Building Custom GIS Applications

Philip Bailey, North Arrow Research
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Outline

• What is a custom GIS application?
• Why would you want to build one?
• Example: the River Bathymetry Toolkit (RBT)
• How to build custom GIS applications
• Tips, tricks and pitfalls
• Resources & further reading
What is a custom GIS application?

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Arc Hydro
Groundwater by AquaVeo

Display, analyze and archive your groundwater & subsurface data. All within ArcGIS.
Model Builder
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Scripts and Tools
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What is a custom GIS application?

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- Adding new, or combining existing, functionality
- Deployable (can be shared with others)
- Reusable
- Reliable
- Predictable
- Scalable
- Documented
- Transparent
- Supported

River Bathymetry Toolkit

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RBT & GCD Architecture

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Documentation

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User Support
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Why would you want to build one?
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How to Build a Custom GIS Application?

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Software Development Lifecycle

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**Requirements Gathering**
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- It’s an art
- Constantly shifting
- Beware of over-scoping
- Think big but build small
- Beware of fickle clients
- Beware of undemanding clients
- Speak to real users
- Experiment with real data

**Be a pessimist! Ask “what could go wrong?”**
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**GIS Dataset**
- Must exist with specified name (error)
- Must have spatial reference (error)
- Spatial reference is project and in UTM meters (errors)
- File Path is less than 256 characters

**Raster Dataset**
- Orthogonal corners

**DEM**
- Minimum cell value > 0 (error)
- Max – Min < 100 (error)

**Extended DEM**
- Same corner coordinates as DEM (error)
- Max – Min < 100 (error)

**Vector Feature Classes**
- Must have at least one feature (table with one record) (error)

**Point Feature Class**
- Geometry type is point (error)

**Edge of Water Points**
- Text field called “Description” (error)
- At least one feature with “0” or “1” (error)
Design

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- Research
  - What is already out there?
  - Avoid reinventing the wheel
  - Every bug you write is your problem!
- Balance architecture with a responsive design
- Don’t let perfection get in the way of progress
Design Example
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Plan For Problems
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- How will users report them?
- What information will you need to solve the problem?
Exception Handling
Input & Output Validation

```vbnet
Public Sub DeleteFile(sFilePath As String)
    If String.IsNullOrEmpty(sFilePath) Then
        Throw New ArgumentException(sFilePath, "The file path cannot be empty")
    End If

    If Not IO.File.Exists(sFilePath) Then
        Throw New ArgumentException(sFilePath, "The file must exist before you delete it")
    End If

    Try
        If Do something risky here
        IO.File.Delete(sFilePath)
    Catch ex As Exception
        ' Add specific information about the exception here.
        ' Only show message here if at the user interface.
        ' Throw the exception again if unable to recover.
        ex.Data.Add("file path", sFilePath)
        Throw ex
    Finally
        ' Clean up here.
    End Try

    If IO.File.Exists(sFilePath) Then
        ' Use ex as New Exception("The file still exists")
        ex.Data.Add("file path", sFilePath)
    End If
End Sub
```

Design
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- Choose well supported technologies with a strong user community
If you have to use ESRI...

- Use geoprocessing as much as possible
- Avoid trying to support more than one version
- Don’t be an early adopter!

Extensions

- Two types
  - Regular (RBT) and “Just In Time” (Spatial Analyst)
- Compiled into DLL Assembly
- Registered with ArcMap using ESRI RegASM
- Deployed by install pack
- Can include:
  - User interface
  - Databases
  - External dependencies (beware the single process!)
- Only use when you need external dependencies to your code assembly.
ArcGIS Add-Ins
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- Do not need to be registered!!!!!!!!!!!!
- Single assembly DLL
- Actually just a zip file!
- Can include the same functionality as extensions
- This is the direction that ESRI is pushing

Add-In Demo
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Geoprocessing Inside a Custom Application

```
Public Sub Hillshade(ByVal in_raster As String, ByVal out_raster As String)
    Dim GP As New Geoprocessor
    Dim HillShadeTool As New ESRI.ArcGIS.SpatialAnalystTools.HillShade
    Dim bAddToMap As Boolean = GP.AddOutputsToMap
    HillShadeTool.in_raster = in_raster
    HillShadeTool.out_raster = out_raster
    GP.SetEnvironmentValue("workspace", WorkspaceManager.WorkspacePath)
    GP.TemporaryMapLayers = False
    GP.AddOutputsToMap = False
    GP.ClearMessages()
    Try
        GP.Execute(HillShadeTool, Nothing)
        Helpers.ProcessGPExceptions(GP)
    Catch ex As Exception
        ex.Data.Add("in_raster", in_raster)
        ex.Data.Add("out_raster", out_raster)
        GisCode.Exceptions.AddGPMessageToException(ex, GP)
        Throw ex
    Finally
        GP.AddOutputsToMap = bAddToMap
    End Try
End Sub
```

Python Inside a Custom Application

```
# Run a python script using the argument parameters

# @param out_file
# @param rasters
# @param rasters
# @param file_path
Try:
    rasters = subprocess.check_output(['script.py', out_file, rasters, rasters, file_path]).decode('utf-8')
    execute_tools(rasters, file_path)
Catch ex As Exception
    rasters = ex2.Data.Add("tool name", rasters)
    ex2.Data.Add("tool name", rasters)
```
Pitfalls

- Rushing or skipping requirements
- Building monuments to your intellect
- Overly elegant (read “complicated”) code
- Poorly documented code...
  - it will burn you
- Always version your application
- Don’t be the only tester of your own application
- Never directly alter user data

My Stable of Tools

<table>
<thead>
<tr>
<th>Type</th>
<th>My go-to Tool</th>
<th>Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop GIS</td>
<td>ArcGIS 10 SP5 with SDK</td>
<td>Quantum GIS, GME, R?</td>
</tr>
<tr>
<td>IDE</td>
<td>Visual Studio 10</td>
<td>Easy Php</td>
</tr>
<tr>
<td>Code Repository</td>
<td>Source Gear Vault</td>
<td>GIT, Cloud</td>
</tr>
<tr>
<td>Text Editor</td>
<td>TextPad++</td>
<td></td>
</tr>
<tr>
<td>Image Editor</td>
<td>Paint.net</td>
<td>PhotoShop, InkScape</td>
</tr>
<tr>
<td>Data Manipulation</td>
<td>Excel, Access</td>
<td>R</td>
</tr>
<tr>
<td>File Transfer</td>
<td>FileZilla</td>
<td></td>
</tr>
<tr>
<td>Browser</td>
<td>Chrome with FireBug</td>
<td></td>
</tr>
<tr>
<td>Virtualization</td>
<td>Virtual Box, Spoon.net</td>
<td></td>
</tr>
<tr>
<td>Documentation</td>
<td>Google Sites, FastStone</td>
<td>WordPress, Camtasia</td>
</tr>
<tr>
<td>User Support Forums</td>
<td>phpBB</td>
<td></td>
</tr>
<tr>
<td>Issue Tracking</td>
<td>unFuddle</td>
<td>Bugzilla</td>
</tr>
</tbody>
</table>
### Preferred GIS Data Formats

<table>
<thead>
<tr>
<th>Format</th>
<th>Vector</th>
<th>Raster</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverages</td>
<td>✔</td>
<td></td>
<td>No longer used</td>
</tr>
<tr>
<td>ShapeFiles</td>
<td>✔</td>
<td></td>
<td>Useful</td>
</tr>
<tr>
<td>Personal Geodatabases</td>
<td>✔</td>
<td></td>
<td>Out of Favor</td>
</tr>
<tr>
<td>File Geodatabases</td>
<td>✔ ✔</td>
<td></td>
<td>Recommended</td>
</tr>
<tr>
<td>ESRI Grids</td>
<td>✔ ✔</td>
<td></td>
<td>Avoid</td>
</tr>
<tr>
<td>GeoTIFF</td>
<td>✔</td>
<td></td>
<td>Useful</td>
</tr>
<tr>
<td>Erdas Imagine Image Files</td>
<td>✔ ✔</td>
<td></td>
<td>OK</td>
</tr>
<tr>
<td>ArcSDE /Enterprise RDBMS</td>
<td>✔ ✔</td>
<td></td>
<td>Overkill</td>
</tr>
</tbody>
</table>

### Resources & Further Reading

- **Forums**
  - gis.stackexchange.com
  - ESRI Developer Network (EDN)
- **Books**
  - Getting to Know ArcObjects
  - Framework Design Guidelines (Kwalina & Abrams, 2009)
  - “Windows User Experience Interaction Guidelines”
  - C++ The Core Language (Brown & Satir, 1995)
  - ESRI Map Book (27 editions)