Modulus of Rigidity) - the ratio between the shearing stress in a plane divided by the associated shearing strain (N/m<sup>2</sup>)
- **Thermal Conductivity** - rate of heat transfer through a unit thickness of the material per unit temperature difference. (W/m K)
- **Poisson's Ratio** - ratio between the contraction (transverse strain), normal to the applied load to the extension (axial strain), in the direction of the applied load. Poisson's ratio is a dimensionless quantity.
- **Tensile Strength** –the maximum amount of tensile stress that a material can be subjected to before failure (N/m<sup>2</sup>)
- **Yield Strength** – Stress at which the material becomes permanently deformed (N/m<sup>2</sup>)

# SolidWorks Sustainability

- Same functions as SustainabilityXpress
- LCA of assemblies
- Configuration support
  - Save inputs and results per configuration
- Expanded reporting capabilities for assemblies
- Specify amount & type of energy consumed during use
- Specify method of transportation
- Support for Assembly Visualization



# Sustainable Report

## Sustainability Report

Baseline

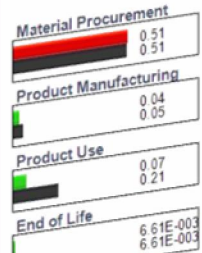


## Sustainability Report

Model Name: Chann96mm Material: 1060 Alloy

Volume: 1.46e+4 mm<sup>3</sup>  
Surface Area: 1.75e+4 mm<sup>2</sup>  
Weight: 39.4 g Manufacturing Type: Stamped/formed Sheetmetal

### Chart Header 2



### Carbon Footprint - CO<sub>2</sub>e

Total: 1060 Alloy: 0  
1060 Alloy: 0

Original Design: Better (Green), Worse (Red)  
New Design: Baseline (Black)

### Comments



### Water Eutrophication

Total: 1060 Alloy: 0  
1060 Alloy: 0

Original Design: Better (Green), Worse (Red)  
New Design: Baseline (Black)

## Sustainability Report

Model Name: Chann96mm Material: 1023 Carbon Steel Sheet (SS)

Volume: 1.46e+4 mm<sup>3</sup>  
Surface Area: 1.75e+4 mm<sup>2</sup>  
Weight: 115 g Manufacturing Type: Milled

### Chart Header



1.03 kg CO<sub>2</sub>e

Material: 0.315 kg CO<sub>2</sub>e  
Manufacturing: 0.0924 kg CO<sub>2</sub>e  
Use: 0.606 kg CO<sub>2</sub>e  
End of Life: 0.0192 kg CO<sub>2</sub>e

### Water Eutrophication



0.000531 kg PO<sub>4</sub>e

Material: 7.98e-5 kg PO<sub>4</sub>e  
Manufacturing: 5.03e-5 kg PO<sub>4</sub>e  
Use: 0.000398 kg PO<sub>4</sub>e  
End of Life: 3.69e-6 kg PO<sub>4</sub>e



0.00454 kg SO<sub>2</sub>e

Material: 0.000852 kg SO<sub>2</sub>e  
Manufacturing: 0.00119 kg SO<sub>2</sub>e  
Use: 0.00247 kg SO<sub>2</sub>e  
End of Life: 1.9e-5 kg SO<sub>2</sub>e

### Total Energy Consumed



13.8 MJ

Material: 4.19 MJ  
Manufacturing: 0.922 MJ  
Use: 8.66 MJ  
End of Life: 0.0108 MJ

# SolidWorks Sustainability - Online Calculator

Converts environmental impacts into human scale parameters  
Example: Carbon Footprint converted into miles driven in a car

The screenshot displays the SolidWorks Sustainability Online Calculator interface. The page title is "Sustainable design" and the breadcrumb is "Home > Sustainable Design". The main content area is titled "Air Acidification: Contamination of Households' Worth of Water in a Year". It compares two designs: "CURRENT DESIGN" (File 1 Solidpart, 10.56 units, 25 quantity, 77,600 units) and "BASELINE DESIGN" (File 2 Solidpart, 16.78 per unit, 40 quantity, 92,100 units). A green bar indicates that the current design saves 14,500 cups of drinking water from contamination, which is equivalent to 35% reduction. Below this, a horizontal bar chart shows other environmental impacts: Carbon Footprint (100,000 - 120,000 contaminating cups of drinking water), Energy Consumption (50,000 - 80,000 cultivating and consuming pounds of coffee), Air Acidification (200,000 - 360,000 minutes of acid rain in greater Boston area), and Water Evaporation (10,000 - 22,000 creating liters of sulfuric acid). The "Summary of Environmental Impact" section states: "The current design will contribute [quantity] towards Air Acidification. The baseline design will contribute [quantity]. The current design will reduce 35% of the impact, which is equivalent to saving \$140 households worth of water from contamination." The "Share Your Findings" section includes social media icons for LinkedIn, Facebook, Twitter, YouTube, and RSS, and a "Print-Friendly Version" link.

| Design   | Name             | Value          | Quantity | Impact (Units) |
|----------|------------------|----------------|----------|----------------|
| Current  | File 1 Solidpart | 10.56 units    | 25       | 77,600         |
| Baseline | File 2 Solidpart | 16.78 per unit | 40       | 92,100         |

Water Usage: 1 cup = 100 US Household water usage per year  
Date Capture: 16 Aug 2009  
Saved 14,500 cups of drinking water from contamination (35% reduction)

| Impact Category    | Value   |
|--------------------|---|
| Carbon Footprint   | 100,000 - 120,000 contaminating cups of drinking water        |
| Energy Consumption | 50,000 - 80,000 cultivating and consuming pounds of coffee    |
| Air Acidification  | 200,000 - 360,000 minutes of acid rain in greater Boston area |
| Water Evaporation  | 10,000 - 22,000 creating liters of sulfuric acid              |

Summary of Environmental Impact: The current design will contribute [quantity] towards Air Acidification. The baseline design will contribute [quantity]. The current design will reduce 35% of the impact, which is equivalent to saving \$140 households worth of water from contamination.

Share Your Findings: LinkedIn, Facebook, Twitter, YouTube, RSS, Print-Friendly Version (only if you really need it)



# Why SolidWorks Sustainability in the classroom?

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- **Students need** to learn, understand, improve, and communicate the environmental impact of their design
- **Educators can** provide insights on how choices in material and manufacturing processes affect the environment.
- **Instruction combines** design and technology with the social, environmental, and economic conditions

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# THANK YOU

