LUSAS Programmable Interface (LPI) Developer Guide

LUSAS Version 15.2 : Issue 1

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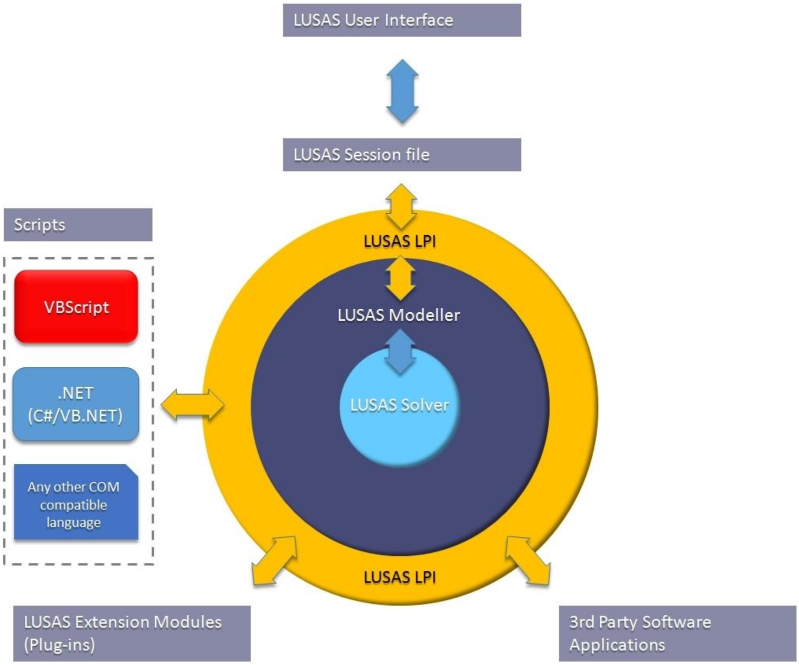
Table of Contents

Introduction

Introduction

LUSAS software is highly customisable. The built-in LUSAS Programmable Interface (LPI) allows the customisation and automation of modelling and results processing tasks and creation of user-defined menu items, dialogs and toolbars as a means to access those user-defined resources. It can also be used for transferring data between LUSAS and other software applications, and to control other programs from within LUSAS Modeller, or control LUSAS Modeller from other programs.



With LPI, any user can automate the creation of complete structures, either in LUSAS or from third-party software, carrying out design checks, optimising members and outputting graphs, spreadsheets of results and custom reports. Because everything carried out by a user is recorded in a LUSAS Modeller session file, anything that LUSAS can do, can also be controlled by another application via the LUSAS Programmable Interface. This means that you can view and edit a recorded session, parameterise those commands, turn them into sub-routines, add loops and other functions to the scripts and create a totally different application or program - using the proven core technology of LUSAS.

In addition to the accessing and customising LUSAS Modeller via the LUSAS Programmable Interface, user-defined material models (written in Fortran) can be compiled and built into a customised LUSAS Solver executable by using the LUSAS Material Model Interface (LUSAS MMI).

Topics covered in this guide

The aim of this guide is to help you use the more advanced facilities available to customise LUSAS and interface with other applications. The guide covers:

- ❑ **Creating dialogs using VB.NET**
- ❑ **LUSAS via COM**
- ❑ **LUSAS Material Model Interface**

LPI Customisation and Automation Guide

A separate LPI Customisation and Automation Guide is also available covering more basic topics:

- ❑ **Getting started with the LUSAS Programmable Interface (LPI)**
- ❑ **Identifying LPI Functions**
- ❑ **Customising the interface**
- ❑ **Getting started with VBS**
- ❑ **A simple example script**
- ❑ **Creating your own menus**

Creating dialogs using VB.NET

A dialog is a window that appears on the display screen to neatly present information or request input from the user. Creating dialogs, and some other advanced features, such as object oriented programming, is a more advanced topic, and some programming skills are required.

VBScript belongs to the group of interpreted languages, meaning that there is no need for compilers to be used. This is because the implementations execute directly, line by line. Examples of other interpreted languages are JavaScript, Python and Perl.

To create a dialog you will need to use a compiled programming language. Examples of compiled languages are Visual Basic .NET (VB .NET), C#, Java, C++. For this example VB.NET will be used, because although it is a different language to VBScript, it uses the same syntax, and you should be already familiar with it. Also, and more importantly, you do not need to be familiar with COM programming, as you would if C++ was used instead.

Advantages of VB.NET over VBScript include

- Better user-interface creation
- Debugging with break points
- More extensible. Allows Object Oriented Programming (OOP)
- Multiple functions saved into one .dll file. Easier to share across the company than multiple .vbs script files
- Easier to do testing

Choosing a development environment

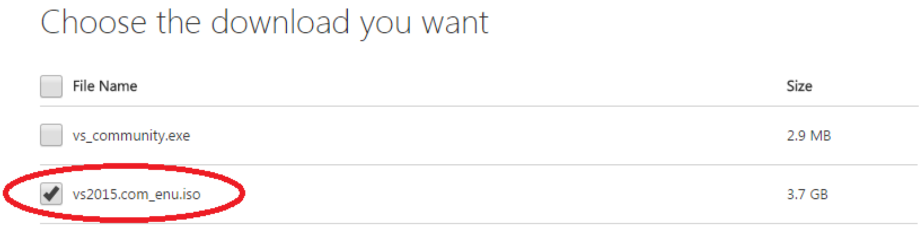
To use VB.NET a compiler needs to be installed. Both Visual Studio Express and Visual Studio Community are free to use and could be used but the **Visual Studio Community** edition, which is a fully featured and extensible Integrated Development Environment (IDE) is the application recommended by LUSAS and the application that is documented in this guide. This is used in preference to the more limited Visual Studio Express version, which is a closed IDE that cannot use any Visual Studio extensions.

Visual Studio Community is free for individual developers, open source projects, academic research, education, and small professional teams. Users should be aware of the licensing terms under which it is supplied.

Downloading and installing Visual Studio Community

Visual Studio Community is free to use and can be downloaded from:

https://www.microsoft.com/en-us/download/details.aspx?id=48146



Choose the download you want

□ File Name	Size
□ vs_community.exe	2.9 MB
☑ vs2015.com_enu.iso	3.7 GB

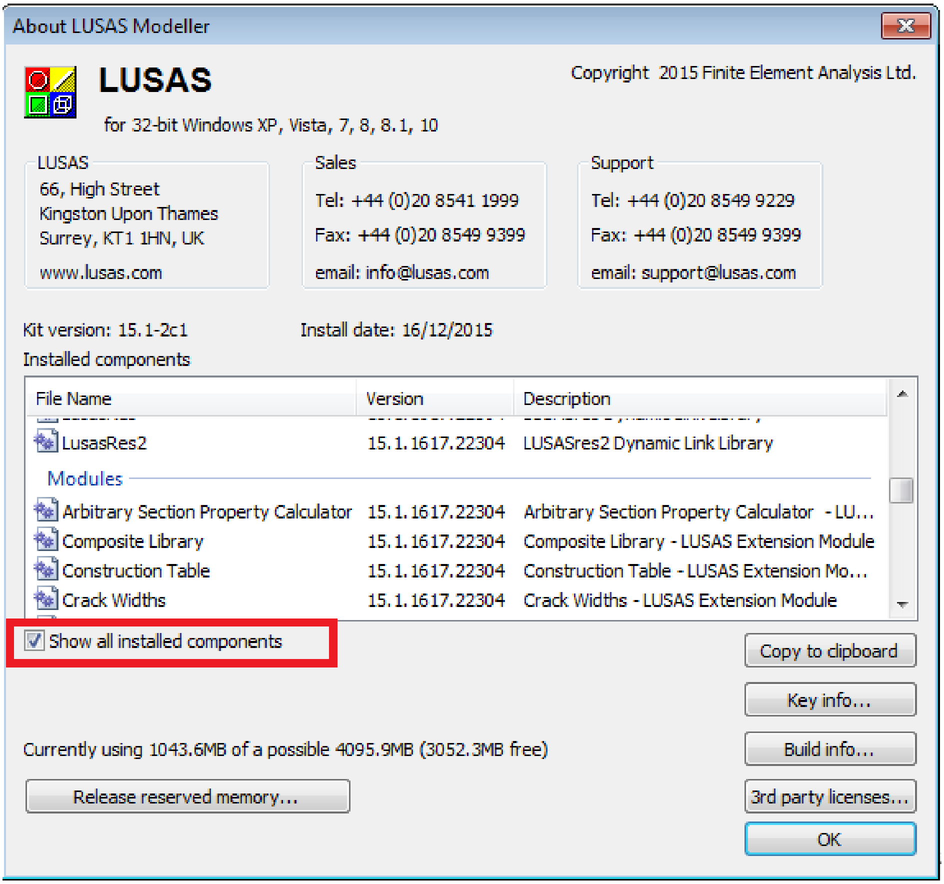
Note. Problems can be experienced when installing Visual Studio Community from a downloaded exe file (relating to the installation being unable to locate the package source as a result of you attempting to install the software when you are part of a company network). To overcome this issue, download the .iso file instead and burn it onto a DVD. Then install it from the DVD (or alternatively virtually mount the iso image).

Visual Studio Community can take a long time to install.

Creating a LUSAS dialog

To create a LUSAS dialog, you will need to add a new **Module** to LUSAS. Modules are like plugins.

1. Run LUSAS.
2. All the installed modules can be seen by selecting the menu item **Help** > **About LUSAS Modeller** and checking **"Show all installed components"**



About LUSAS Modeller

LUSAS

Copyright 2015 Finite Element Analysis Ltd.

for 32-bit Windows XP, Vista, 7, 8, 8.1, 10

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email: support@lusas.com

Kit version: 15.1-2c1

Install date: 16/12/2015

Installed components

File Name	Version	Description
LusasRes2	15.1.1617.22304	LUSASres2 Dynamic Link Library
Modules		
Arbitrary Section Property Calculator	15.1.1617.22304	Arbitrary Section Property Calculator - LU...
Composite Library	15.1.1617.22304	Composite Library - LUSAS Extension Module
Construction Table	15.1.1617.22304	Construction Table - LUSAS Extension Mo...
Crack Widths	15.1.1617.22304	Crack Widths - LUSAS Extension Module

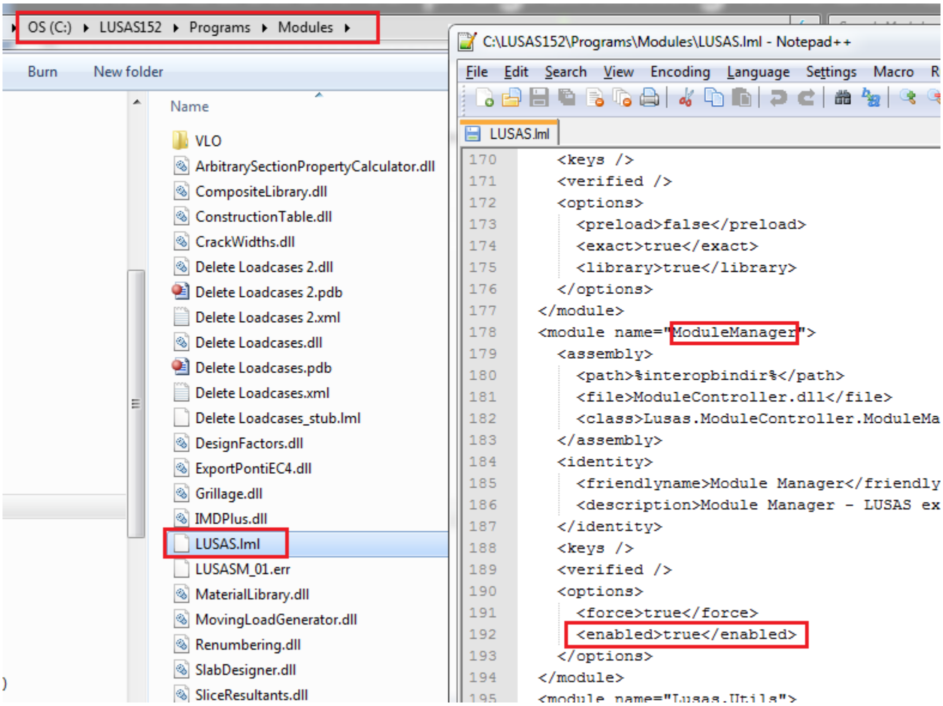
☑ Show all installed components

Currently using 1043.6MB of a possible 4095.9MB (3052.3MB free)

Module Manager

LUSAS Modeller’s Modules are controller by the Module Manager and the Module Manager dialog can be displayed by following the steps below.

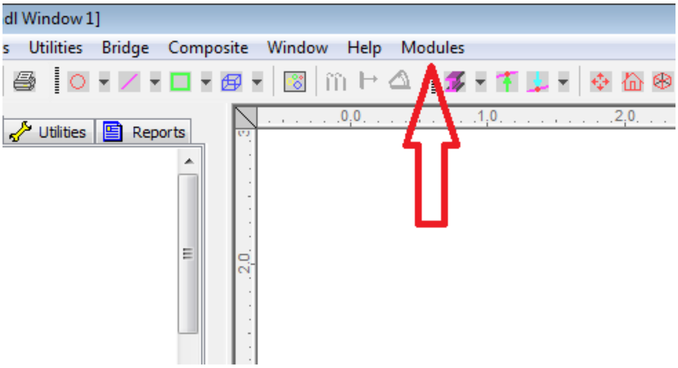
1. Open the file **C:\<LUSAS Installation Folder>\Programs\Modules\LUSAS.lml** into a text file editor.
2. Search for the text **ModuleManager**
3. Enable it by changing **false** to **true** as shown below
4. Save the file.


OS (C:) ▸ LUSAS152 ▸ Programs ▸ Modules ▸
Burn
New folder
Name
C:\LUSAS152\Programs\Modules\LUSAS.lml - Notepad++
File
Edit
Search
View
Encoding
Language
Settings
Macro
R
LUSAS.lml

VLO
ArbitrarySectionPropertyCalculator.dll
CompositeLibrary.dll
ConstructionTable.dll
CrackWidths.dll
Delete Loadcases 2.dll
Delete Loadcases 2.pdb
Delete Loadcases 2.xml
Delete Loadcases.dll
Delete Loadcases.pdb
Delete Loadcases.xml
Delete Loadcases_stub.lml
DesignFactors.dll
ExportPontiEC4.dll
Grillage.dll
IMDPlus.dll
LUSAS.lml
LUSASM_01.err
MaterialLibrary.dll
MovingLoadGenerator.dll
Renumbering.dll
SlabDesigner.dll
SliceResultants.dll

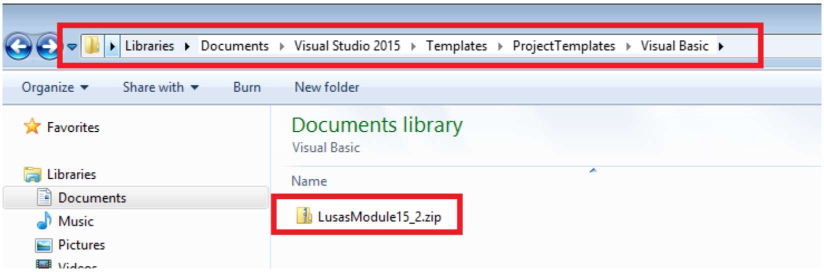
```
    <keys />
    <verified />
    <options>
      <preload>false</preload>
      <exact>true</exact>
      <library>true</library>
    </options>
  </module>
  <module name="ModuleManager">
    <assembly>
      <path>%interopbindir%</path>
      <file>ModuleController.dll</file>
      <class>Lusas.ModuleController.ModuleMa
    </assembly>
    <identity>
      <friendlyname>Module Manager</friendly
      <description>Module Manager - LUSAS ex
    </identity>
    <keys />
    <verified />
    <options>
      <force>true</force>
      <enabled>true</enabled>
    </options>
  </module>
  <module name="Lusas.Utils">
```

From now on, when you run LUSAS Modeller you will see the **Modules** menu:



Creating a new module

- Copy the **LusasModule<version_number>.zip** file from the LUSAS installation directory **C:\<LUSAS Installation Folder>\Programs** to the Visual Studio project template folder. For instance: **Libraries\Documents\Visual Studio 2015\Templates\ProjectTemplates\Visual Basic**

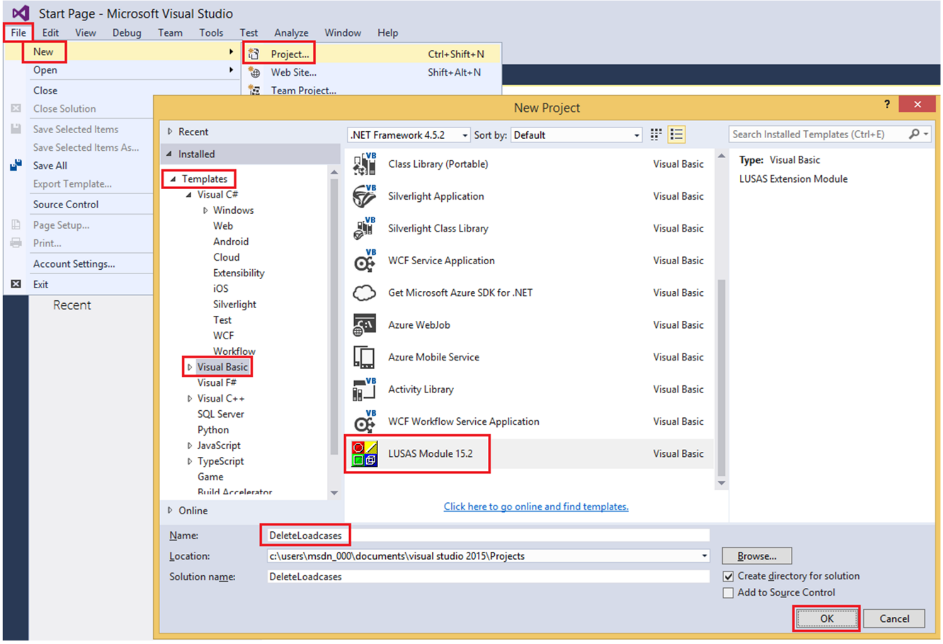


Running Visual Studio

- Open Visual Studio and select **File> New Project**
- In Visual Studio select the **LUSAS Module<version number>** template for your version of LUSAS).
- The dialog example that will be covered in this guide creates a new module to delete loadcases, therefore enter the name **DeleteLoadcases** (without any space) and click **OK.**

Note. It is important to use a sensible name as this propagates throughout the automatically generated code.

Note. Spaces can be used within Module names, but LUSAS generally avoids the use of spaces in its own scripted file names.



Name: DeleteLoadcases

Location: c:\users\msdn_000\documents\visual studio 2015\Projects

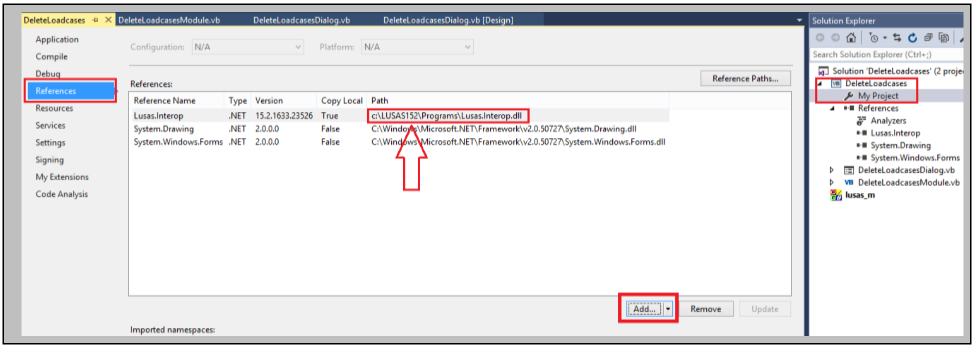
Solution name: DeleteLoadcases

☑ Create directory for solution

□ Add to Source Control

Note. If more than one version of LUSAS is installed on your machine you should check the version number of LUSAS that is being referenced by Visual Studio and ensure that this number is what is required. This can be done by checking the path to the LusasInterop dll.

- If this is required, on the **Solution Explorer** double-click on **My Project** and visually check the path for LusasInterop.dll



Configuration: N/A Platform: N/A

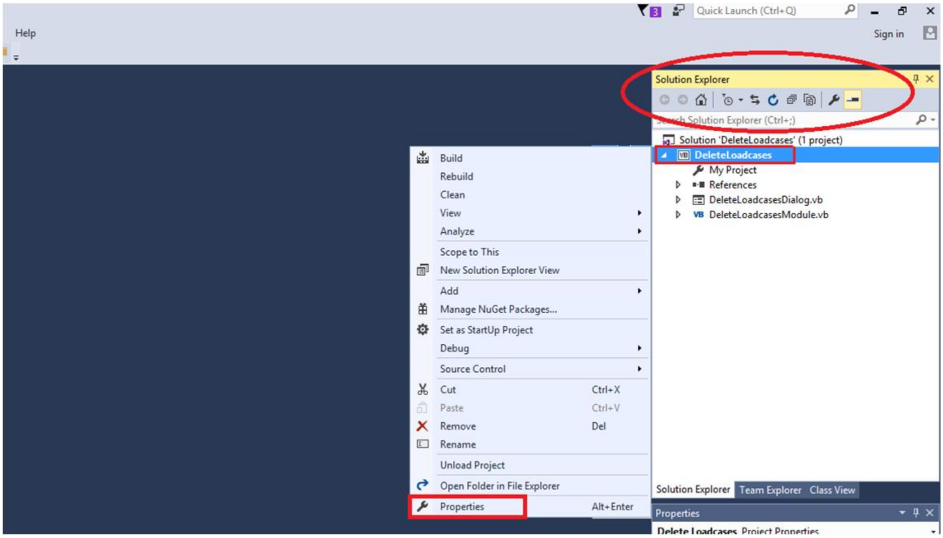
References:

Reference Name	Type	Version	Copy Local	Path
Lusas.Interop	.NET	15.2.1633.23526	True	c:\LUSAS152\Programs\Lusas.Interop.dll
System.Drawing	.NET	2.0.0.0	False	C:\Windows\Microsoft.NET\Framework\v2.0.50727\System.Drawing.dll
System.Windows.Forms	.NET	2.0.0.0	False	C:\Windows\Microsoft.NET\Framework\v2.0.50727\System.Windows.Forms.dll

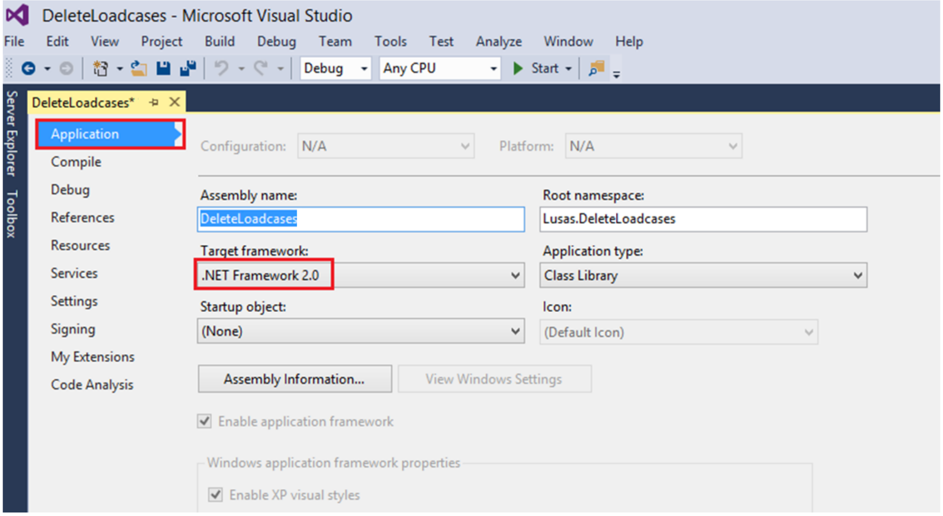
- If the wrong version of LUSAS is being referenced, click **Add** and search for the Lusas.Interop.dll file in the right version path,

Carrying on:

- In the **Solution Explorer** right-click on **DeleteLoadcases** and choose **Properties**



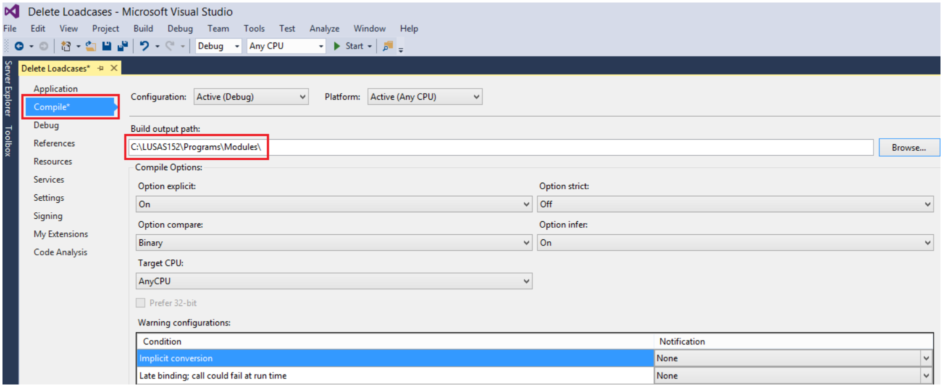
- On the **Application** page set the Target framework to **.NET Framework 2.0**



Configuration: N/A
Platform: N/A
Assembly name: DeleteLoadcases
Root namespace: Lusas.DeleteLoadcases
Target framework: .NET Framework 2.0
Application type: Class Library
Startup object: (None)
Icon: (Default Icon)
☑ Enable application framework
Windows application framework properties
☑ Enable XP visual styles

Note. For LUSAS v15.2, .NET Framework 2.0 is needed. Later versions of LUSAS will require a different target framework to be set.

- On the **Compile** page browse and change the build output path to **C:\<LUSAS Installation Folder>\Programs\Modules\**



Configuration: Active (Debug)

Platform: Active (Any CPU)

Build output path: C:\LUSAS152\Programs\Modules\

Compile Options:

Option explicit: On

Option strict: Off

Option compare: Binary

Option infer: On

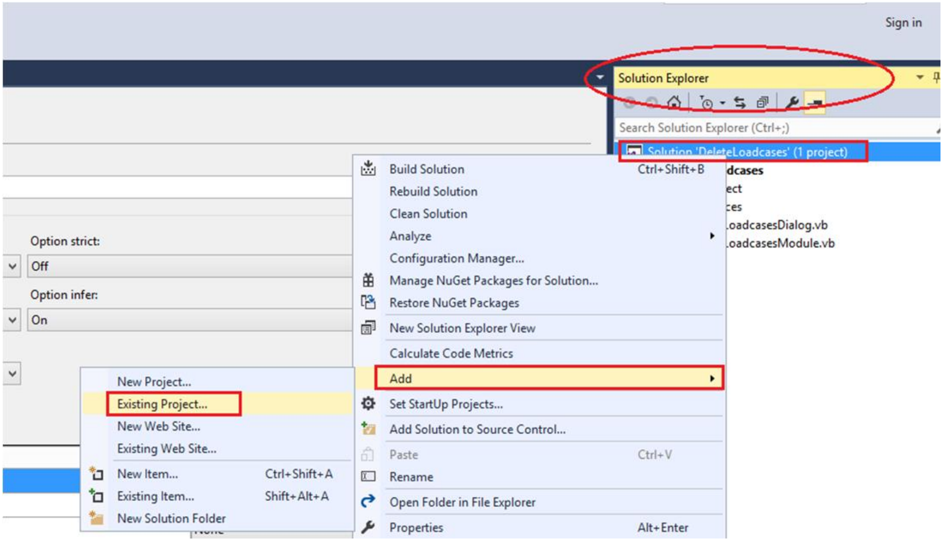
Target CPU: AnyCPU

□ Prefer 32-bit

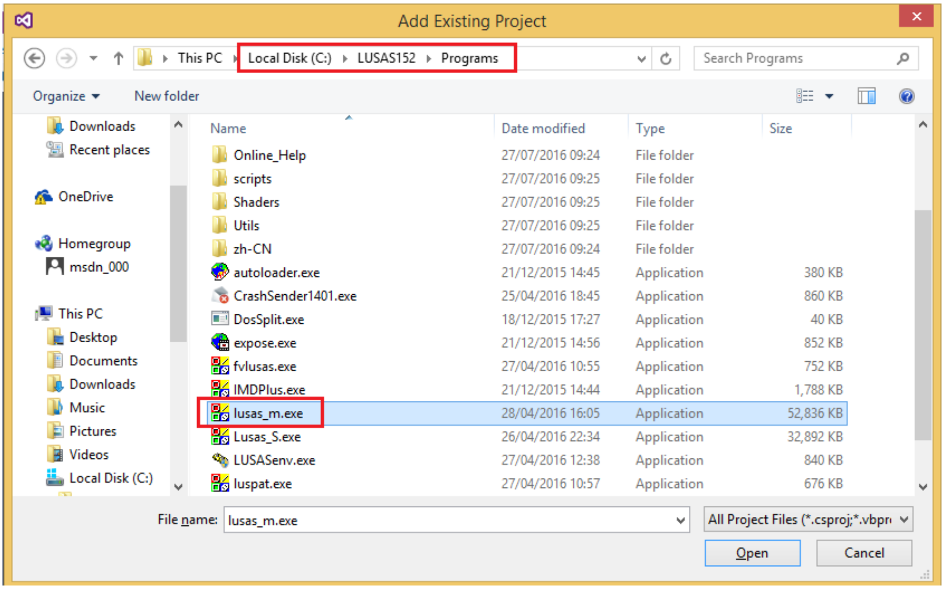
Warning configurations:

Condition	Notification
Implicit conversion	None
Late binding; call could fail at run time	None

- From the **Solution Explorer** right-click on Solution ‘**DeleteLoadcases**’ and select **Add > Existing Project**



- On the **Add** > **Existing Project** dialog browse for the location of the version of LUSAS that you wish to run and press **Open**



Add Existing Project

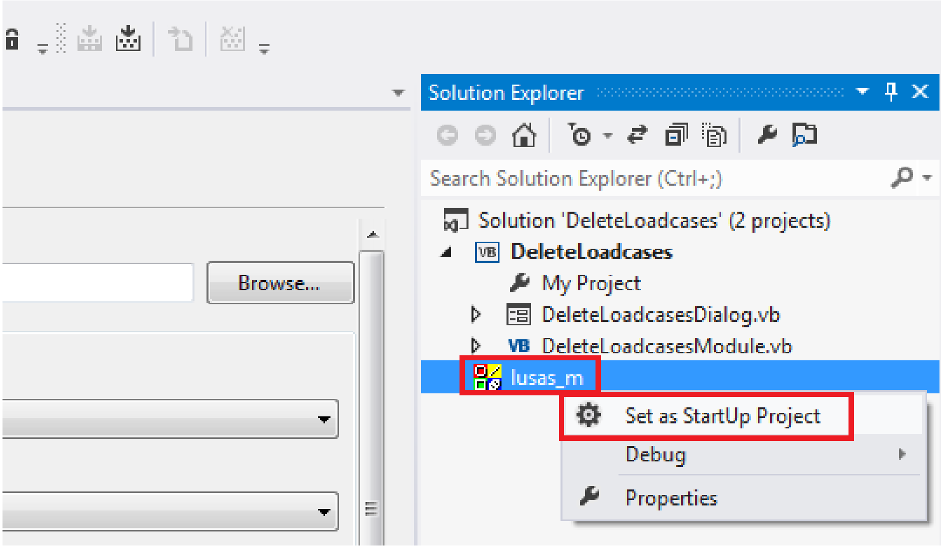
This PC ▸ Local Disk (C:) ▸ LUSAS152 ▸ Programs

Name	Date modified	Type	Size
Online_Help	27/07/2016 09:24	File folder	
scripts	27/07/2016 09:25	File folder	
Shaders	27/07/2016 09:25	File folder	
Utils	27/07/2016 09:25	File folder	
zh-CN	27/07/2016 09:24	File folder	
autoloader.exe	21/12/2015 14:45	Application	380 KB
CrashSender1401.exe	25/04/2016 18:45	Application	860 KB
DosSplit.exe	18/12/2015 17:27	Application	40 KB
expose.exe	21/12/2015 14:56	Application	852 KB
fvlusas.exe	27/04/2016 10:55	Application	752 KB
IMDPlus.exe	21/12/2015 14:44	Application	1,788 KB
lusas_m.exe	28/04/2016 16:05	Application	52,836 KB
Lusas_S.exe	26/04/2016 22:34	Application	32,892 KB
LUSASenv.exe	27/04/2016 12:38	Application	840 KB
luspat.exe	27/04/2016 10:57	Application	676 KB

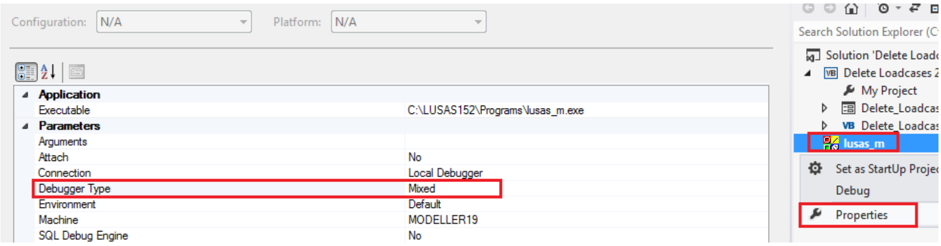
File name: lusas_m.exe

All Project Files (*.csproj;*.vbpr

- In the Solution Explorer right-click on the **lusas_m** entry and select **Set as Startup Project**.



- In the Solution Explorer right-click on the **lusas_m** entry and select **Properties**, and set the Debugger type to **Mixed**

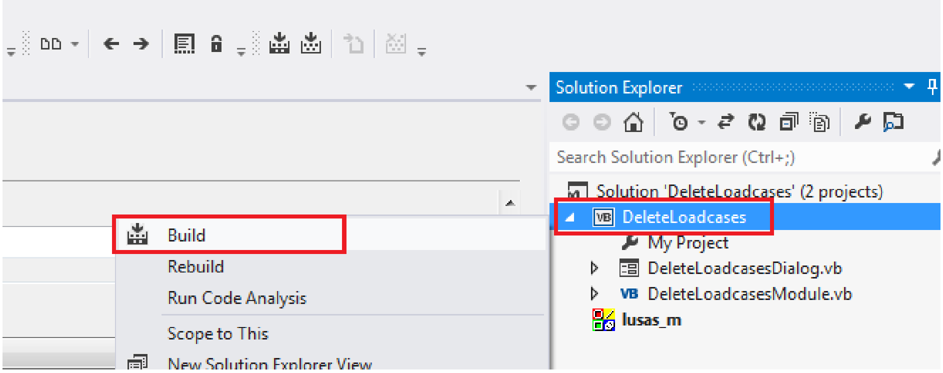


Configuration: N/A Platform: N/A

Application	
Executable	C:\LUSAS152\Programs\lusas_m.exe
Parameters	
Arguments	
Attach	No
Connection	Local Debugger
Debugger Type	Mixed
Environment	Default
Machine	MODELLER19
SQL Debug Engine	No

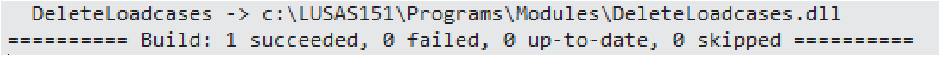
Build the project

- In the Solution Explorer right-click on the **DeleteLoadcases** entry and select **Build**.



Note. In Visual Studio you can also press **F7** to build the project.

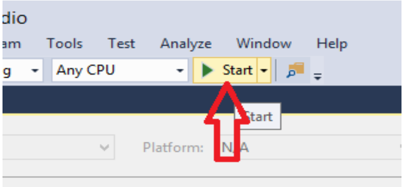
Details of the build will appear in the output window.



```
  DeleteLoadcases -> c:\LUSAS151\Programs\Modules\DeleteLoadcases.dll
========== Build: 1 succeeded, 0 failed, 0 up-to-date, 0 skipped ==========
```

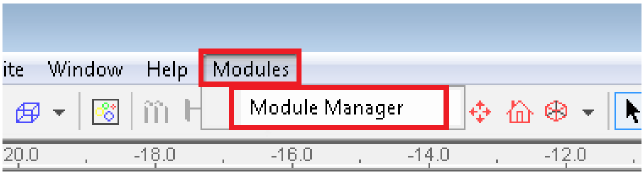
Run the project

- Press the **F5** Key in Visual Studio to run (or click on start button)

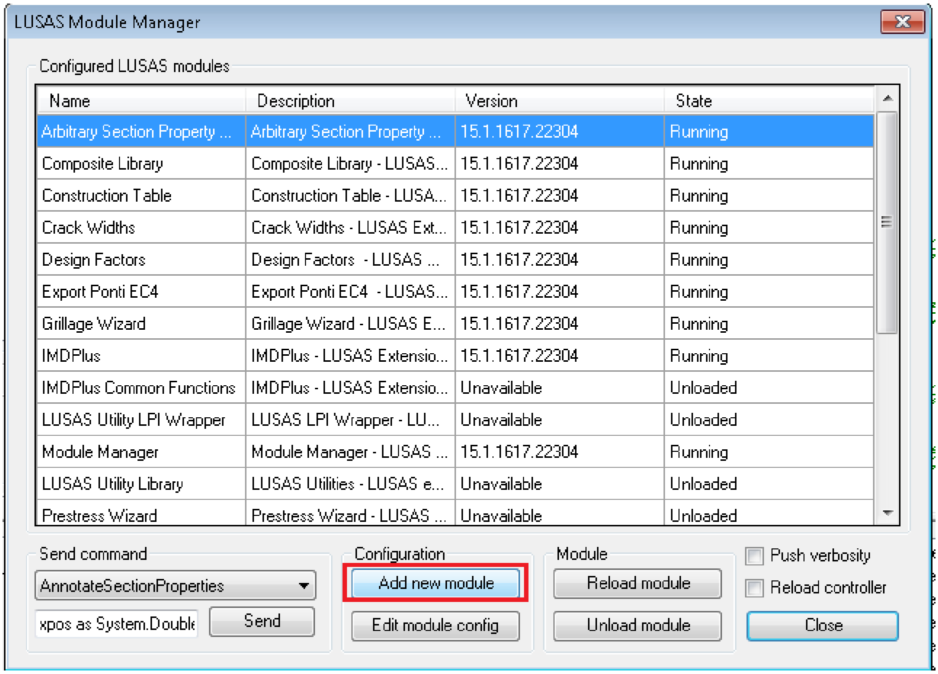


LUSAS Modeller should start.

- Open a LUSAS model or create a new one.
- Open the **Module Manager**



- Click **Add new module**

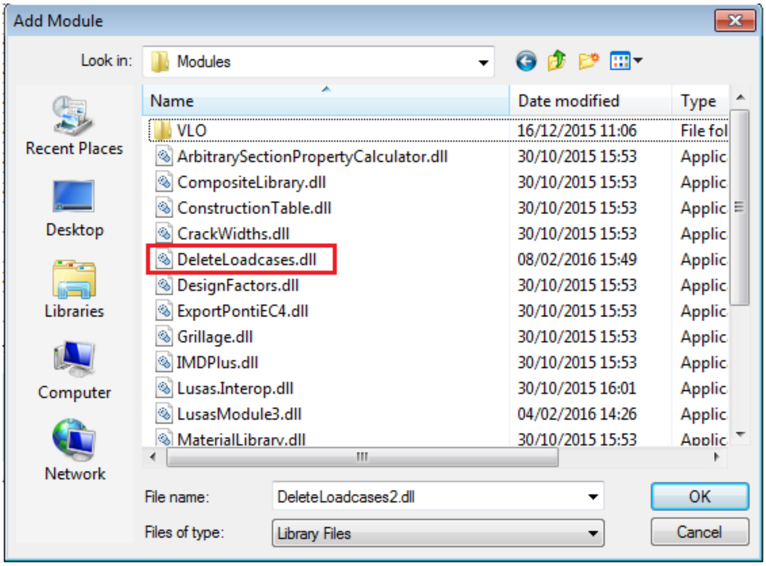


Name	Description	Version	State
Arbitrary Section Property ...	Arbitrary Section Property ...	15.1.1617.22304	Running
Composite Library	Composite Library - LUSAS...	15.1.1617.22304	Running
Construction Table	Construction Table - LUSA...	15.1.1617.22304	Running
Crack Widths	Crack Widths - LUSAS Ext...	15.1.1617.22304	Running
Design Factors	Design Factors - LUSAS ...	15.1.1617.22304	Running
Export Ponti EC4	Export Ponti EC4 - LUSAS...	15.1.1617.22304	Running
Grillage Wizard	Grillage Wizard - LUSAS E...	15.1.1617.22304	Running
IMDPlus	IMDPlus - LUSAS Extensio...	15.1.1617.22304	Running
IMDPlus Common Functions	IMDPlus - LUSAS Extensio...	Unavailable	Unloaded
LUSAS Utility LPI Wrapper	LUSAS LPI Wrapper - LU...	Unavailable	Unloaded
Module Manager	Module Manager - LUSAS ...	15.1.1617.22304	Running
LUSAS Utility Library	LUSAS Utilities - LUSAS e...	Unavailable	Unloaded
Prestress Wizard	Prestress Wizard - LUSAS ...	Unavailable	Unloaded

Send command: AnnotateSectionProperties

xpos as System.Double

- Browse on the Add Module dialog for **C:\<LUSAS Installation Folder>\Programs\Modules\DeleteLoadcases.dll** and click **OKn**



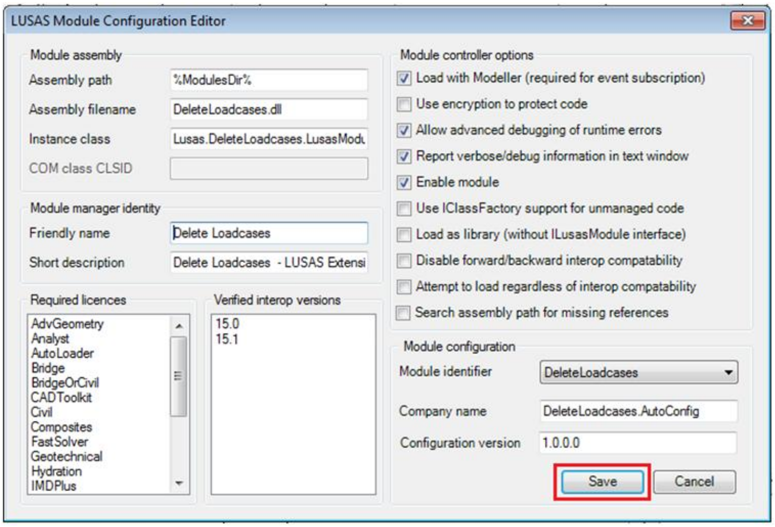
Look in: Modules

Name	Date modified	Type
VLO	16/12/2015 11:06	File fol
ArbitrarySectionPropertyCalculator.dll	30/10/2015 15:53	Applic
CompositeLibrary.dll	30/10/2015 15:53	Applic
ConstructionTable.dll	30/10/2015 15:53	Applic
CrackWidths.dll	30/10/2015 15:53	Applic
DeleteLoadcases.dll	08/02/2016 15:49	Applic
DesignFactors.dll	30/10/2015 15:53	Applic
ExportPontiEC4.dll	30/10/2015 15:53	Applic
Grillage.dll	30/10/2015 15:53	Applic
IMDPlus.dll	30/10/2015 15:53	Applic
Lusas.Interop.dll	30/10/2015 16:01	Applic
LusasModule3.dll	04/02/2016 14:26	Applic
MaterialLibrary.dll	30/10/2015 15:53	Applic

File name: DeleteLoadcases2.dll

Files of type: Library Files

The LUSAS Module Configuration Editor dialog will appear. This permits (amongst many other features) restricting the Module to only work with a particular LUSAS version or licence key. No additional settings should be made on this dialog for this example.



Module assembly

Assembly path: %ModulesDir%

Assembly filename: DeleteLoadcases.dll

Instance class: Lusas.DeleteLoadcases.LusasModu

COM class CLSID:

Module manager identity

Friendly name: Delete Loadcases

Short description: Delete Loadcases - LUSAS Extensi

Required licences: AdvGeometry, Analyst, AutoLoader, Bridge, BridgeOrCivil, CADToolkit, Civil, Composites, FastSolver, Geotechnical, Hydration, IMDPlus

Verified interop versions: 15.0, 15.1

Module controller options

- ☑ Load with Modeller (required for event subscription)
- ☐ Use encryption to protect code
- ☑ Allow advanced debugging of runtime errors
- ☑ Report verbose/debug information in text window
- ☑ Enable module
- ☐ Use IClassFactory support for unmanaged code
- ☐ Load as library (without ILusasModule interface)
- ☐ Disable forward/backward interop compatability
- ☐ Attempt to load regardless of interop compatibility
- ☐ Search assembly path for missing references

Module configuration

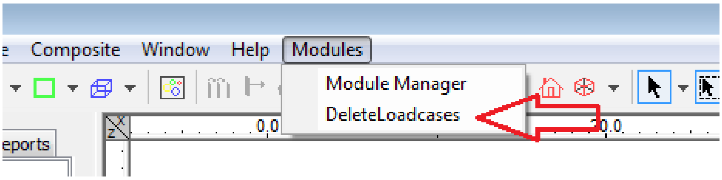
Module identifier: DeleteLoadcases

Company name: DeleteLoadcases.AutoConfig

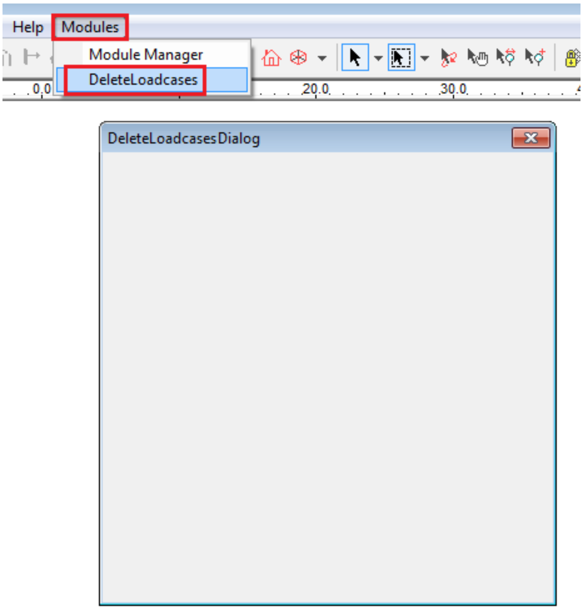
Configuration version: 1.0.0.0

- Press the **Save** button and then **Close**

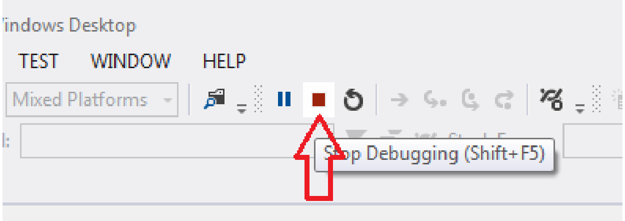
From now on, you will see the **Delete Loadcases** item in the modules menu.



- Choose the **DeleteLoadcases** menu item. A blank window is displayed, because you have not yet added any controls or written any code.

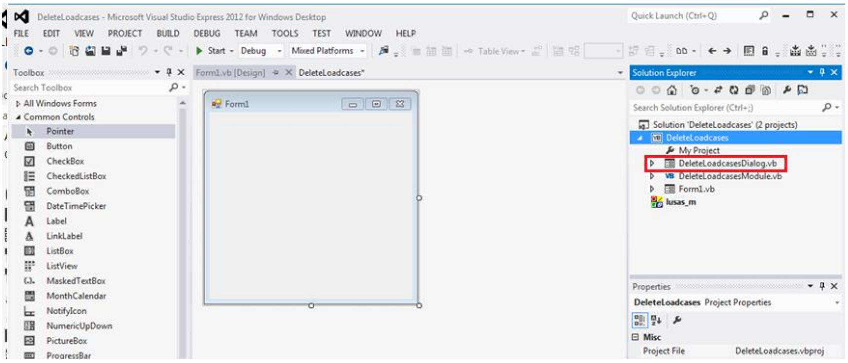


- Click on **Stop Debugging** in Visual Studio to close LUSAS Modeller and amend the project.

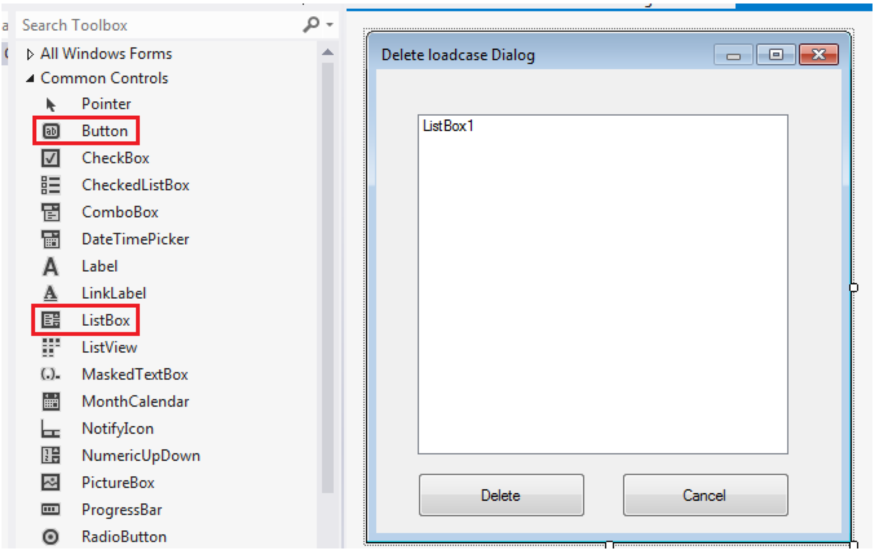


Adding dialog controls

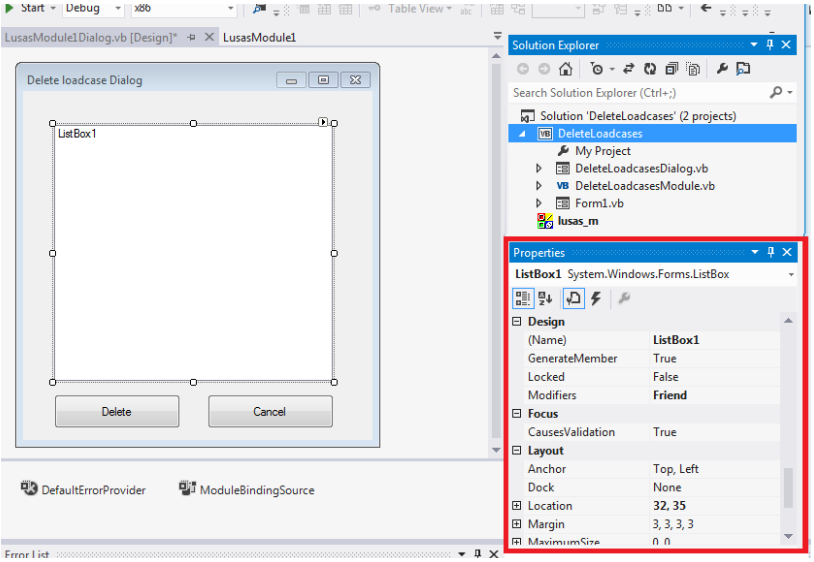
- In Visual Studio double-click on **DeleteLoadcasesDialog.vb** to open a blank dialog.



- Add a **ListBox** and two **Buttons**



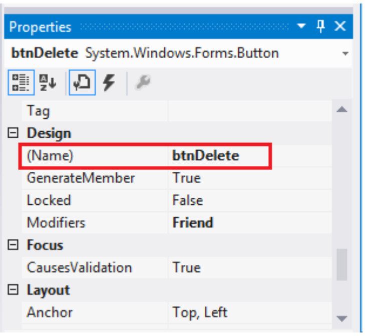
- Select each of the controls to modify its properties (Name, location, size...)



ListBox1 System.Windows.Forms.ListBox

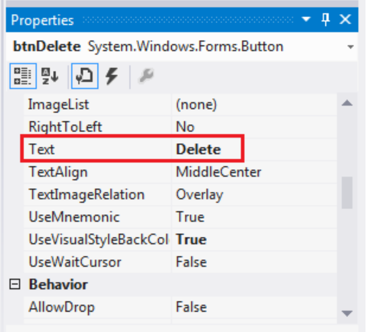
Design	
(Name)	**ListBox1**
GenerateMember	True
Locked	False
Modifiers	**Friend**
Focus	
CausesValidation	True
Layout	
Anchor	Top, Left
Dock	None
Location	**32, 35**
Margin	3, 3, 3, 3
MaximumSize	0, 0

- For Button 1 define its Name to be **btnDelete** with Text: **Delete**



btnDelete System.Windows.Forms.Button

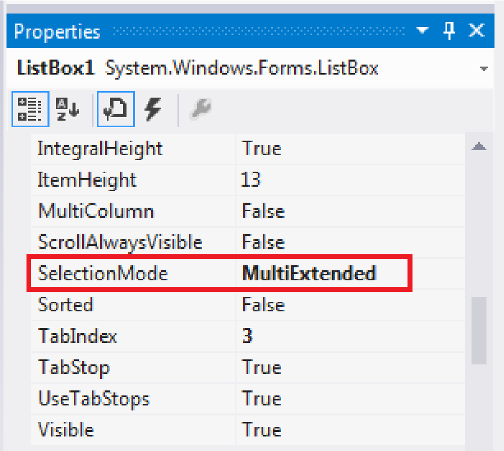
Tag	
Design	
(Name)	**btnDelete**
GenerateMember	True
Locked	False
Modifiers	**Friend**
Focus	
CausesValidation	True
Layout	
Anchor	Top, Left



btnDelete System.Windows.Forms.Button

ImageList	(none)
RightToLeft	No
Text	**Delete**
TextAlign	MiddleCenter
TextImageRelation	Overlay
UseMnemonic	True
UseVisualStyleBackCol	**True**
UseWaitCursor	False
Behavior	
AllowDrop	False

- For Button 2 define its Name to be **btnCancel** with Text: **Cancel**
- For the ListBox define the Selection Mode to be **MultiExtended** (This will allow selection of multiple items in the listbox).



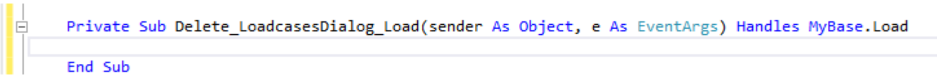
ListBox1 System.Windows.Forms.ListBox

IntegralHeight	True
ItemHeight	13
MultiColumn	False
ScrollAlwaysVisible	False
SelectionMode	**MultiExtended**
Sorted	False
TabIndex	**3**
TabStop	True
UseTabStops	True
Visible	True

Defining a ListBox

All the loadsets (Loadcases, Combinations and Envelopes) are to be listed in the ListBox

- Double-click on the form to create an event handler for the form load event



```
Private Sub Delete_LoadcasesDialog_Load(sender As Object, e As EventArgs) Handles MyBase.Load

End Sub
```

Modify the code as shown below:

Tip. Open the PDF file for this guide and copy and paste the script text required. Take care to ensure that any unwanted line breaks are removed.

```
Private Sub Delete_LoadcasesDialog_Load(sender As Object, e As
    EventArgs) Handles MyBase.Load
           Call PopulateListBox()
End Sub


Private Sub PopulateListBox()
        'Delete previous items from listbox
        ListBox1.Items.Clear()
        'Add loadsets to the listbox
        Dim LoadsetsArray = moduleObject.Modeller.db.getLoadsets("All",
"All")
        For i = 0 To UBound(LoadsetsArray)
            ListBox1.Items.Add(LoadsetsArray(i).getName())
        Next
    End Sub
```

Defining a Delete Button

The selected loadsets of the list box need to be deleted when pressing this button, so:

- Double-click on the button **Delete** to create an event handler for this button's click event.
- Modify it by typing the following:

Tip. Rather than type the lines of VB Script required, open the PDF file for this guide and for the remainder of this section of the Guide copy and paste the script code where needed. Take care to ensure that any unwanted line breaks are removed.

```
    Private Sub btnDelete_Click(sender As Object, e As EventArgs)
Handles btnDelete.Click

       'Delete loadsets that are selected in the listbox
        For Each Item In ListBox1.SelectedItems
           Call moduleObject.Modeller.database.deleteLoadset(Item)
        Next

        Call PopulateListBox()

    End Sub
```

Defining a Cancel Button

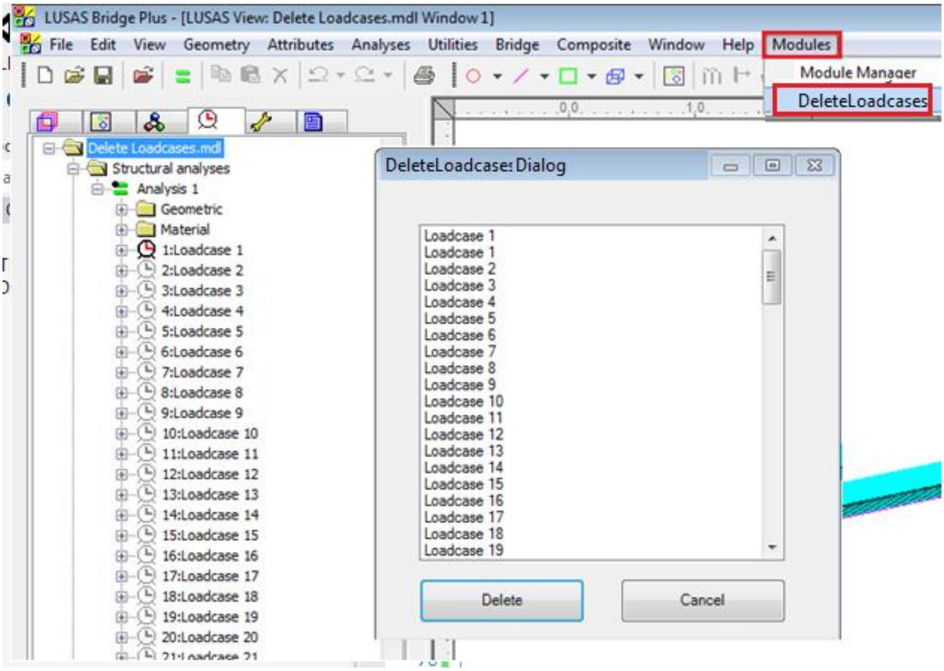
To cause the dialog to close:

- Double-click on the button **Cancel** to create an event handler for this buttons click even and modify it to:

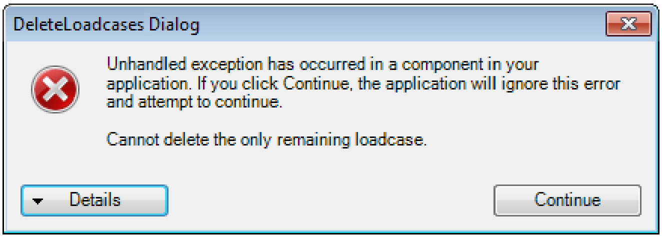
```
    Private Sub btnCancel_Click(sender As Object, e As EventArgs)
Handles btnCancel.Click
        Close()
    End Sub
```

- Now build the project by pressing the **F7** key and run it by pressing the **F5** key.

- In LUSAS Modeller select the menu item **Modules> DeleteLoadcases**, then select which loadcase to delete and press the **Delete** button.



You may have noticed that if you try to delete all loadcases you get the following:



DeleteLoadcases Dialog

Unhandled exception has occurred in a component in your application. If you click Continue, the application will ignore this error and attempt to continue.

Cannot delete the only remaining loadcase.

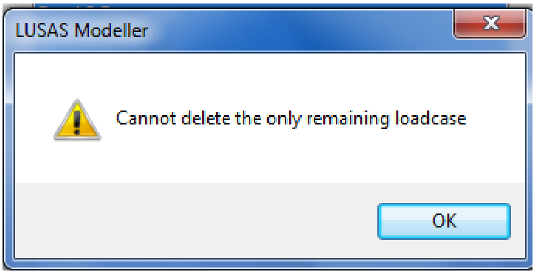
This is because Modeller has raised an exception as there must always be at least one loadcase. You can handle or catch the exception so you get a meaningful message saying “Cannot delete the only remaining loadcase”

Handling errors

The code will be modified to handle this situation. Add the following code at the beginning of the **btnDelete_Click** function.

```
    Private Sub btnDelete_Click(sender As Object, e As EventArgs) Handles
btnDelete.Click
        Dim loadcaseArray =
moduleObject.Modeller.database.getLoadsets("Loadcase", "All")


        Try
            'Delete loadsets that are selected in the listbox
            For Each Item In ListBox1.SelectedItems
                Call moduleObject.Modeller.database.deleteLoadset(Item)
            Next

        Catch ex As Exception
            Call moduleObject.Modeller.AfxMsgBox(ex.Message())

        End Try

        Call PopulateListBox()

    End Sub
```

Now, if you try to delete all loadcases you get the following 'cleaner' message:


LUSAS Modeller

Cannot delete the only remaining loadcase

General considerations

Basic dialog design

- Use the ToolBox to create controls
- Double-click on the control in the toolbox to create the control at standard size
- Drag and drop to desired position using grid lines to line up with other controls
- Name the controls in Properties using standard naming convention (See basic dialog controls prefixes below e.g. txt, btn, opt, chk)
- Set FormBorderStyle = FixedDialog
- Set Localizable = True

Basic dialog controls

- TextBox (**txt**) – string of input or output
- Button (**btn**) – activate an event
- ComboBox (**cbo**) – choice of preset input
- CheckBox (**chk**) – true or false
- RadioButton (**opt**) – choice of a number of options
- NumericUpDown (**spn**) – Integer or decimal within specified range
- PictureBox (**img**) – display images on dialog
- GroupBox (**grp**) – groups radio buttons
- Label (**lbl**) – add text to dialog
- Panel (**pnl**)– invisible group, enable/disable multiple controls

Code design considerations

- **Only code relating to the dialog should be contained in the dialog class <projectname>Dialog.vb** – e.g. Events, data check functions, change label text etc. (Access to the module code is achieved by using moduleObject.<function>)
- **Place all worker code in module class <projectnameModule.vb>** (access to Modeller LPI functions is achieved using Modeller.<LPIfunction>")
- **All variables must be allocated a Type.** Modeller has a number of predefined data types e.g. IFPoint, IFLine. All Modeller data types start with IF and a full list is automatically displayed in Visual Studio when the type is being declared.
- **Use access modifiers to restrict the scope of functions as much as possible.** Only make the function public if it is required outside the module.
  - Private only available to routines in this module
  - Protected only available within class and derived classes
  - Friend only available within the assembly (Dialog to module)
  - Public visible globally and outside of the assembly
- **It is a good idea to comment all functions, classes, modules etc using the standard XML comment blocks**. Note: Typing three quotes (`'''`) on the line immediately above the function name will automatically present the standard html template with the parameters included.

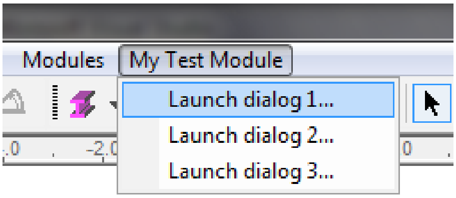
Multiple Dialogs in a single module

By default the LUSAS module template is set up to handle a single dialog. It is possible for a module to provide multiple dialogs and provide multiple menu entries. It is good practice to keep all related functionality in a single module.

When a module creates a new menu item, Modeller will return a unique id for that menu item, these id's should be stored in "member" variables within the module. Modules can create new menu items in the onRefreshMainMenu function as shown below:

```
Private m_dialog1_ID As Integer
Private m_dialog2_ID As Integer
Private m_dialog3_ID As Integer

''' <summary>
''' Called when Modeller is redrawing the Main Menu.
''' </summary>
''' <remarks>
''' Allows custom modules to append and maintain their own menus.
''' </remarks>
Protected Overrides Sub onRefreshMainMenu()
    Dim myModuleMenu As IFMenu = menu.appendMenu("My Test Module")
    m_dialog1_ID = myModuleMenu.appendItem("Launch dialog 1...",
"textwin.writeLine(""Test Dialog 1"")")
    m_dialog2_ID = myModuleMenu.appendItem("Launch dialog 2...",
"textwin.writeLine(""Test Dialog 2"")")
    m_dialog3_ID = myModuleMenu.appendItem("Launch dialog 3...",
"textwin.writeLine(""Test Dialog 3"")")
End Sub
```

When the user clicks these menu items all modules will be called with the id of the menu item. It is the responsibility of the module to listen for any menu ids it creates and respond accordingly.



The modules are called via the **onMenuClick** function

The module should respond when it is called with the correct menu ID.

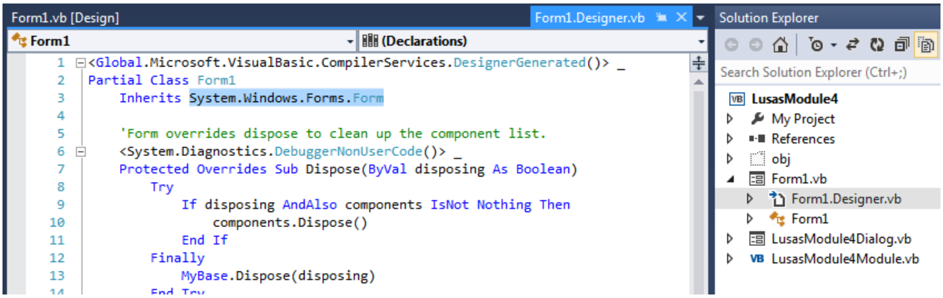
For each menu id the moduleDialog should be set to a new instance of the correct dialog before the runModule function is called. This way the correct dialog will be shown, as below.

```
''' <summary>
''' Called when the user clicks on a menu entry.

''' </summary>
''' <param name="menuID">ID of the menu that has been clicked.</param>
''' <param name="edittingObj">Object that is being edited (nothing when
creating a new object).</param>
''' <param name="clientData">Data that was provided to Modeller when
defining edittingObj.</param>
''' <returns>true if the click event was handled by this
Module.</returns>
''' <remarks>
''' LUSAS expects the a Module handling the event to execute itself
(typically using runModule()).
''' </remarks>
Function onMenuClick(ByVal menuID As Integer, ByVal edittingObj As
Object, Optional ByVal clientData As Object = Nothing) As Boolean

    If (m_dialog1_ID = menuID) Then
        moduleDialog = New myDialog1(Me)
        runModule()
        Return True
    End If
    If (m_dialog2_ID = menuID) Then
        moduleDialog = New myDialog2(Me)
        runModule()
        Return True
    End If
    If (m_dialog3_ID = menuID) Then
        moduleDialog = New myDialog3(Me)
        runModule()
        Return True
    End If
    Return False
End Function
```

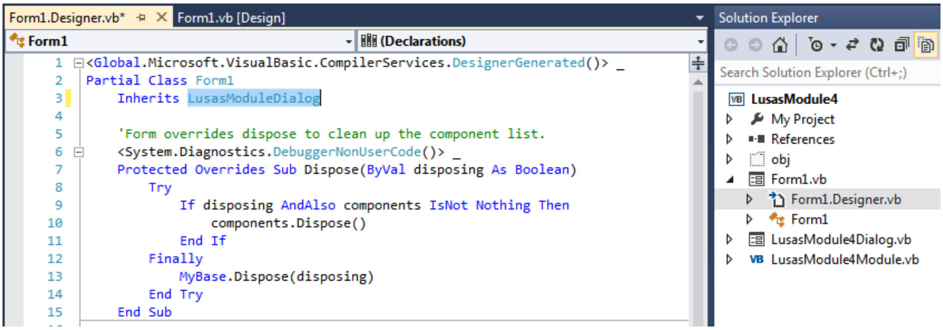
Menu items maybe enabled or disabled in the **onMenuUpdate** event

```
''' <summary>
''' Called when a menu entry needs to be drawn.
''' Allows the Module to specify whether the menu item should be disabled
or checked.
''' </summary>
''' <param name="menuID">ID of the menu that has been clicked.</param>
''' <param name="edittingObj">Object that is being edited (nothing when
creating a new object).</param>
''' <param name="enable">Set to true to enable the menu item.</param>
''' <param name="checked">
''' Set to 0 to show an 'off' tickbox next to the menu.
''' Set to 1 to show an 'on' tick mark by the side of the menu.
''' Set to 2 to show an indeterminate check.
''' Set to 3 to show no tick at all.
''' </param>
''' <param name="clientData">Data that was provided to Modeller when
defining edittingObj.</param>
''' <returns>true if the update event was handled by this
Module.</returns>
''' <remarks>
''' Only when a Module handles an menu update event are the changed
values of enable/checked respected.
''' </remarks>
Function onMenuUpdate(ByVal menuID As Integer, ByVal edittingObj As
Object, ByRef enable As Boolean, ByRef checked As Integer, Optional ByVal
clientData As Object = Nothing) As Boolean

    If (m_dialog1_ID = menuID) Then
        enable = (Modeller.db.countSurfaces() > 0)
        Return True
    End If
    If (m_dialog2_ID = menuID) Then
        enable = True
        Return True
    End If
    Return False
End Function
```

Note. All dialogs <u>must</u> inherit from LusasModuleDialog. When adding a new dialog you should change the code in the dialog designer to inherit from LusasModuleDialog rather than System.Windows.Forms.Form



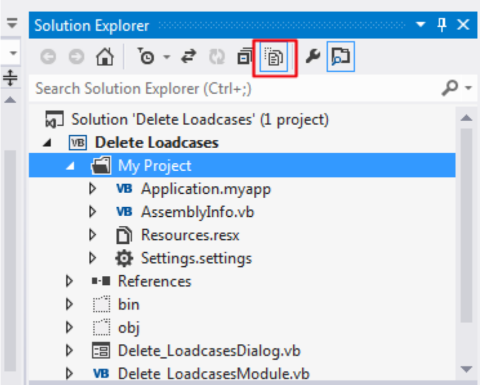
```
<Global.Microsoft.VisualBasic.CompilerServices.DesignerGenerated()> _
Partial Class Form1
    Inherits System.Windows.Forms.Form

    'Form overrides dispose to clean up the component list.
    <System.Diagnostics.DebuggerNonUserCode()> _
    Protected Overrides Sub Dispose(ByVal disposing As Boolean)
        Try
            If disposing AndAlso components IsNot Nothing Then
                components.Dispose()
            End If
        Finally
            MyBase.Dispose(disposing)
        End Try
```



```
<Global.Microsoft.VisualBasic.CompilerServices.DesignerGenerated()> _
Partial Class Form1
    Inherits LusasModuleDialog

    'Form overrides dispose to clean up the component list.
    <System.Diagnostics.DebuggerNonUserCode()> _
    Protected Overrides Sub Dispose(ByVal disposing As Boolean)
        Try
            If disposing AndAlso components IsNot Nothing Then
                components.Dispose()
            End If
        Finally
            MyBase.Dispose(disposing)
        End Try
    End Sub
```

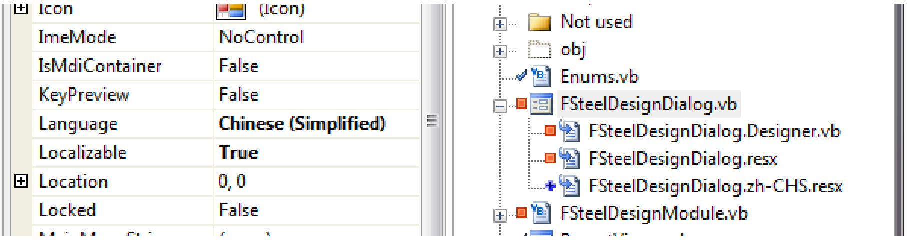
Translation considerations

The default language should always be **English**. All strings should be defined in the Resources.resx file. To access the Resources.resx file pick the **Show All Files** button in the Solution Explorer.


Solution Explorer
Search Solution Explorer (Ctrl+;)
Solution 'Delete Loadcases' (1 project)
Delete Loadcases
My Project
Application.myapp
AssemblyInfo.vb
Resources.resx
Settings.settings
References
bin
obj
Delete_LoadcasesDialog.vb
Delete_LoadcasesModule.vb

Double clicking on the Resources.resx will display a window to name and define the strings.

Note. If languages other than English are to be supported the dialog property **Localizable** property should be set to be **True and the Language** should be changed to the translation language, as for example for Chinese (Simplified) This will automatically create a new resource file for the dialog where the translated string should be defined and allow the labels to be translated and the size and position of the controls to be customised. Changing the **Language** back to **Default** will display the English labels with the controls set to in their original size and position.



⊞ Icon	(Icon)
ImeMode	NoControl
IsMdiContainer	False
KeyPreview	False
Language	**Chinese (Simplified)**
Localizable	**True**
⊞ Location	0, 0
Locked	False

```
⊞ Not used
⊞ obj
  Enums.vb
⊟ FSteelDesignDialog.vb
    FSteelDesignDialog.Designer.vb
    FSteelDesignDialog.resx
    FSteelDesignDialog.zh-CHS.resx
⊞ FSteelDesignModule.vb
```

By using this approach any strings which do not have a translation will be displayed in English and an Language for which translation is not supported will show English labels and strings.

VB.NET online tutorials

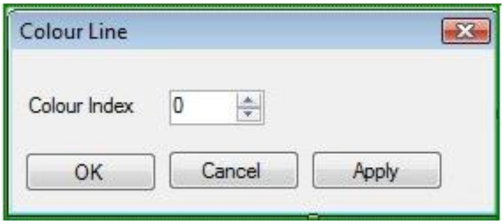
VB.NET online tutorials are widely available. Here are some examples:

English:
https://www.youtube.com/watch?v=hkcO_M9gcNw&index=1&list=PL42055376AE25291E

English:
https://www.youtube.com/watch?v=AJpTbPasJqI&list=PLS1QulWo1RIYLpgVN_CpXbkOQoYJTItzg

Chinese: https://channel9.msdn.com/Series/Visual-Basic-Fundamentals-for-Absolute-Beginners/01

VB .NET dialog exercise



The preceding dialog is required to allow a user to change the colour of all Lines in a model. The dialog should be activated from the menu item **My Menu> Colour Line**

Write the code to enable this to take place.

The solution is shown on the next page.

VB.NET dialog solution

1. In Dialog Class:

```
    Private Sub btnOK_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles btnOK.Click
        Call btnApply_Click(sender, e)
        Call btnCancel_Click(sender, e)
    End Sub

    Private Sub btnApply_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles btnApply.Click
        moduleObject.ColourLines(spnColourIndex.Value)
    End Sub

    Private Sub btnCancel_Click(ByVal sender As System.Object, ByVal e As
System.EventArgs) Handles btnCancel.Click
        Me.Close()
    End Sub
```

2. In Module Class, in existing function **`onRefreshMainMenu`** change:

```
If rootMenu.exists("Modules") Then
    modMenu = rootMenu.getSubMenu("Modules")
Else
    modMenu = rootMenu.appendMenu("Modules")
End If
```

to:

```
Dim menuName As String = "My Menu"
If rootMenu.exists(menuName) Then
    modMenu = rootMenu.getSubMenu(menuName)
Else
    modMenu = rootMenu.appendMenu(menuName)
End If
```

3. Add function

```
    ''' <summary>
    ''' Routine to colour lines
    ''' </summary>
    ''' <param name="colour">colour index</param>
    ''' <remarks></remarks>
    Public Sub ColourLines(ByVal colour)
        Dim lines As Object = Modeller.database.getObjects("Lines",
"All")
        For Each line As IFLine In lines
            line.setPen(colour)
        Next
    End Sub
```

LUSAS via COM

Component Technology

The LUSAS Programmable Interface allows interfacing with other compatible Windows programs through a Component Object Model (COM) interface. This defines a set of rules by which two programs can communicate and allows controlling those programs as if they were part of LUSAS Modeller. LUSAS can also be used as a component of another system (running transparently if required) providing modelling capabilities, analysis solutions and results viewing and processing options for that application.

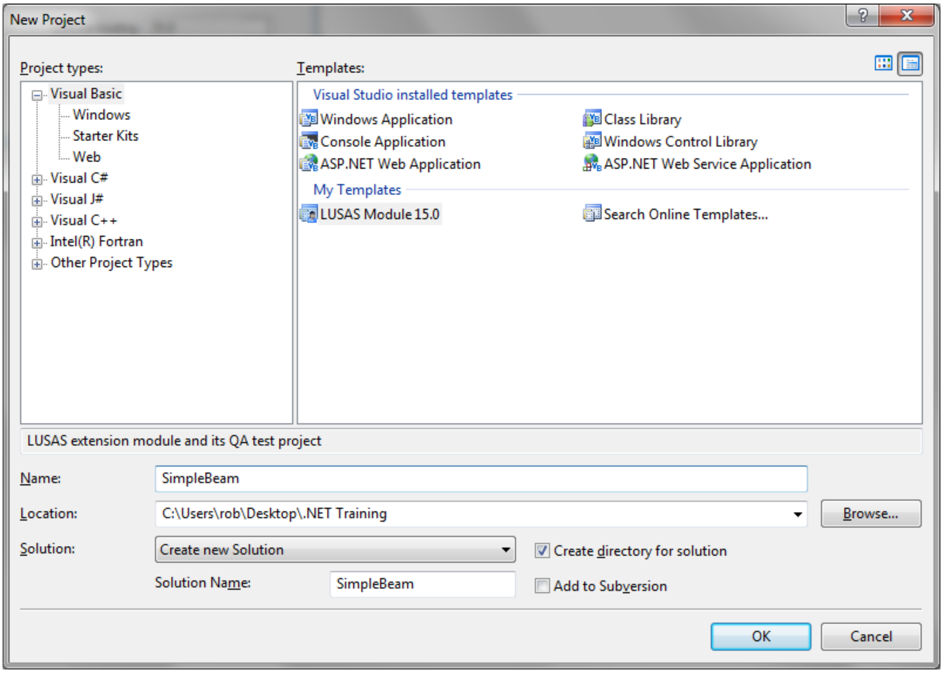
In order to drive LUSAS from a standalone application via COM (Component Object Model), LUSAS must be installed and licenced. When creating a COM instance of LUSAS a licence will be used. The licence will be in use for the lifetime of the instance and must be properly disposed of to release the licence.

Application Example

To illustrate the process involved, a stand-alone application called SimpleBeam will be created. The application will accept two parameters, length and load. The application will use LUSAS to analyse the beam and return the results for the maximum bending moment.

Create a new project

- In Visual Studio create a new Windows Application called SimpleBeam.



LUSAS extension module and its QA test project

Name: SimpleBeam

Location: C:\Users\rob\Desktop\.NET Training

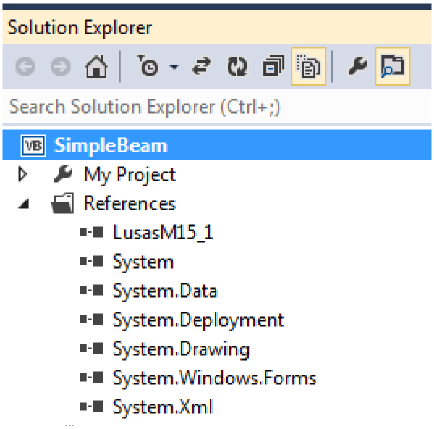
Solution: Create new Solution

☑ Create directory for solution

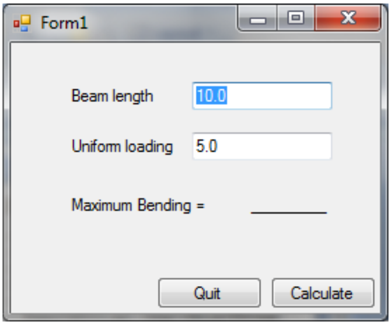
Solution Name: SimpleBeam

□ Add to Subversion

- Add a reference to LUSAS Modeller.
- In Solution Explorer, click **Show All Files**
- Right-click on **References** and select **Add reference**
- In the COM tab select **LUSAS Modeller ActiveX Script Language 15.1**



- Create the following dialog:



Beam length 10.0

Uniform loading 5.0

Maximum Bending = ______

For simplicity all code is placed in the dialog as follows

```
Imports LusasM15_1

Public Class Form1

    Private m_lusas As LusasM15_1.LusasWinApp' Reference to Lusas
Modeller

    Private Sub btnCalculate_Click(sender As System.Object, e As
System.EventArgs) Handles btnCalculate.Click
        analyseBeam()
    End Sub

    Private Sub analyseBeam()
        ' Get the params
        Dim length As Double = Double.Parse(txtLength.Text)
        Dim loading As Double = Double.Parse(txtLoading.Text)

        ' Create an instance of modeller
        m_lusas = New LusasM15_1.LusasWinApp

        ' Create a new model
        m_lusas.newDatabase()
        ' Set the vertical axis
        m_lusas.db.setLogicalUpAxis("Z")
        ' Set the unit system
        m_lusas.db.setModelUnits("kN,m,t,s,C")


        ' *** Create a line ***
        ' Get the geometry data object
        Dim geomData As IFGeometryData = m_lusas.geometryData()
        ' Set the defaults
        geomData.setAllDefaults()
        ' Set the coordinates of the first point
        geomData.addCoords(0, 0, 0)
        ' Set the coordinates of the second point
        geomData.addCoords(length, 0, 0)
        ' Create the line object
        Dim linesDBop As IFObjectSet = m_lusas.db.createLine(geomData)
        ' Get the lines
        Dim lines() = linesDBop.getObjects("Lines", "All")
        ' Get a reference to the created line
        Dim beamLine As IFLine = lines(0)


        ' *** Create a mesh attribute ***
        Dim meshAttr As IFMeshLine = m_lusas.db.createMeshLine("Beam
Mesh")
        ' Set the element type and number of elements (1m elements here)
        meshAttr.setNumber("BMS3", length)


        ' *** Create a geometric attribute ***
        Dim geomAttr As IFGeometricLine =
m_lusas.db.createGeometricLine("Beam Geometry")
        ' Set the element type
        geomAttr.setValue("elementType", "3D Thick Beam")
        ' Set the beam properties
        geomAttr.setBeam(0.0125, 0.0004573, 0.00002347, 0.0, 0.00000121,
0.00532608, 0.00755776, 0.0, 0.0, 0)


        ' *** Create a material attribute ***
        Dim materialAttr As IFMaterialIsotropic =
m_lusas.db.createIsotropicMaterial("Steel", 209000000.0, 0.3, 7.8)


        ' *** Create a support attribute (fixed) ***
        Dim fixedSupport As IFSupportStructural =
m_lusas.db.createSupportStructural("Fixed")
        ' set the freedoms
        fixedSupport.setStructural("R", "R", "R", "F", "F", "F", "F",
"F", "F")

        ' *** Create a support attribute (pinned) ***
        Dim pinnedSupport As IFSupportStructural =
m_lusas.db.createSupportStructural("Pinned")
        ' set the freedoms
        pinnedSupport.setStructural("F", "R", "R", "F", "F", "F", "F",
"F", "F")


        ' *** Create a load attribute ***
        Dim loadAttr As IFLoadingGlobalDistributed =
m_lusas.db.createLoadingGlobalDistributed("UDL")
        ' Set the parameters
        loadAttr.setGlobalDistributed("Length", 0.0, 0.0, -loading, 0.0,
0.0, 0.0, 0.0, 0.0)


        ' *** Assign the attributes to the geometry ***
        ' get the assignment object
        Dim assignment As IFAssignment = m_lusas.assignment()
        ' set the defaults
        assignment.setAllDefaults()

        ' Assign the mesh
        meshAttr.assignTo(beamLine, assignment)
        ' Assign the geometry
        geomAttr.assignTo(beamLine, assignment)
        ' Assign the material
        materialAttr.assignTo(beamLine, assignment)
        ' Assign the loading
        loadAttr.assignTo(beamLine, assignment)

        ' Assign the supports to the points of the line
        ' get the points - Lower Order Features
        Dim pointsArray() = beamLine.getLOFs()

        ' Assign the fixed support to the first point
        fixedSupport.assignTo(pointsArray(0), assignment)
        ' Assign the pinned support to the last point
        pinnedSupport.assignTo(pointsArray(1), assignment)

        ' Set the mesh
        m_lusas.db.updateMesh()

        ' The model is ready to be solved - get the temporary file path
        Dim tempFilePath As String = System.IO.Path.GetTempPath()

        ' Get the solverOptions object and set the defaults
        Dim solverOptions As IFLusasRunOptionsObj =
m_lusas.solverOptions()
        solverOptions.setAllDefaults()

        ' Get the exporter object that will export the model to solver
        Dim solverExport As IFTabulateDataObj = m_lusas.solverExport()
        ' Set the defaults
        solverExport.setAllDefaults()
        ' Set a filename
        solverExport.setFilename(tempFilePath &
"beam.dat").setSearchAreaFileOn()
        ' Export the model as a solver data file (.dat)
        Dim returnCode As Integer = m_lusas.db.exportSolver(solverExport,
solverOptions)
        If (returnCode <> 0) Then
            ' If the export fails we cannot run the analysis
            MsgBox("The tabulation failed")
            Return
        End If
        ' Save the model before solving
        m_lusas.db.saveAs(tempFilePath & "beam.mdl")
        ' If we sucessfully exported the .dat file we can run the
analysis
        returnCode = m_lusas.solve(tempFilePath & "beam.dat",
solverOptions)
        If (returnCode <> 0) Then
            ' If the analysis fails we cannot access the results
            MsgBox("The analysis failed")
            Return
        Else
            ' if the analysis is sucessfull load the results
            m_lusas.database.openResults(tempFilePath & "beam.mys")
            m_lusas.database.getResultsCache().calculateNow()
        End If
        ' *** Successful analysis - Process the results to determine the
max bending ***
        Dim maxMom As Double
        Dim nodeNum As Integer
        ' Get the results at each node to determine the max
        For Each element As IFElement In beamLine.getElements()
            For Each node As IFNode In element.getNodes()
                ' Extract the nodal result for the required Entity and
Component
                Dim my As Double = node.getResults("Force/Moment - Thick
3D Beam", "My")
                ' Save the minimum (sagging) momnet
                If my < maxMom Then
                    maxMom = my
                    nodeNum = node.getID()
                End If
            Next
        Next


        ' Get the units of the current model for display
        Dim forceUnit As String =
m_lusas.db.getModelUnits().getForceShortName()
        Dim lengthUnit As String =
m_lusas.db.getModelUnits().getLengthShortName()

        ' Set the dialog label
        lblMaxMom.Text = m_lusas.convertToString(maxMom) & forceUnit &
lengthUnit ' String.Format("{0:0.000}{1}{2}", maxMom, forceUnit,
lengthUnit)

        ' Quit the application and free the licence
        m_lusas.quit()
    End Sub


    Private Sub btnClose_Click(sender As System.Object, e As
System.EventArgs) Handles btnQuit.Click
        For Each p As Process In
System.Diagnostics.Process.GetProcessesByName("Lusas_m")
            Try
                p.Kill()
                p.WaitForExit()
            Catch ex As Exception

            End Try
        Next
        Me.Close()
    End Sub
End Class
```

Interfacing to LUSAS using C++

Generally, LUSAS recommends that you use VB or any other language that natively supports COM interfaces. C++ does not natively support COM interfaces, thus COM programming in C++ is much more complex, and results in code which is more likely to contain bugs and is harder to read. However, it is possible for experienced C++ programmers to interface to Modeller. A simple example follows:.

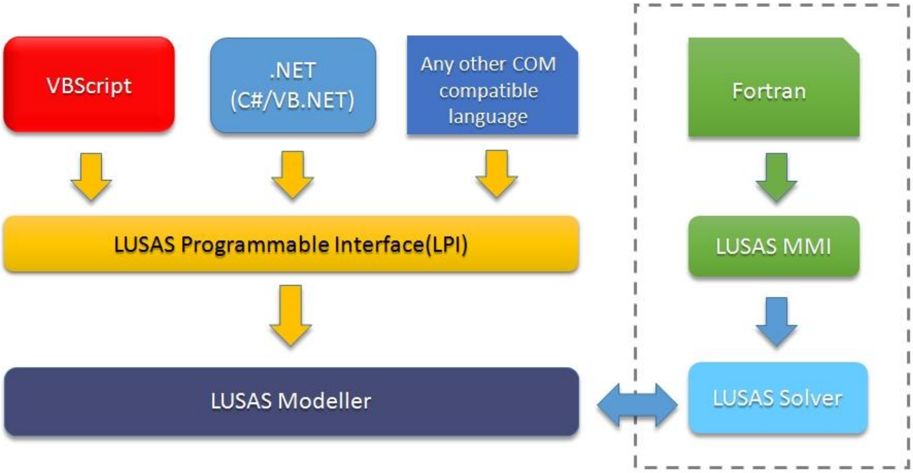
```
#import “C:\LUSAS152\programs\Lusas_m.exe“
// create a modeller
    pModeller = IFModellerPtr("LUSAS.Modeller.15.2");
// create and return a database
    IFDatabasePtr db = pModeller->newDatabase();
// create and return a line
    IFLinePtr l = db->createLineByCoordinates(0, 0, 0, 5, 5, 5);
// calculate line length
    double len = l->getLineLength();
```

Note. The LPI functions often return a base class pointer which often needs to be downcast to the desired type (e.g. attribute -> material). VB will do this for you, but C++ will not. Therefore you must explicitly cast, and catch any exceptions that may result

Note. LPI functions often have VARIANT inputs and outputs. VB will handle conversion between simple data types (integers, strings, objects) and VARIANTs, but C++ will not. Therefore you must be familiar with the use of the VARIANT type. If in doubt, consult Microsoft documentation.

LUSAS Material Model Interface

In addition to the accessing and customising LUSAS Modeller via the LUSAS Programmable Interface, user-defined material models (written in Fortran) can be compiled and built into a customised LUSAS Solver executable by using the LUSAS Material Model Interface (LUSAS MMI).


VBScript
.NET
(C#/VB.NET)
Any other COM compatible language
Fortran
LUSAS Programmable Interface(LPI)
LUSAS MMI
LUSAS Modeller
LUSAS Solver

The use of LUSAS MMI is beyond the scope of this manual. Please contact LUSAS Technical Support for more information.