

# **Package Designer**

## **Software Manual**

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## 1 Introduction

CDO Technologies, Inc. (CDO) developed Package Designer version 2.0 under contracts GS05T12BMC0004 / ITSS 5TP57110044 for the Air Force Packaging Technology and Engineering Facility (AFPTEF). Package Designer is the property of the AFPTEF, AFSC/LOEP, 5215 Thurlow Street, Suite 5, Building 70, Area A, Wright-Patterson AFB, OH 45433-5540. For information about the application, requests for assistance, problem reports, and suggestions for improvements, please contact the AFPTEF Webmaster.

- Email: [afptefwebmaster@wpafb.af.mil](mailto:afptefwebmaster@wpafb.af.mil)
- Phone: 937-257-4519 (DSN 787-4519)
- Fax: 937-656-1350 (DSN 986-1350)

The Package Designer materials are public information. They may be copied and distributed without restriction.

### 1.1 System Overview

Package Designer helps users develop and analyze cushioning and container requirements in accordance with *MIL-HDBK-304C Package Cushioning Design*. Packaging requirements include the type and amount of cushion required for safe transportation. Cushioning requirements take into account the peak acceleration that the package may experience during transportation and the possible height from which the item may be dropped during transportation. Solutions are within +/- 1% of the theoretical optimum.

Figure 1 shows Package Designer's functional components.

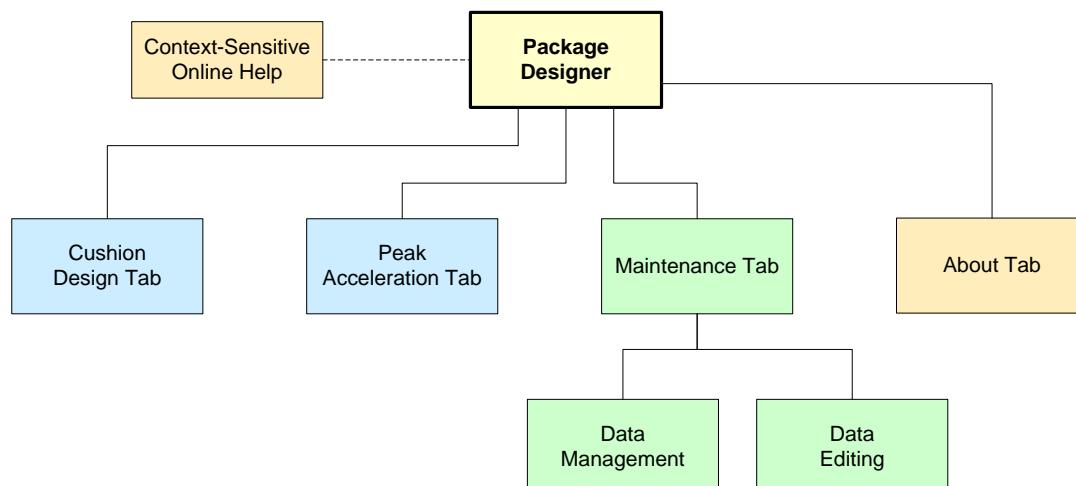


Figure 1: Functional Components

Package Designer 2.0 features:

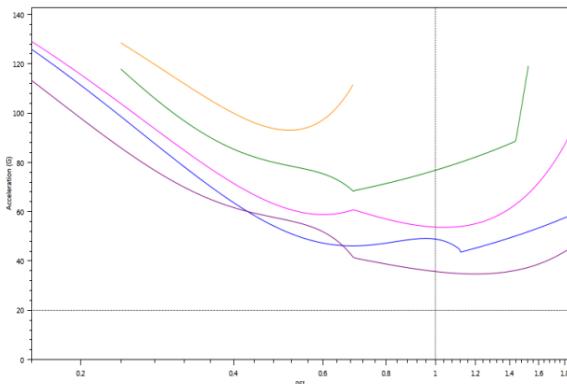
- This release updates the application to run in 64-bit Microsoft Windows environments.
- A single Microsoft Installer file makes installation a snap.
- Context-sensitive online help puts assistance at users' fingertips.
- XML data files are easily portable between systems and across the Internet.

## 1.2 Improvements in Package Designer Version 2.0

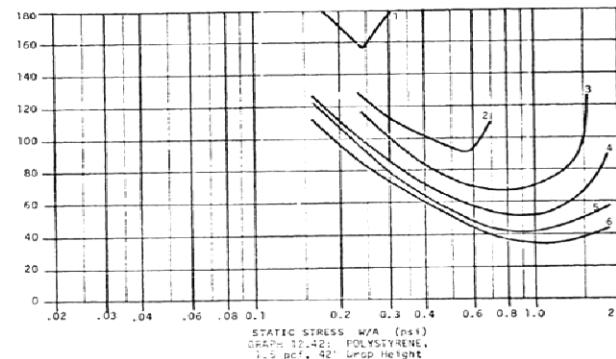
A number of improvements make the new Package Designer superior to the previous version.

### 1.2.1 Peak Acceleration Curve Accuracy

Package Designer 1.0 used cubic equations to calculate peak acceleration. Not only are cubic equations unwieldy to maintain, in several cases they introduced errors. Compare the graph from Package Designer with cubic equations (Figure 2) with the original graph from *MIL-HDBK-304B* (Figure 3).

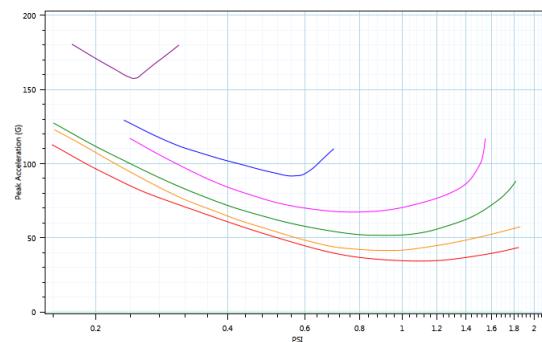


**Figure 2: Graph From Cubic Equations**



**Figure 3: Graph From MIL-HDBK-304B**

To address this issue, we used Engauge to extract the data from the graphs in the handbook and convert it to X,Y values. Note the improved correlation between original graph (Figure 3) and the graph from Package Designer 2.0 with digitized data (Figure 4).



**Figure 4: Graph From Digitized Data**

### 1.2.2 Code

The code was improved in a number of ways:

- Redesigned to use object-oriented techniques
- Modernized language from Access 2002 VBA to C# 4.0
- Fixed bugs in corner padding logic
- Changed security from embedded password to Windows authentication

### 1.2.3 User Interface

Added functionality in the new user interface:

- Displaying all solutions at once for comparison
- Displaying multiple acceleration curves at the same time for comparison
- Sorting solutions by cost, weight, or volume
- Zooming, panning, and copying graphs

### 1.2.4 Data

The data was extracted from Microsoft Access into XML. XML format has a number of advantages:

- XML data is highly portable
- XML data can be inspected independently of the application
- XML data can be hosted in a common location for multiple users
- XML data designs can be shared

Package Designer 2.0 imports and exports data as XML. The export feature doubles as a backup mechanism.

## 1.3 Document Overview

This software manual covers the following topics for Package Designer version 2.0:

- User Guide – Instructions for installing and using the application
- Technical Specifications – Detailed specifications and build procedures

## 1.4 Writing Conventions

This document uses the following writing conventions:

- Instructions – Screen elements with which the user interacts are bolded, as shown:

To clear all inputs in the tab, click **Clear**.

- Notes –The word “Note” is bolded and the note text is italicized, as shown:

**Note:** *For documents or web sites that list no edition, version, or date, ...*

- References – Titles of publications are italicized, as shown:

The primary audience for this *Package Designer Software Manual* is AFPTEF ...

- Software code – Code is presented in Proggy Clean font. Large blocks of code are marked with a 15% gray background, as shown:

```
<?xml version="1.0" encoding="UTF-8"?>
<CushionDesignTypes>
    <CushionDesignType id="1">
        <Description>Complete Encapsulation</Description>
    </CushionDesignType>
</CushionDesignTypes>
```

## **1.5 Intended Audience**

The primary audience for this *Package Designer Software Manual* is AFPTEF and its customers. *Section 2 User Guide* is aimed at application Package Designer Users and System Administrators. *Section 3 Technical Specifications* is aimed at Software Developers; System Administrators may also find this information useful.

## **1.6 References**

Table 1 lists documents and/or websites referenced in, or used to develop this *Package Designer Software Manual*.

**Table 1: References**

<b>Author / Publisher</b>	<b>Title and Version or Edition (not year)</b>	<b>City and State of Publication</b>	<b>Year Published</b>
Apache Software Foundation	Apache Subversion <a href="http://subversion.apache.org">subversion.apache.org</a>		
Department of Defense	<i>MIL-HDBK-304C Package Cushioning Design (DoD Handbook)</i>	WPAFB, OH	1 June 1997
Department of Defense	<i>MIL-HDBK-304B Package Cushioning Design (DoD Handbook)</i>	WPAFB, OH	31 October 1978
Frontier Engineering, Inc.	<i>Package Designer Application, version 1.0</i>	Dayton, OH	31 Mar 1996
Frontier Engineering, Inc.	<i>Package Designer User's Guide, version 1.0</i>	Dayton, OH	27 Jul 2000
Microsoft	Microsoft Download Center, <a href="http://www.microsoft.com/en-us/download/details.aspx?id=21138">www.microsoft.com/en-us/download/details.aspx?id=21138</a>		
Microsoft	OxyPlot on CodePlex, <a href="http://oxyplot.codeplex.com">oxyplot.codeplex.com</a>		
NuGet	NuGet, <a href="http://nuget.org">nuget.org</a>		
NUnit	NUnit, <a href="http://www.nunit.org">www.nunit.org</a>		
Wikipedia	en.wikipedia.org/wiki		

**Note:** For documents or web sites that list no edition, version, or date, use the most current version.

## 2 User Guide

Package Designer helps identify and evaluate packaging solutions (designs). Enter the characteristics of the item to be shipped, and select the container and cushion parameters. The application calculates and lists package dimensions and cost. It also calculates, graphs, and compares how well specific solutions protect the package contents. Users need a basic knowledge of package engineering.

**Caution:** While Package Designer is a useful tool, environmental factors (such as temperature and humidity) can impact package life. It is essential to test the performance of packaging materials in the (actual or simulated) conditions under which they will be used.

### 2.1 Prerequisites

Package Designer 2.0 is designed and tested for use on Windows 32-bit and 64-bit platforms. It requires a version of Microsoft Windows that supports the .NET Framework, version 4.0 or higher. It has no special hardware requirements.

### 2.2 Installing the Application

For easy installation, a single Microsoft Installer (MSI) file contains all the executable components and data files.

To install Package Designer:

1. Double-click on the file PackageDesigner.msi. The Package Designer Installer launches.
2. Accept the default settings unless otherwise instructed. The Package Designer Icon displays on the desktop when installation is complete.

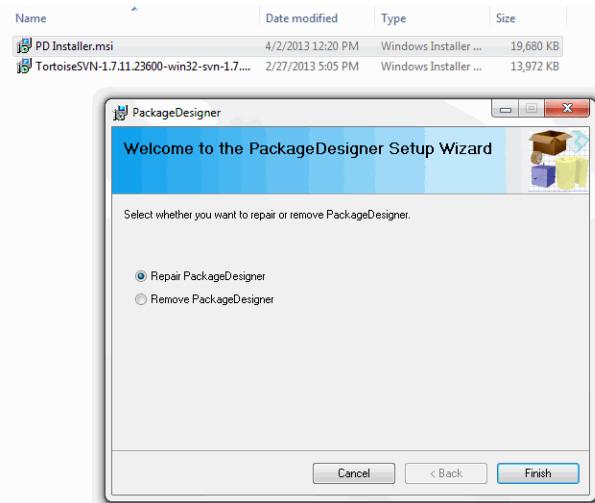


Figure 5: Package Designer Installer

### 2.3 Starting the Application

To start Package Designer, do one of the following:

- Select Package Designer in the Windows Application Menu.
- Double-click on the **Package Designer** Icon.



Figure 6: Package Designer Application Icon

- Double-click on a Package Designer data file (\*.pdxm).

	Antenna.pdxm	PDXML File
	ComputerMonitor.pdxm	PDXML File
	Gyro.pdxm	PDXML File
	Missle.pdxm	PDXML File

Figure 7: Package Designer Data File

Package Designer opens to the Cushion Design Tab. Online help puts assistance at your fingertips. Press **F1** anywhere in the application to bring up context-sensitive help.

## 2.4 *Cushion Design Tab*

The Cushion Design Tab identifies potential packaging solutions for an item. Four areas are labeled:

- Item Characteristics – Enter data about an item here.
- Design Parameters – Select the design parameters here.
- Cost Factors – Select, enter, or update cost factors here.
- Solution List – View potential solutions here.

Cushion Material	Top Thickness	Side Thickness	End Thickness	Cost	Weight	Volume	Dimensions (LxWxH)
Polyurethane-Ether 4 lb/cubic ft.	2 in.	2 in.	2 in.	\$52.81	299.75 lbs.	48.15 cu ft.	52 in. x 40 in. x 40 in.
Polyurethane-Ester 1.5 lb/cubic ft.	3 in.	3 in.	3 in.	\$41.22	278.80 lbs.	55.13 cu ft.	54 in. x 42 in. x 42 in.
Polyurethane-Ester 2 lb/cubic ft.	2 in.	2 in.	2 in.	\$40.75	278.51 lbs.	48.15 cu ft.	52 in. x 40 in. x 40 in.
Polyurethane-Ester 4 lb/cubic ft.	2 in.	2 in.	2 in.	\$79.42	297.89 lbs.	48.15 cu ft.	52 in. x 40 in. x 40 in.
Polyethylene Foam 2 lb/cubic ft.	3 in.	3 in.	3 in.	\$36.79	274.00 lbs.	55.13 cu ft.	54 in. x 42 in. x 42 in.
Polyethylene Foam 4 lb/cubic ft.	3 in.	3 in.	3 in.	\$42.11	278.75 lbs.	55.13 cu ft.	54 in. x 42 in. x 42 in.
Polystyrene Foam 1.5 lb/cubic ft.	4 in.	4 in.	4 in.	\$26.41	276.42 lbs.	62.74 cu ft.	56 in. x 44 in. x 44 in.
Polystyrene Foam 2.5 lb/cubic ft.	4 in.	4 in.	4 in.	\$31.50	280.05 lbs.	62.74 cu ft.	56 in. x 44 in. x 44 in.
Polyethylene Minicell L-200	3 in.	3 in.	3 in.	\$38.45	274.00 lbs.	55.13 cu ft.	54 in. x 42 in. x 42 in.

Figure 8: Cushion Design Tab

- To load an existing data file and display its parameters, click **Load**. A pop-up window lets you browse to a location and enter or select a File Name. File Type defaults to .pdxm. The fields on the Cushion Design and Peak Acceleration Tabs populate.
- To save a new or updated item and design parameters, click **Save**. A pop-up window lets you browse to a location and enter or select a File Name. File Type defaults to .pdxm.
- To clear all inputs in the tab, click **Clear**.

- When **Auto Calculate** is checked (the default), the Solution List automatically displays or updates and Calculate is disabled.
- To update the Solution List manually, uncheck **Auto Calculate** and click **Calculate**.

#### **2.4.1 Item Characteristics**

- Description: Enter a brief description of the design. This is the default filename for new files.
- Length, Width, and Height: Enter the item length, width, and height in inches.
- Weight: Enter the item weight in pounds.
- Fragility: Top, Side, and End: Enter fragility of the top, side, and end of the item in Gs. Fragility is the maximum g-force the item can withstand without sustaining damage.

#### **2.4.2 Design Parameters**

- Drop Height: Select the maximum drop height in inches.
- Design Type: Select the type of cushioning design.
- Container Type: Select the type of container.
- Container Material: Select the container material.

#### **2.4.3 Cost Factors**

You can override the default to the values from the cost factor table on the Maintenance Tab here. Package Designer saves the cost factors with the container, so each container can have unique values. Package Designer calculates the total cost of each solution from your entries and displays it in the Solution List.

- Shipping Cost: Shipping cost for the item in dollars.
- Ship By: Select shipment method.
- Labor: Enter the hourly rate in dollars for labor to assemble, load, and close the container.
- Tape: Enter the cost in dollars per yard for tape to assemble and close the container.
- Glue: Enter the cost in dollars for glue to assemble and close the container.
- Cut-Perf-Fold: Enter the cost in dollars per inch for processing (perforating, cutting, folding, or creasing) material to construct the container.
- FTC Extra: Enter the cost in dollars to process the container cover. Only visible when you select Container Type FTC in Design Parameters.

#### **2.4.4 Solution List**

Package Designer summarizes possible solutions here. Click on a column head to sort by that field. Click again to reverse the sort order. Double-click on an entry to open the Detail Report Window.

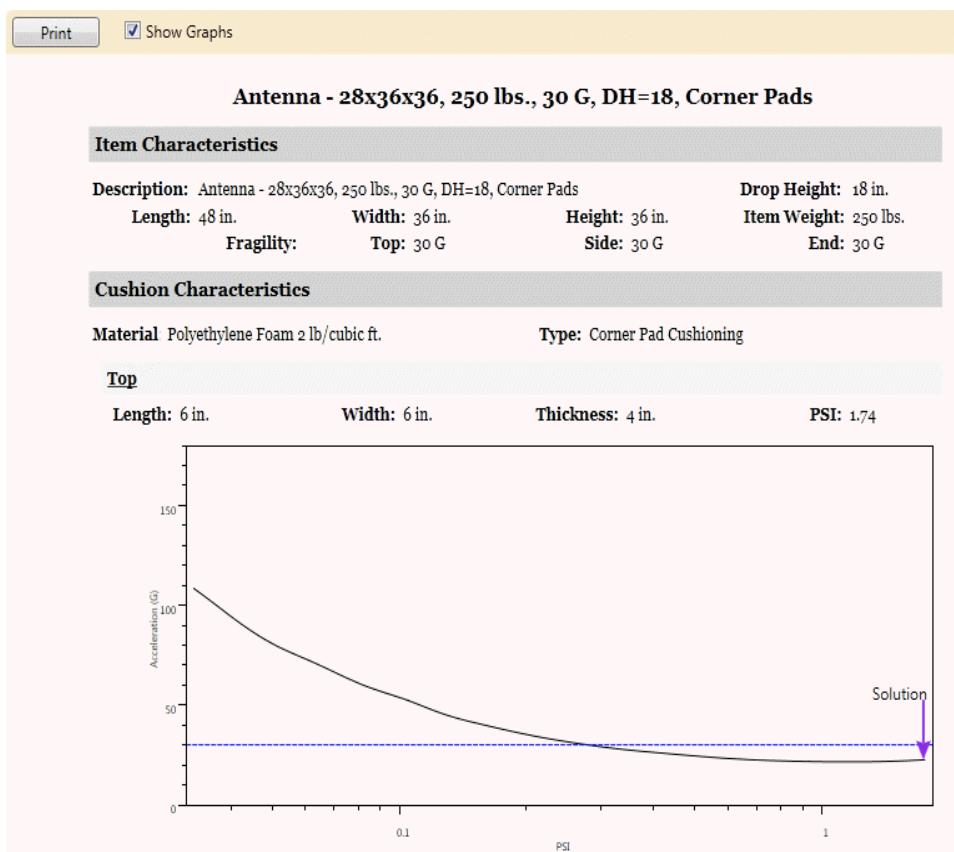
- Cushion Material: Material used.
- Top, Side, and End Thickness: Recommended thickness of the top, side, and end cushions in inches.
- Cost: Total cost associated with the solution in dollars.

- Weight: Total weight of the item, cushioning, and container combined in pounds.
- Volume: Total volume of the container in cubic feet.
- Dimensions: Length x Width x Height in inches.

#### **2.4.5 Detail Report Window**

The Detail Report Window provides details of the selected packaging solution. Four areas are labeled:

1. Item Characteristics - Values from the Cushion Design Tab.
2. Cushion Characteristics - Material description and design type, as well as cushioning details for each item face (top, side, and end).
3. Container Characteristics - Container details (material, type, dimensions).
4. Cost/Weight - Detailed breakdown of the total cost and weight for the solution.



**Figure 9: Detail Report Window with Graphs**

Graphs show where the selected solution falls relative to the curve for each face.

- To print the solution details, click **Print**.
- To hide the graphs, uncheck **Show Graphs**.
- To view the window contents, scroll.
- To zoom in or out, maximize the window and use the slider in the lower left.



**Figure 10: Detail Report Window Slider**

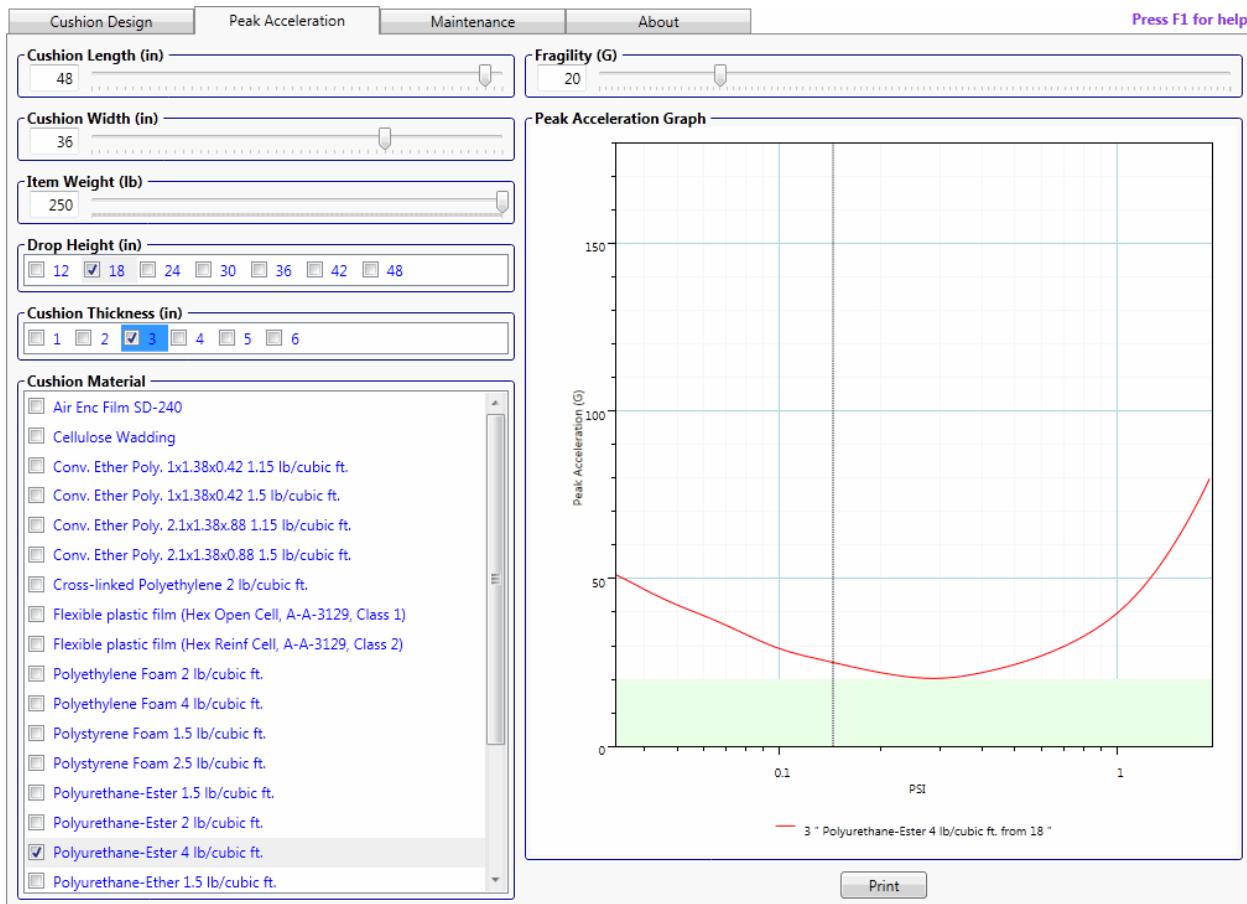
**Antenna - 28x36x36, 250 lbs., 30 G, DH=18, Corner Pads**

Item Characteristics			
Description:	Antenna - 28x36x36, 250 lbs., 30 G, DH=18, Corner Pads		
Length:	48 in.	Width:	36 in.
Fragility:	Top: 30 G	Height:	36 in.
		Side: 30 G	Drop Height: 18 in.
			Item Weight: 250 lbs.
			End: 30 G
Cushion Characteristics			
Material	Polyurethane-Ester 2 lb/cubic ft.		
Type	Corner Pad Cushioning		
Top	Length: 13 in.	Width: 13 in.	Thickness: 2 in.
PSI:	0.37		
Side	Length: 13 in.	Width: 13 in.	Thickness: 2 in.
PSI:	0.37		
End	Length: 13 in.	Width: 13 in.	Thickness: 2 in.
PSI:	0.37		
Container Characteristics			
Material:	Single Wall V3C	Type:	FTC
Length:	52 in.	Width:	40 in.
		Volume:	48.15 cu ft.
		Height:	40 in.
Cost/Weight			
Cushion Cost:	\$23.89	Item Weight:	250 lbs.
Cushion Cutting Cost:	\$0.10	Cushion Weight:	10.91 lbs.
Container Cost:	\$16.76	Container Weight:	17.6 lbs.
Closing Cost:	\$0.00		
Tape Cost:	\$0.00		
Shipping Cost:	\$0.00		
<hr/>	<hr/>	<hr/>	<hr/>
TOTAL COST:	\$40.75	TOTAL WEIGHT:	278.51 lbs.

**Figure 11: Detail Report Window without Graphs**

## 2.5 Peak Acceleration Tab

The Peak Acceleration Tab illustrates and compares the performance of a single surface cushion design across one or more materials and thicknesses.



**Figure 12: Peak Acceleration Tab**

Package Designer calculates and plots the acceleration force (in G's) the item will experience for a given drop height, in pounds per square inch (PSI), based on your design parameters.

The fields populate from the Cushion Design Tab, however you can adjust or add to the entries.

- **Cushion Length and Cushion Width:** Select or enter the cushion length and cushion width in inches.
- **Item Weight:** Select or enter the item weight in pounds.
- **Drop Height, Cushion Thickness, and Cushion Material:** Select up to 12 combinations of drop height, cushion thickness, and cushion material. The graph plots each combination.
- **Fragility:** Select or enter the maximum allowable acceleration for the item in Gs.

The Peak Acceleration Graph illustrates and compares the performance of up to 12 packaging designs. For instructions on manipulating the graph view, see *section 2.6 Using Graphs*. To print a graph with legend, click **Print**.

## **2.6     *Using Graphs***

Package Designer uses OxyPlot Graph functions.

- To fit a graph to the window, click anywhere in the graph and press Home.
- To reset the graph axes, place the mouse anywhere in the graph and press A.
- To display a data point on a graph, mouse over the location and press the left mouse button.

### **2.6.1     *Copy and Paste***

To copy a graph and paste it into a Microsoft application:

1. Click anywhere in the graph. Windows selects the graph.
2. Press Ctrl-C. Windows copies the graph to the clipboard.
3. Open the target file and press Ctrl-V. Windows pastes the graph into the file.

### **2.6.2     *Pan***

To pan on the entire plot, do one of the following:

- Press the right mouse button and drag (left, right, up, or down).
- Use the arrow keys to move left, right, up, or down.

To pan on a single axis, place the mouse over the axis, press the right mouse button and do one of the following:

- Drag (left or right for X-axis; up or down for Y-axis).
- Use the arrow keys to move left, right, up, or down.

### **2.6.3     *Zoom***

To zoom on the entire plot, place the mouse over the location and do one of the following:

- Roll the mouse wheel forward to zoom in or backward to zoom out.
- On the keypad, press the plus key (+) to zoom in or the minus key (-) to zoom out.
- For smaller zoom steps, hold down the Control Key (Ctrl) while zooming.

To zoom on a single axis, place the mouse over the axis and roll the mouse wheel forward to zoom in or backward to zoom out.

To zoom by rectangle, place the mouse over the location and do the following:

- Press Ctrl and the right mouse button, and move the mouse. A rectangle highlights a portion of the graph.
- Release Ctrl and the right mouse button. Package Designer zooms in on the area in the rectangle.

## 2.7 Maintenance Tab

The Maintenance Tab lets System Administrators edit data tables and manage the database as a whole. By default, the first user to run the application becomes the System Administrator. System Administrators can grant administrative rights to other users. See section 2.7.2 *Manage Database* for details.

The Maintenance Tab has two drop-down menus, Edit Database and Manage Database.

The screenshot shows the maintenance tab interface. At the top, there are four tabs: 'Cushion Design', 'Peak Acceleration', 'Maintenance' (which is selected), and 'About'. On the left, a sidebar menu is open under 'Edit Database'. It includes sections for 'Container Materials', 'Container Types', 'Cushion Materials', 'Transportation Types', 'Peak Acceleration Data', and 'Cost Factors'. Below this, another section for 'Manage Database' is shown with options: 'Control Access', 'Import', 'Export', 'Restore', and 'Change Location'. A note at the bottom of the sidebar says 'Double click on row to edit contents.' To the right of the sidebar, a table titled 'Container Materials' is displayed. The table has columns for 'Material ID', 'Description', 'Cost \$/sq ft', and 'Weight lb/sq ft'. Four rows are listed:

Material ID	Description	Cost \$/sq ft	Weight lb/sq ft
1	Single Wall V3C	0.0762	0.22
2	Double Wall V11C	0.1187	0.39
3	Solid Wall V2S	0.0832	0.32
4	Solid Wall V3S	0.0699	0.31

Figure 13: Maintenance Tab Menus

### 2.7.1 Edit Database

The data behind the application can be modified. When the data is changed, the application must be restarted to take advantage of the changes. System Administrators can edit six data tables from the Edit Database Menu:

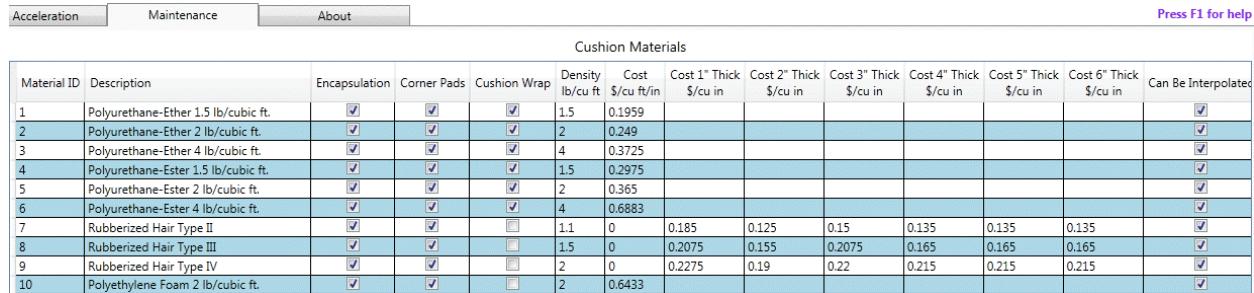
1. Container Materials
  2. Container Types
  3. Cushion Materials
  4. Transportation Types
  5. Peak Acceleration Data
  6. Cost Factors
- To edit a table, select the table in the drop-down menu. The main panel displays the table on top and the Add, Delete, and Save buttons at the bottom.
  - To select a row in the table, click in the row. Package Designer highlights the row.
  - To edit the contents of a cell, click in the cell, and enter the changes. Package Designer highlights the row, outlines the cell, and displays your changes on screen.
  - To add a new row to the table, click **Add**. Package Designer adds an empty row.
  - To delete a row from the table, select the row and click **Delete**. Package Designer deletes the highlighted row.
  - To save changes, click **Save**. Package Designer saves your changes to an XML file.

See section 3.6.2 *Data File Formats* for details on Package Designer data tables.

### 2.7.1.1 *Cushion Materials Table*

There are two ways to enter cost in the Cushion Materials Table.

1. If cost is a linear ratio (cost of 1" thick material x 2 = cost of 2" thick material, etc.), enter or update the field **Cost**.
2. Otherwise, set Cost to 0 and enter thickness-specific values in the fields for **Cost n" Thick**.



The screenshot shows a software interface titled "Cushion Materials". At the top, there are tabs for "Acceleration", "Maintenance", and "About", with "Acceleration" being the active tab. A status bar at the top right says "Press F1 for help". The main area contains a table with 10 rows of data. The columns are: Material ID, Description, Encapsulation, Corner Pads, Cushion Wrap, Density lb/cu ft, Cost \$/cu ft/in, Cost 1" Thick \$/cu in, Cost 2" Thick \$/cu in, Cost 3" Thick \$/cu in, Cost 4" Thick \$/cu in, Cost 5" Thick \$/cu in, Cost 6" Thick \$/cu in, and Can Be Interpolated. The data includes various cushion materials like Polyurethane-Ether and Rubberized Hair, along with their specific properties and cost details.

Material ID	Description	Encapsulation	Corner Pads	Cushion Wrap	Density lb/cu ft	Cost \$/cu ft/in	Cost 1" Thick \$/cu in	Cost 2" Thick \$/cu in	Cost 3" Thick \$/cu in	Cost 4" Thick \$/cu in	Cost 5" Thick \$/cu in	Cost 6" Thick \$/cu in	Can Be Interpolated
1	Polyurethane-Ether 1.5 lb/cubic ft.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1.5	0.1959							<input checked="" type="checkbox"/>
2	Polyurethane-Ether 2 lb/cubic ft.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	2	0.249							<input checked="" type="checkbox"/>
3	Polyurethane-Ether 4 lb/cubic ft.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	4	0.3725							<input checked="" type="checkbox"/>
4	Polyurethane-Ester 1.5 lb/cubic ft.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1.5	0.2975							<input checked="" type="checkbox"/>
5	Polyurethane-Ester 2 lb/cubic ft.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	2	0.365							<input checked="" type="checkbox"/>
6	Polyurethane-Ester 4 lb/cubic ft.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	4	0.6883							<input checked="" type="checkbox"/>
7	Rubberized Hair Type II	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.1	0	0.185	0.125	0.15	0.135	0.135	0.135	<input checked="" type="checkbox"/>
8	Rubberized Hair Type III	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	1.5	0	0.2075	0.155	0.2075	0.165	0.165	0.165	<input checked="" type="checkbox"/>
9	Rubberized Hair Type IV	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	2	0	0.2275	0.19	0.22	0.215	0.215	0.215	<input checked="" type="checkbox"/>
10	Polyethylene Foam 2 lb/cubic ft.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	2	0.6433							<input checked="" type="checkbox"/>

Figure 14: Cushion Materials Table

### 2.7.1.2 *Peak Acceleration Data Table and Edit Window*

Double-click on a row in the Peak Acceleration Data Table to open the related Edit Peak Acceleration Data Window and edit the peak acceleration characteristics and data.

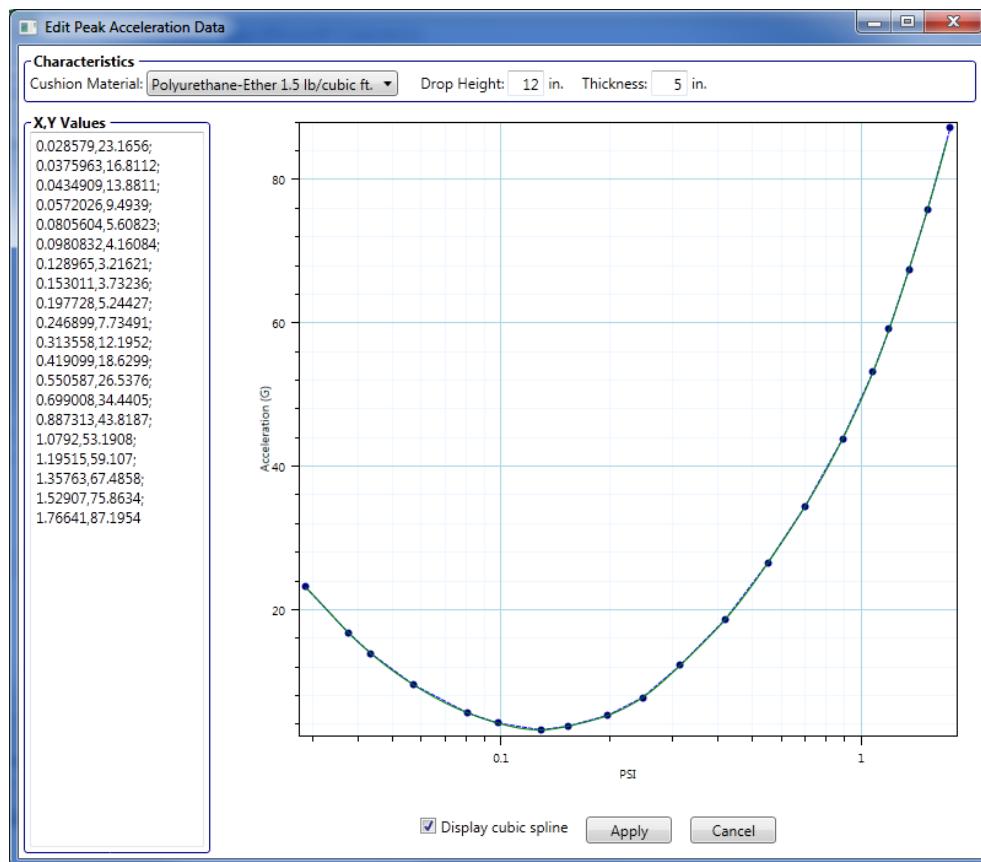


Figure 15: Edit Peak Acceleration Data Window

The Edit Peak Acceleration Data Window lets you enter and update X and Y values for peak acceleration data, where X is the PSI and Y is the acceleration force in G's. Provide a minimum of three points. Separate each set of X and Y values with a comma and each pair of X,Y points with a semi-colon.

For convenience, you can copy a pair of columns from Microsoft Excel and paste them directly into the X,Y Values Text Box. Changes to the X,Y Values update the graph immediately.

Package Designer plots point pairs as small blue circles connected with a blue dashed line (straight-line interpolation). The solid green line is the cubic spline interpolation the application uses to calculate additional points for graphing.

- To apply your changes and return to the Maintenance Tab, click **Apply**.  
**Caution:** *This does not save your changes.*
- To save your changes to the database, click **Save** on the Maintenance Tab.
- To cancel your changes and return to the Maintenance Tab, click **Cancel**.

### **2.7.2      Manage Database**

System Administrators can select five actions from the Manage Database Menu:

1. Control Access: Add or delete administrators. Use the Windows-authenticated logon domain/user name to identify the account.
2. Import: Import an XML file of application data to replace (overwrite) the current database.
3. Export: Export application data to an XML file to backup the current database.
4. Restore: Restore the database to its original (installed) state.
5. Change Location: Save the database to a new location. By default, Package Designer saves the database in the shared application data folder. This feature moves it to a different location, such a shared network folder for multi-user access.

When you select Import, Export, or Change Location, a pop-up window lets you browse to a location and enter or select a File Name. File Type defaults to .xml.

### **2.8      About Tab**

The About Tab displays information about the application. Scroll to view the contents.

### 3 Technical Specifications

This section covers the functional requirements, design, and build procedures. Package Designer 2.0 is a Windows client application, written in C#. Developers need a working knowledge of Microsoft Visual Studio, as well as a basic knowledge of software design and development.

#### 3.1 Background

Frontier Engineering, Inc. developed the original Package Designer (version 1.0) in Microsoft Access. CDO reverse engineered Package Designer and converted it to a Windows client application using Windows Presentation Foundation (WPF) for the UI and Extensible Markup Language (XML) to store the data.

#### 3.2 Functional Requirements

Table 2 lists the functional requirements as they relate to testing.

**Table 2: Requirements Traceability Matrix**

Number	Customer Requirement	Test Case
PD-01	Operable on 64-bit Windows Platforms	Customer Acceptance
PD-02	Deliver Application Installer	Customer Acceptance
PD-03	Design Cushioning	PD-4, PD-6, PD-7
PD-04	Peak Acceleration	PD-5
PD-05	Edit Container Material	
PD-06	Edit Container Types	
PD-07	Edit Cushion Materials	
PD-08	Edit Drop Height	
PD-09	Edit Transportation Types	
PD-10	Edit Equations	
PD-11	About Screen	
PD-12	Save and Load Designs	PD-1
PD-13	Export/Import Database	

### 3.3 Distribution Disk

The Package Designer distribution disk contains the complete software project folder, including source code, unit test code, test data, and intermediate files generated by the compiler and used by the development environment (Table 3). Each source code file contains a statement of ownership, along with reproduction and distribution instructions. Copy the entire distribution disk to a folder on the target system.

**Table 3: Distribution Disk Directories**

Directories	Contents
Code\PackageDesigner\PackageDesigner	PD project source code (UI)
Code\PackageDesigner\PD Installer	MSI installer project source files
Code\PackageDesigner\UnitTest	Unit test project source code
Code\PackageDesigner\UnitTest\TestData	Data required to conduct tests
Code\PackageDesigner\PackageDesigner\Data	PD data object classes source code (Data Layer)
Code\PackageDesigner\PD Installer Custom Actions	Actions installer uses to set database access privileges
Code\PackageDesigner\packages	External software libraries required to build PD
Code\PackageDesigner\bin\Release	Location of PD application executable
Code\PackageDesigner\PD Installer\bin\Release	Location of production MSI installer
Curve Data	Digitized curve data and input files used to generate them. Sub-folders break down information by cushion material
Documentation\Correspondence	Communications between developers and customer
Documentation\Deliverables	Location of Package Designer Software Manual
Documentation\Design	Design information
Documentation\Old Application	Copy of original Package Designer software
Documentation\References	Reference material
Documentation\Requirements	Project requirements
Documentation\Test Cases	PD Test cases
Documentation\Test Data	Data to verify test results
Software	Copy of software used to digitize graphs

#### 3.3.1 Application Source Code

Table 4 lists the files in the folder Code\PackageDesigner required to build the Package Designer Application.

**Table 4: Application Source Code Files**

File Name	Comments
PackageDesigner.sln	MS Visual Studio solution file
PackageDesigner\app.config	Application configuration information
PackageDesigner\App.xaml	Application design and code behind files

<b>File Name</b>	<b>Comments</b>
PackageDesigner\App.xaml.cs	
PackageDesigner\Converters.cs	WPF UI converter classes
PackageDesigner>EditEquationWindow.xaml	UI and code behind to edit acceleration curve data
PackageDesigner>EditEquationWindow.xaml.cs	
PackageDesigner\MainWindow.xaml	
PackageDesigner\MainWindow.xaml.cs	Main window UI and code-behind
PackageDesigner\PackageDesigner.csproj	MS Visual Studio project file
PackageDesigner\packages.config	NuGet packages configuration file
PackageDesigner\pd.ico	PD data file icon
PackageDesigner\pd_app.ico	PD application icon
PackageDesigner\Product.cs	Product attribute class used by About Tab
PackageDesigner\DetailReportWindow.xaml	
PackageDesigner\DetailReportWindow.xaml.cs	Solution Detail Report UI and code-behind
PackageDesigner\SortAdorner.cs	Class to provide sort direction to column headers
PackageDesigner\Units.cs	Class to hold unit conversion constants
PackageDesigner\Controls\AboutTabContent.xaml	
PackageDesigner\Controls\AboutTabContent.xaml.cs	About Tab UI and code-behind
PackageDesigner\Controls\CushionDesignTabContent.xaml	
PackageDesigner\Controls\CushionDesignTabContent.xaml.cs	Cushion Design tab UI and code-behind
PackageDesigner\Controls\MaintenanceTabContent.xaml	
PackageDesigner\Controls\MaintenanceTabContent.xaml.cs	Maintenance Tab UI and code-behind
PackageDesigner\Controls\PeakAccelerationTabContent.xaml	
PackageDesigner\Controls\PeakAccelerationTabContent.xaml.cs	Peak Acceleration Tab UI and code-behind
PackageDesigner\Data\Admins.cs	Class for accessing Administrator data
PackageDesigner\Data\AnalysisResults.cs	Class to hold analysis results
PackageDesigner\Data\ContainerMaterial.cs	Class for accessing Container Materials
PackageDesigner\Data\ContainerType.cs	Class for accessing Container Types
PackageDesigner\Data\CostFactor.cs	Class for accessing default Cost Factors
PackageDesigner\Data\CushionDesignType.cs	Class for accessing Cushion Design Types
PackageDesigner\Data\CushionMaterial.cs	Class for accessing Cushion Materials
PackageDesigner\Data\Equation.cs	Class for accessing Acceleration Curve data
PackageDesigner\Data\ExistingDesign.cs	Class for accessing Package Design information
PackageDesigner\Data\Solution.cs	Class to hold valid design solution
PackageDesigner\Data\TransportationType.cs	Class for accessing Transportation Types
PackageDesigner\Examples\Antenna.pdxml	
PackageDesigner\Examples\ComputerMonitor.pdxml	Sample design files
PackageDesigner\Examples\Gyro.pdxml	

<b>File Name</b>	<b>Comments</b>
PackageDesigner\Examples\Missle.pdxml	
PackageDesigner\Help\About.htm	About Tab Help
PackageDesigner\Help\CushionDesign.htm	Cushion Design Tab Help
PackageDesigner\Help>EditEquation.htm	Edit Acceleration data Screen Help
PackageDesigner\Help\GeneralMain.htm	Basic application help
PackageDesigner\Help\help.css	Help page style sheet
PackageDesigner\Help\HelpProvider.cs	WPF help integration class
PackageDesigner\Help\Home.htm	Help default page
PackageDesigner\Help\Index.hhk	Help index file
PackageDesigner\Help\Maintenance.htm	Maintenance Tab Help
PackageDesigner\Help\ManageGraphs.htm	OxyPlot Graph Help
PackageDesigner\Help\pd logo.png	Small PD Logo
PackageDesigner\Help\pd.chm	Compiled help file
PackageDesigner\Help\pd.chw	Help configuration file
PackageDesigner\Help\pd.hhp	Help configuration file
PackageDesigner\Help\PeakAcceleration.htm	Peak Acceleration Help
PackageDesigner\Help\SolutionDetail.htm	Solution Detail Window Help
PackageDesigner\Help\Table of Contents.hhc	Help table of contents configuration
PackageDesigner\Licenses\EULA.rtf	Package Designer End User License
PackageDesigner\Licenses\OxyPlot - License.pdf	OxyPlot License
PackageDesigner\Properties\AssemblyInfo.cs	Assembly properties (these are displayed in the About Tab via Product.cs)
PackageDesigner\Properties\Resources.Designer.cs	Application resource information
PackageDesigner\Properties\Resources.resx	
PackageDesigner\Properties\Settings.Designer.cs	
PackageDesigner\Properties\Settings.settings	Application settings
PackageDesigner\Resources\AFMC.png	AFMC Logo
PackageDesigner\Resources\AFPTEF.png	AFPTEF Logo from web site
PackageDesigner\Resources\AFSC.png	AFSC Logo
PackageDesigner\Resources\PD Logo.png	Large Package Designer Logo
PackageDesigner\Resources\PD.rtf	Owner information displayed in About Tab

### 3.3.2 *Installer Source Code*

Table 5 lists the files in the folder Code\PackageDesigner required to build the Package Designer Installer.

**Table 5: Installer Source Code Files**

File Name	Comments
PackageDesigner.sln	MS Visual Studio solution file
PD Installer\banner.bmp	Installer banner
PD Installer\PD Installer.vdproj	Installer project
PD Installer\splash.bmp	Installer splash screen
PD Installer Custom Actions\CustomActions.cs	Custom action to set database file access privileges
PD Installer Custom Actions\PD Installer Custom Actions.csproj	Visual Studio project file
PD Installer Custom Actions\Properties\AssemblyInfo.cs	Custom action DLL assembly properties

### 3.3.3 *Unit Test Source Code*

Table 6 lists the files in the folder Code\PackageDesigner required to build the Package Designer Unit Tests.

**Table 6: Unit Test Source Code Files**

File Name	Comments
PackageDesigner.sln	MS Visual Studio solution file
UnitTest\ContainerMaterial.cs	Container Material Tests
UnitTest\ContainerType.cs	Container Type Tests
UnitTest\CushionDesignType.cs	Cushion Design Type Tests
UnitTest\CushionMaterial.cs	Cushion Material Tests
UnitTest\Equation.cs	Equation Tests
UnitTest\ExistingDesign.cs	Existing Design Tests
UnitTest\packages.config	NuGet Package configurations
UnitTest\TransportationType.cs	Transportation Type Tests
UnitTest\UnitTest.csproj	Visual Studio project file
UnitTest\Properties\AssemblyInfo.cs	Project assembly info
UnitTest\TestData\Container Materials.xml	Default application data and test files
UnitTest\TestData\Container Types.xml	
UnitTest\TestData\Cushion Design Types.xml	
UnitTest\TestData\Cushion Materials.xml	
UnitTest\TestData\Equations.xml	
UnitTest\TestData\Existing Designs.xml	
UnitTest\TestData\Test Design.xml	

File Name	Comments
UnitTest\TestData\Transportation Types.xml	

### **3.4 Build Procedures**

Developers can modify the Package Designer source code and update the OxyPlot Library to support new or modified features. This section covers how to build the application and installer for testing or production after modifications.

#### **3.4.1 Required Tools**

Follow the manufacturer's instructions for full installation of each tool.

These tools are required to build and test the source code:

- Microsoft Visual Studio (VS) 2010 Professional – Include all C# features and libraries in the installation.
- HTML Help Workshop 1.3 – Download from <http://www.microsoft.com/en-us/download/details.aspx?id=21138>.
- NUnit v2.6 – The distribution disk includes the binaries. Download updates from <http://www.nunit.org>.
- OxyPlot – The distribution disk includes the binaries. Download updates from <http://oxyplot.codeplex.com>.

These tools are not required for build and test, but help with maintenance:

- Microsoft Word 2007 (or other word processor) to edit the copyright and owner information RTF file.
- NuGet – A Visual Studio extension to synchronize and update packages used within the application. Currently it manages NUnit and OxyPlot packages, ensuring the latest versions are installed. Download from <http://nuget.org>.
- SubVersion – An open-source source control and versioning system. Download from <http://subversion.apache.org>.

#### **3.4.2 Production Build**

Follow these steps to build the installer file:

1. Open the solution (PackageDesigner.sln) file. Visual Studio launches.
2. Select **Configuration Management | Release**. The project switches to Release Mode.
3. In the Solution Explorer Window, locate **PD x86 Project**, right-click on the project, and select **Build**. Visual Studio builds the application and installer, and places the file PackageDesigner.msi in the directory PD Installer Release.

### 3.4.3 Debug or Testing Build

Follow these steps to build a Windows-compatible test environment:

1. Open the solution (PackageDesigner.sln) file. Visual Studio launches.
2. Select **Configuration Management | Debug**. The project switches to Debug Mode.
3. Select **Build (top menu) | Rebuild Solution**. Visual Studio rebuilds the solution.
4. Run the Unit Tests in the NUnit GUI. These are not part of the distributed application, but are extremely useful for requirement verification and regression testing.

## 3.5 Application Files

This application consists of an executable file (.exe) with three library files (.dll). Building the source code creates these files. PackageDesigner.msi installs the files in Table 7. [PF] represents the default application program file directory and [PD] represents the shared application data directory. These will vary with the version of Microsoft Windows.

Table 7: Installed Files

File Name	Comments
<b>Application</b>	
[PF]/ AFPTEF/PackageDesigner/PackageDesigner.exe	Main program
[PF]/ AFPTEF/PackageDesigner/OxyPlot.dll	OxyPlot Core Library
[PF]/ AFPTEF/PackageDesigner/OxyPlot.Wpf.dll	OxyPlot Visual Library
[PF]/ AFPTEF/PackageDesigner/OxyPlot.Xps.dll	OxyPlot Printing Library
[PF]/ AFPTEF/PackageDesigner/pd.ico	Package Designer Icon
[PF]/ AFPTEF/PackageDesigner/EULA.rtf	PD End User License Agreement
[PF]/ AFPTEF/PackageDesigner/Licenses/EULA.rtf	PD End User License Agreement (copy)
[PF]/ AFPTEF/PackageDesigner/Licenses/OxyPlot - License.pdf	MIT License used by OxyPlot
[PF]/ AFPTEF/PackageDesigner/banner.bmp	Banner used by installer
[PF]/ AFPTEF/PackageDesigner/splash.bmp	Splash screen used by installer
<b>Data</b>	
[PF]/AFPTEF/PackageDesigner/Init/Container Materials.xml	Installer-provided data. File names are self-explanatory. Use to reset the data to the original state if desired.
[PF]/AFPTEF/PackageDesigner/Init/Container Types.xml	
[PF]/AFPTEF/PackageDesigner/Init/Cushion Design Types.xml	
[PF]/AFPTEF/PackageDesigner/Init/Cushion Materials.xml	
[PF]/AFPTEF/PackageDesigner/Init/Equations.xml	
[PF]/AFPTEF/PackageDesigner/Init/	

File Name	Comments
[PD]/AFPTEF/PackageDesigner/Container Materials.xml	
[PD]/AFPTEF/PackageDesigner/Container Types.xml	
[PD]/AFPTEF/PackageDesigner/Cushion Design Types.xml	
[PD]/AFPTEF/PackageDesigner/Cushion Materials.xml	Production data files. File names are self explanatory.
[PD]/AFPTEF/PackageDesigner/Equations.xml	System Administrators can modify from the Maintenance Tab.
[PD]/AFPTEF/PackageDesigner/Admin.dat	
[PF]/AFPTEF/PackageDesigner/Examples	

### 3.6 Data Flow and Data Files

Package Designer copies the data files to the local machine during installation. Users can back them up to a temporary storage device or move them to another system. They can also restore the data files to their original state by uninstalling and reinstalling the application. See section 2.2 *Installing the Application* for details.

System Administrators can configure the application to save the files a network folder where multiple users can share them. They can also edit and/or restore the data files from the Maintenance Tab. See section 2.7 *Maintenance Tab* for details.

#### 3.6.1 Data Flow

Figure 16 shows the basic data flow and processing within Package Designer.

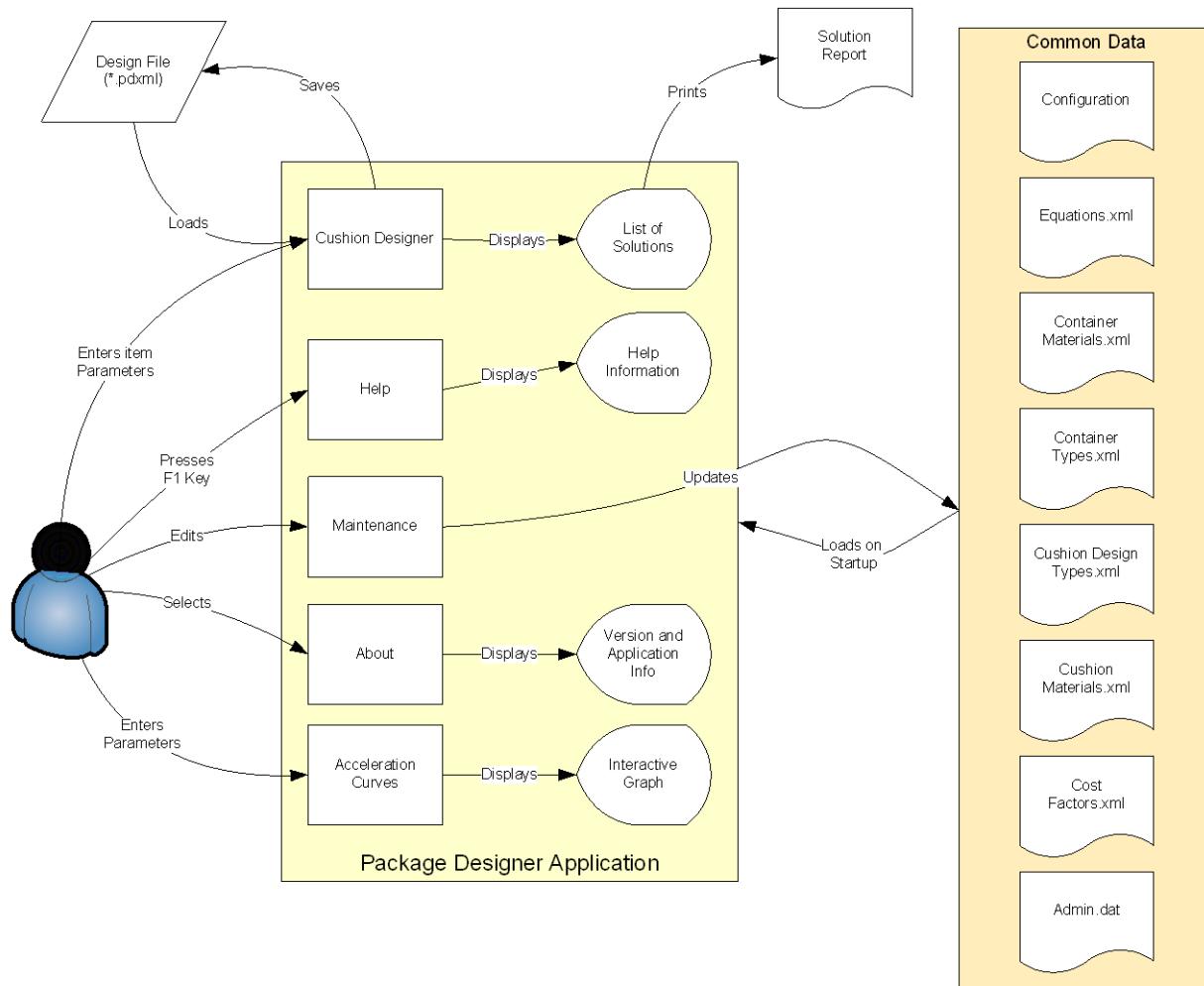


Figure 16: Package Designer Data Flow

Figure 17 shows the data input and output relationships.

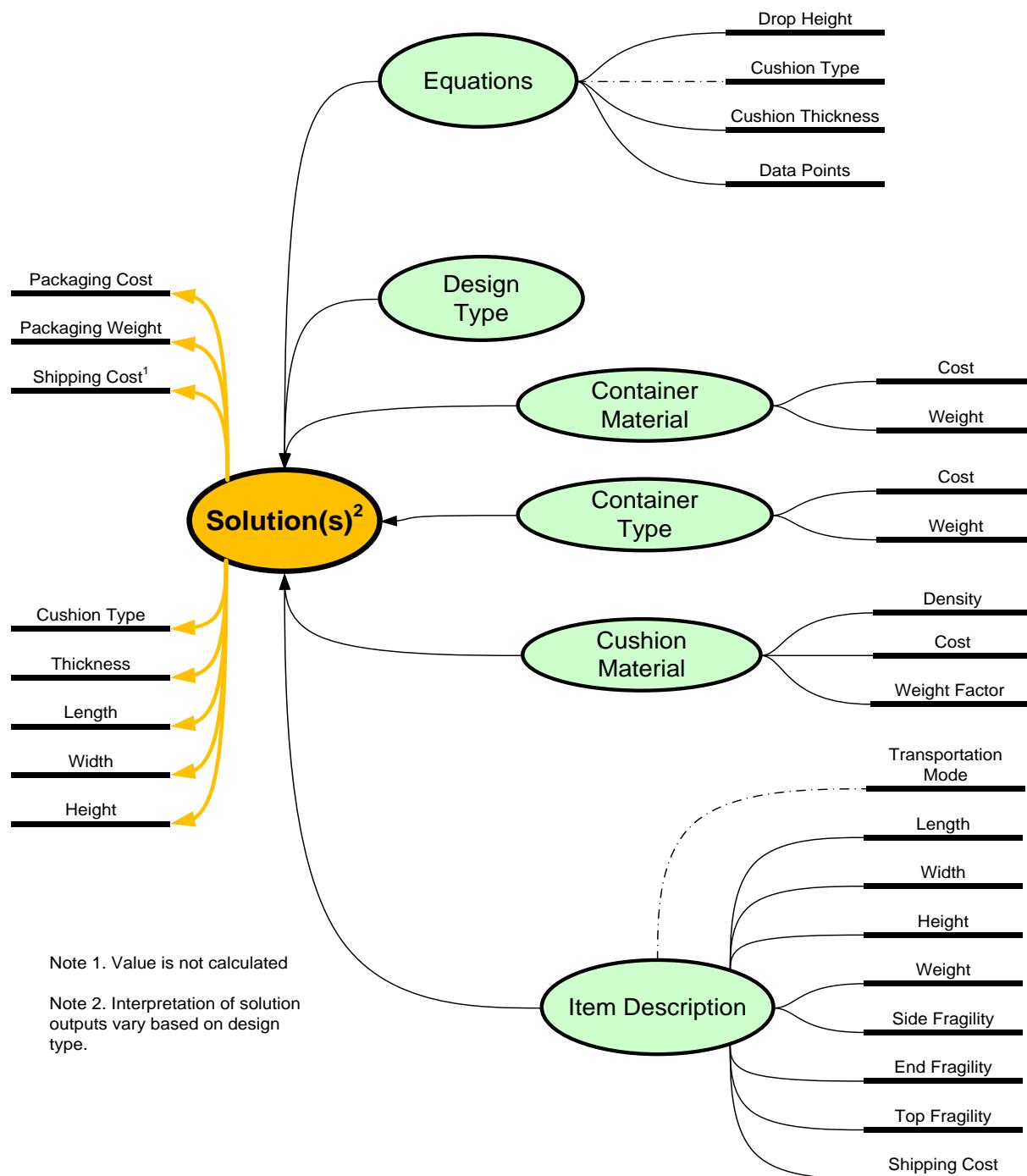
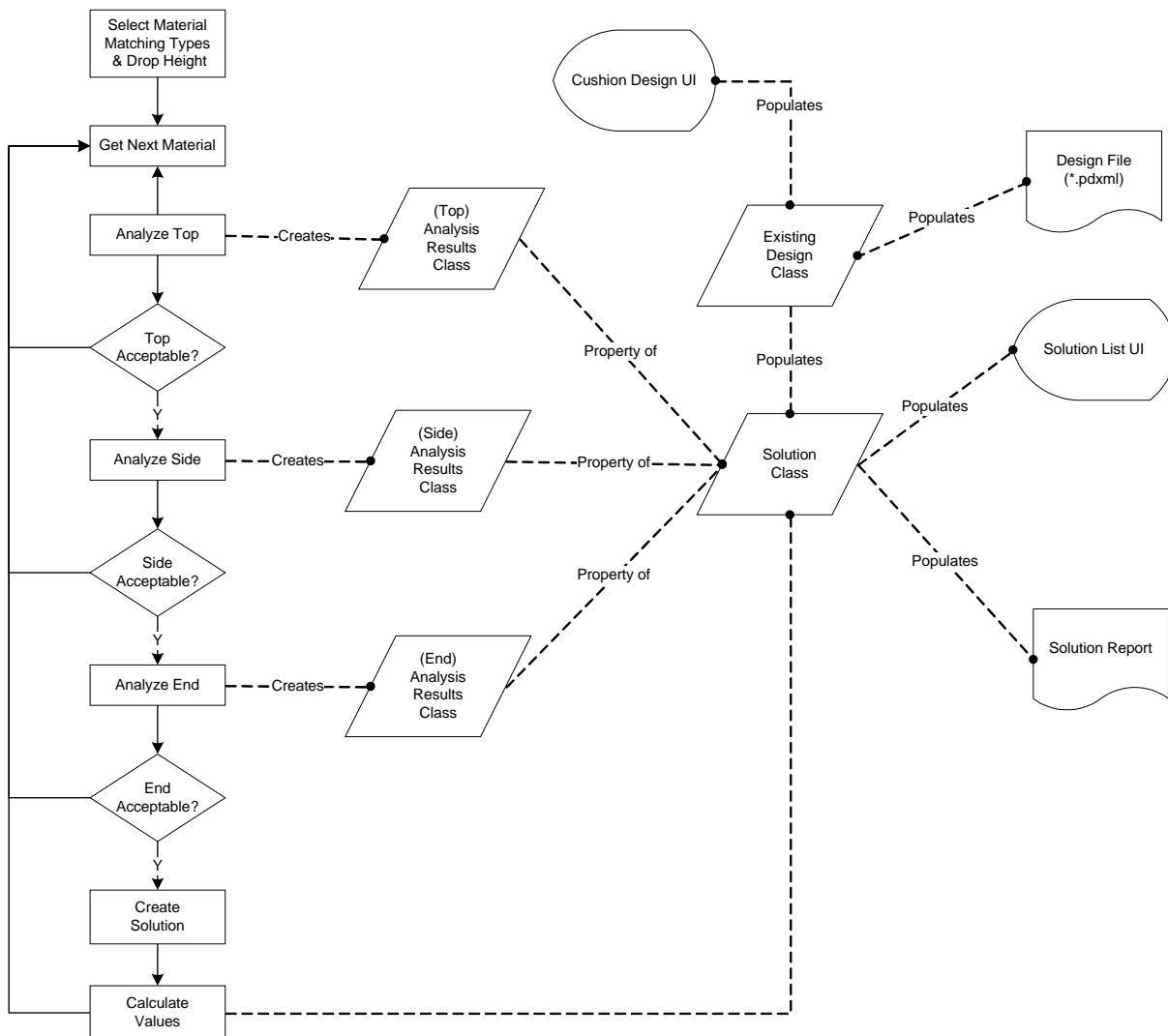


Figure 17: Package Designer Input and Output

Figure 18 shows the design process.



**Figure 18: Package Designer Design Process**

### 3.6.2 Data File Formats

Package Designer 2.0 stores data in XML version 1.0 formatted files. This format is easily ported between modern computer systems and over the Internet. It also eliminates the need for a separate database server. Each file contains a root element with one or more child elements. Each child element has a single attribute—*id*—a unique number identifying the element. The application does not check or rely on the order of the elements within a node. Figure 19 shows the relationships between the files.

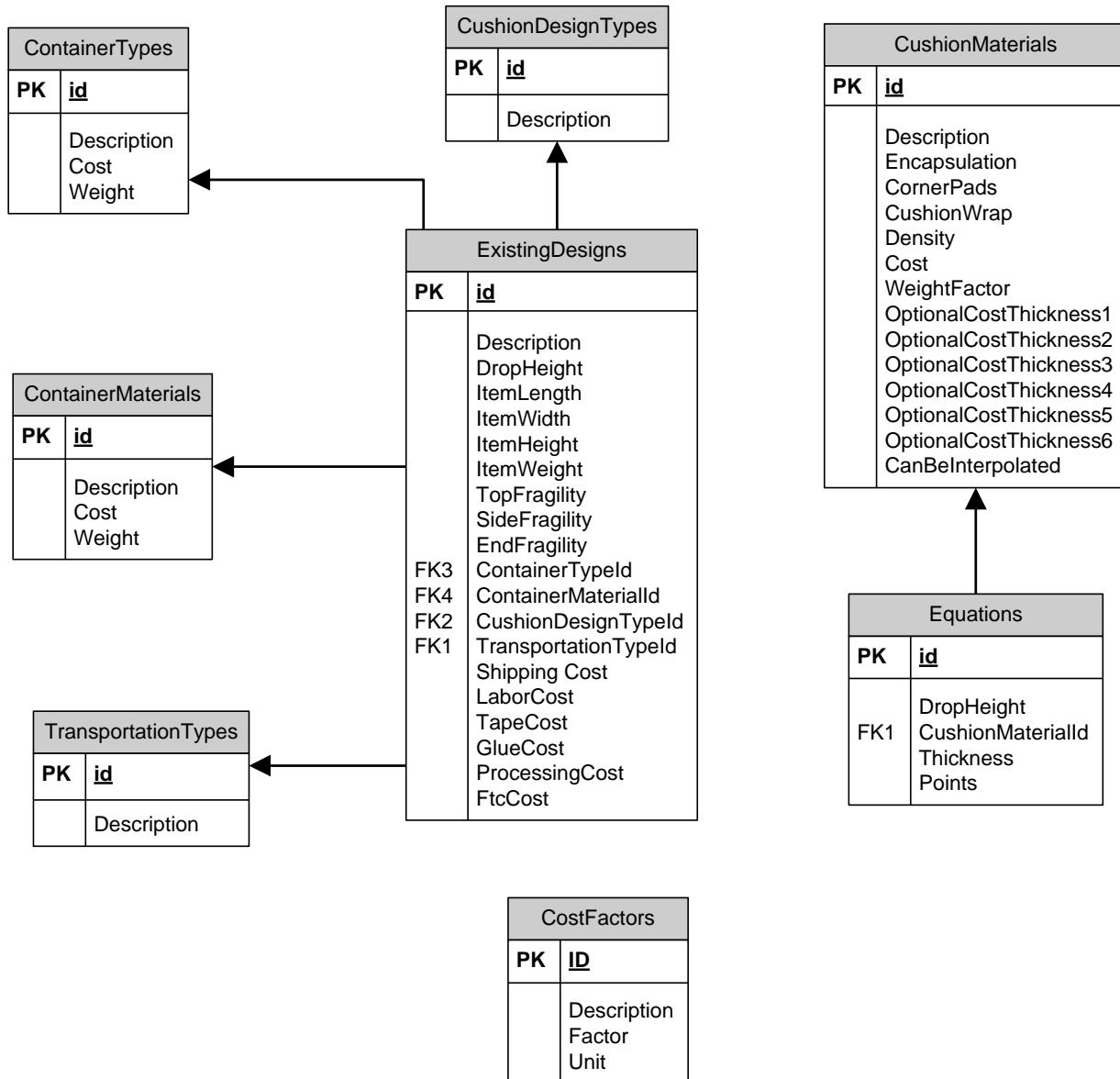


Figure 19: Data Relationships

### 3.6.2.1 *Cushion Design Types*

Table 8 describes the CushionDesignType Node elements and values.

- File Name: cushion design types.xml
- Root Element Name: CushionDesignTypes
- Child Element Name: CushionDesignType

**Table 8: CushionDesignType Node XML Elements**

Element Name	Units of Measure	Description
Description	n/a	Textual description of the cushion design type

Example of a minimal cushion design type XML document.

```
<?xml version="1.0" encoding="UTF-8"?>
<CushionDesignTypes>
    <CushionDesignType id="1">
        <Description>Complete Encapsulation</Description>
    </CushionDesignType>
</CushionDesignTypes>
```

### 3.6.2.2 *Container Materials*

Table 9 describes the ContainerMaterial Node elements and values.

- File Name: container materials.xml
- Root Element Name: ContainerMaterials
- Child Element Name: ContainerMaterial

**Table 9: ContainerMaterial Node XML Elements**

Element Name	Units of Measure	Description
Description	n/a	Textual description of the container material
Cost	USD/Cu. Ft.	Cost per unit of material
Weight	Lbs/Cu. Ft.	Weight per unit of material

Example of a minimal container material XML document.

```
<?xml version="1.0" encoding="UTF-8"?>
<ContainerMaterials>
    <ContainerMaterial id="1">
        <Description>Single Wall V3C</Description>
        <Cost>0.0762</Cost>
        <Weight>0.22</Weight>
    </ContainerMaterial>
</ContainerMaterials>
```

### **3.6.2.3 Container Types**

Table 10 describes the ContainerType Node elements and values.

- File Name: container types.xml
- Root Element Name: ContainerTypes
- Child Element Name: ContainerType

**Table 10: ContainerType Node XML Elements**

Element Name	Units of Measure	Description
Description	n/a	Textual description of the container type
Cost	USD/Cu. Ft.	Cost per unit for type
Weight	Lbs/Cu. Ft.	Weight per unit of type

Example of a minimal container type XML document.

```
<?xml version="1.0" encoding="UTF-8"?>
<ContainerTypes>
    <ContainerType id="1">
        <Description>RSC</Description>
        <Cost>0.08</Cost>
        <Weight>0.32</Weight>
    </ContainerType>
</ContainerTypes>
```

### **3.6.2.4 Cushion Materials**

Table 11 describes the CushionMaterial Node elements and values.

- File Name: cushion materials.xml
- Root Element Name: CushionMaterials
- Child Element Name: CushionMaterial

**Table 11: CushionMaterial Node XML Elements**

Element Name	Units of Measure	Description
Description	n/a	Textual description of the cushion material
Encapsulation	n/a	Indicates whether or not the material can be used for complete encapsulation; 1 = true, 0=false.
CornerPads	n/a	Indicates whether or not the material can be used as corner padding1 = true, 0=false.
CushionWrap	n/a	Indicates whether or not the material can be used as cushion wrap1 = true, 0=false.
Density	Lbs. / Cu. Ft.	Density per unit of material
Cost	USD/Cu. Ft.	Cost per unit of material
Weight Factor	USD/lb	Weight factor for the material
OptionalCostThickness1	USD/Cu. Ft.	Cost per unit for 1" of material
OptionalCostThickness2	USD/Cu. Ft.	Cost per unit for 2" of material
OptionalCostThickness3	USD/Cu. Ft.	Cost per unit for 3" of material
OptionalCostThickness4	USD/Cu. Ft.	Cost per unit for 4" of material
OptionalCostThickness5	USD/Cu. Ft.	Cost per unit for 5" of material
OptionalCostThickness6	USD/Cu. Ft.	Cost per unit for 6" of material
CanBeInterpolated	n/a	Indicates whether or not the selected curve can be interpolated for the material1 = true, 0=false.

Example of a minimal cushion material XML document.

```
<?xml version="1.0" encoding="UTF-8"?>
<CushionMaterials>
    <CushionMaterial id="1">
        <Description>Polyurethane-Ether 1.5 lb/cubic
ft.</Description>
        <Encapsulation>1</Encapsulation>
        <CornerPads>1</CornerPads>
        <CushionWrap>1</CushionWrap>
        <Density>1.5</Density>
        <Cost>0.1959</Cost>
        <WeightFactor>1.5</WeightFactor>
        <OptionalCostThickness1></OptionalCostThickness1>
        <OptionalCostThickness2></OptionalCostThickness2>
        <OptionalCostThickness3></OptionalCostThickness3>
        <OptionalCostThickness4></OptionalCostThickness4>
        <OptionalCostThickness5></OptionalCostThickness5>
        <OptionalCostThickness6></OptionalCostThickness6>
        <CanBeInterpolated>1</CanBeInterpolated>
    </CushionMaterial>
</CushionMaterials>
```

### **3.6.2.5 *Transportation Types***

Table 12 describes the *TransportationType* Node elements and values.

- File Name: transportation types.xml
- Root Element Name: TransportationTypes
- Child Element Name: *TransportationType*

**Table 12: *TransportationType* Node XML Elements**

Element Name	Units of Measure	Description
Description	n/a	Textual description of the transportation type

Example of a minimal transportation type XML document.

```
<?xml version="1.0" encoding="UTF-8"?>
<TransportationTypes>
    <TransportationType id="1">
        <Description>Commercial Air</Description>
    </TransportationType>
</TransportationTypes>
```

### 3.6.2.6 Equations

Table 13 describes the Equation Node elements and values.

- File Name: equations.xml
- Root Element Name: Equations
- Child Element Name: Equation

**Table 13: Equation Node XML Elements**

Element Name	Units of Measure	Description
DropHeight	Inches	Measured height of drop
CushionMaterialId	n/a	Identity of cushion material (see TBD)
Thickness	Inches	Thickness of cushion
Points	PSI, G	Collection of X,Y data points describing the material's peak acceleration for the given drop height. A minimum of three points are required.

Example of a minimal equation XML document.

```
<?xml version="1.0" encoding="UTF-8"?>
<Equations>
    <Equation id="1">
        <DropHeight>12</DropHeight>
        <CushionMaterialId>1</CushionMaterialId>
        <Thickness>1</Thickness>
        <Points>
            0.002,37;
            0.010,39.1;
            0.20,43.6
        </Points>
    </Equation>
</Equations>
```

### 3.6.2.7 Cost Factors

Table 14 describes Cost Factors node elements and values. These cost factors are the default (initial) values for new designs. The application depends on the existence of all five nodes, id's 1-5. Changing the units in this file will not change the interpretation.

- File Name: cost factors.xml
- Root Element Name: CostFactors
- Child Element Name: CostFactor

**Table 14: CostFactors Node XML Elements**

Element Name	Units of Measure	Description
Description	n/a	Textual description of the factor
Factor	n/a	The numerical value of the factor
Unit	n/a	Textual description of the unit of measure for this factor

Example of a minimal cost factors type XML document.

```
<?xml version="1.0" encoding="UTF-8"?>
<CostFactors>
    <CostFactor id="1">
        <Description>Labor Cost</Description>
        <Factor>4.482</Factor>
        <Unit>$/hr</Unit>
    </CostFactor>
    <CostFactor id="2">
        <Description>Tape Cost</Description>
        <Factor>0.039</Factor>
        <Unit>$/yd</Unit>
    </CostFactor>
    <CostFactor id="3">
        <Description>Processing Cost</Description>
        <Factor>0.00062</Factor>
        <Unit>$/in</Unit>
    </CostFactor>
    <CostFactor id="4">
        <Description>Glue Cost</Description>
        <Factor>0.0011</Factor>
        <Unit>$/in</Unit>
    </CostFactor>
    <CostFactor id="5">
        <Description>FTC Processing Cost</Description>
        <Factor>0.045</Factor>
        <Unit>$</Unit>
    </CostFactor>
</CostFactors>
```

### 3.6.3 *Formulas*

Package Designer uses the following formulas to calculate the cost of a design. These formulas are based on two basic container designs: Regular Slotted Container (RSC) and Fully Telescoping Container (FTC).

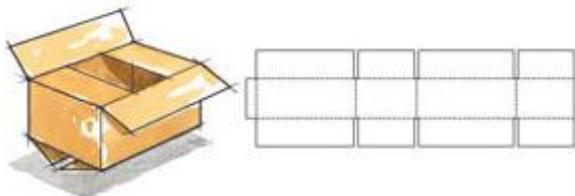


Figure 20: RSC Container

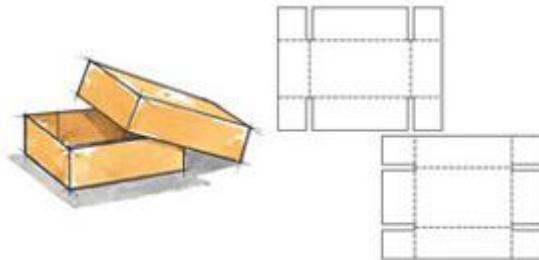


Figure 21: FTC Container

#### 3.6.3.1 *Cushion Cutting Cost*

This appears to be a power-curve law. Values appear to be on low side, especially if foam needs to be cut to correct thickness.

$$L \times 0.231 \times S \text{ } 0.4955$$

- L = Labor Rate in \$ per minute
- S = Surface area of container in square feet

#### 3.6.3.2 *RSC Container Tape Cost*

This allows for one long piece of tape along the center of the container to hold the length-wise flaps together and two shorter pieces of tape to hold the short edges of the length-wise flaps down to the ends of the of the container. The entire value is multiplied by two to tape top and bottom.

$$2 \times [(C_L + 6) + 2 \times (C_W + 6)] \times T \div 36$$

- T = Cost of tape in \$/yard
- C<sub>L</sub> = Container length in inches
- C<sub>W</sub> = Container width in inches

#### 3.6.3.3 *FTC Container Tape Cost*

This allows for a single piece of tape to completely wrap around the container with a two-inch overlap.

$$2 \times (C_L + C_W + 2) \times T \div 36$$

- T = Cost of tape in \$/yard
- C<sub>L</sub> = Container length in inches
- C<sub>W</sub> = Container width in inches

**3.6.3.4 Container Closing Cost**

Package Designer only applies closing cost if  $A \geq 150$ .

$$L \times (1.4334 + 0.0026 \times A)$$

- $L$  = Labor rate in \$ per minute
- $A$  = Surface area of container in square inches

**3.6.3.5 RSC Container Cost**

This is the combined cost of materials for an RSC container. Section (a) calculates the area of the container materials; (b) cutting cost; (c) scoring/folding cost; (d) cost of glue.

$$\begin{aligned} & 2 \times (C_W + C_H) \times (C_L + C_W + 1) \times M \div 144 & (a) \\ & + 2 \times (2 \times C_L + 5 \times C_W + C_H + 4) \times P & (b) \\ & + 4 \times (C_L + C_W + C_H) \times P & (c) \\ & + (C_H - 1) \times B + 2 \times (C_W - 2) \times B & (d) \end{aligned}$$

- $C_L$  = Container length in inches
- $C_H$  = Container height in inches
- $C_W$  = Container width in inches
- $M$  = Cost per cubic foot of RSC container material
- $P$  = Processing cost \$/inch
- $B$  = Cost of glue bead \$/inch

**3.6.3.6 FTC Container Cost**

This is the combined cost of materials for an FTC container. Section (a) calculates the area of the container materials; (b) cutting cost; (c) scoring/folding cost; (d) a fixed cost for gluing/stapling container and cover.

$$\begin{aligned} & 2 \times (C_L + 2 \times C_H) \times (C_W + 2 \times C_H) \times M \div 144 & (a) \\ & + 4 \times (C_W + C_L + 6 \times C_H) \times P & (b) \\ & + 4 \times (C_L + C_W) \times P & (c) \\ & + 0.045 & (d) \end{aligned}$$

- $C_L$  = Container length in inches
- $C_H$  = Container height in inches
- $C_W$  = Container width in inches
- $M$  = Cost per cubic foot of FTC Container Material

### 3.6.3.7 Corner Padding

Corner padding uses eight cushions to hold the item within the container. Each corner pad is a cube with a rectangular section removed.

Some important relationships exist:

- $EW = SW$
- Top/bottom cushioning surface is square

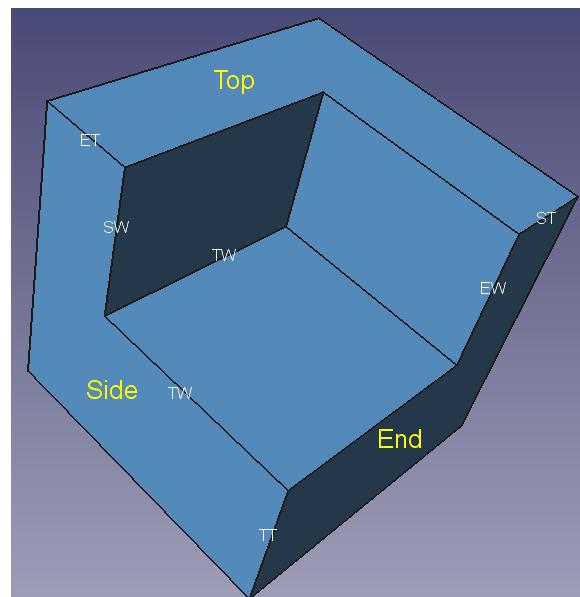


Figure 22: Corner Pad

### 3.6.3.8 Complete Encapsulation

This method uses six cushions to fully enclose the item. The ends enclose the sides. The top and bottom are enclosed within the ends and sides.

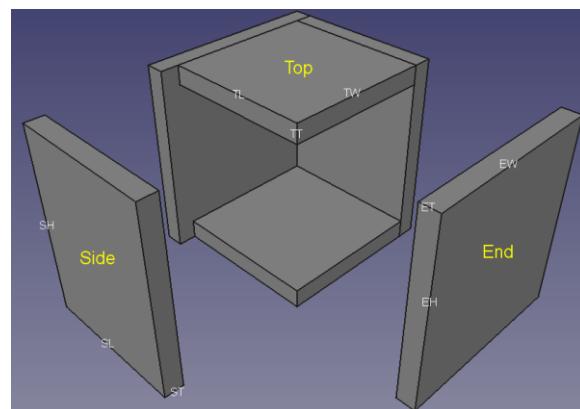


Figure 23: Complete Encapsulation

## Appendix A. Glossary of Terms

Table 15 provides definitions of abbreviations, acronyms, and terms used in this report.

**Table 15: Abbreviations, Acronyms, and Terms**

Term	Definition
AFPTEF	Air Force Packaging Technology and Engineering Facility
CDO	CDO Technologies, Inc.
DB	Database
DoD	Department of Defense
Engauge	A free digitizing tool.
FTC	Full Telescoping Container
G	An acceleration equal to the acceleration of gravity, 980.665 centimeter per second squared, approximately 32.2 feet per second per second at sea level; used as a unit of stress measurement for bodies undergoing acceleration.
NUnit	NUnit is a unit-testing framework for all Microsoft .Net languages.
MSI	Microsoft Installer – Used to install programs on Microsoft Windows platforms.
PD	Package Designer
PSI	Pounds per Square Inch or Pound-Force per Square Inch – A measure of pressure or stress. The pressure resulting from a force of one pound-force applied to an area of one square inch. ( <i>Wikipedia</i> )
RSC	Regular Slotted Container
RTF	Rich Text Format - A document file standard developed by Microsoft.
UI	User Interface – Also called Graphical User Interface (GUI).
VBA	Visual Basic for Applications
VS	Microsoft Visual Studio
WPF	Windows Presentation Foundation – Provides developers with a unified programming model for building rich Windows smart client user experiences that incorporate UI, media, and documents.
XAML	Extensible Application Markup Language – A declarative markup language. XAML simplifies creating a UI for a .NET Framework application.
XML	Extensible Markup Language – A specification developed by the W3C. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.
WPAFB	Wright Patterson Air Force Base

AFPTEF



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