Utilising the Virtual World for Urban Planning and Development

David JONAS, Australia

Paper Outline

7 steps in the Virtual Urban Citymodel Process:

1. User Needs Assessment
2. Data Quality
3. Data Acquisition
4. Visualisation
5. Functionality
6. Maintenance
7. Proposal Dissemination

Case Studies.
1. User Needs Assessment

1. Identify potential users
2. Understand their needs
3. Clarify their intended functionality

Utilise User Stories:
“I am a [user definition] and I would like to …”

Classify User Stories into:
Must have, Should have, Could have, Wont have

Get signoff by Project Sponsors.

2. Data Quality

Review the Data required to meet User Needs:

1. Accuracy
2. Precision
3. Reliability
4. Currency
5. Completeness
6. Reality.
2. Data Quality

Reality and Accuracy:
Everybody \textit{wants} higher degrees of Reality, but some users \textit{need} higher degrees of Accuracy.

\textbf{Higher Accuracy}
User Stories dominate with references to court hearings, legal planning decisions, measurement functionality, references to other datasets and other applications where \textit{“it has to be right”}.

\textbf{Higher Reality}
User Stories dominate with references to visual appeal, aesthetics, public consultation, visual amenity, and other applications where \textit{“it has to look right”}.
3. Data Acquisition

Review the Data Acquisition methodologies against the Data Quality criteria:

1. Satellite imagery
2. Aerial photography
3. Oblique aerial photography
4. Airborne LiDAR
5. Terrestrial LiDAR
6. Terrestrial imagery
7. Existing building footprints
8. As built plans
9. UAVs.

### Satellite Imagery

**Pros:**
- Little (or no) site access required
- Significant archives available
- Often cost efficient
- Cloudy areas can be captured without paying standby aircraft charges

**Cons:**
- Low resolution (0.5m at best)
- Poor resolution for capturing façades
- Archive imagery may be out of date

### Aerial Photography

**Pros:**
- Very high resolution available
- Archives may be available
- Versatility with bespoke capture
- Rapid and efficient capture once on site

**Cons:**
- ATC & possibly military permits reqd
- Poor geometry for capturing façades
- Archive imagery may be out of date
- Higher startup costs
### 3. Data Acquisition

**Oblique Aerial Photography**

<table>
<thead>
<tr>
<th>Pros:</th>
<th>Cons:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- simultaneous nadir &amp; oblique imagery</td>
<td>- ATC &amp; possibly military permits</td>
</tr>
<tr>
<td>- defines façade textures and geometry</td>
<td>- many flightlines for dense definition</td>
</tr>
<tr>
<td>- supports crisp vector definition</td>
<td>- poor definition of lower building parts</td>
</tr>
<tr>
<td>- good definition of upper building parts</td>
<td>- higher startup costs</td>
</tr>
<tr>
<td>- access to all sides of every building</td>
<td>- rapid and efficient capture once on site</td>
</tr>
</tbody>
</table>

**Airborne LiDAR**

<table>
<thead>
<tr>
<th>Pros:</th>
<th>Cons:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- simultaneous LiDAR and imagery</td>
<td>- geometry inferred from point data</td>
</tr>
<tr>
<td>- good definition of upper building parts</td>
<td>- building lines confused by data noise</td>
</tr>
<tr>
<td>- access to all sides of every building</td>
<td>- crisp building lines need high density</td>
</tr>
<tr>
<td>- rapid and efficient capture once on site</td>
<td>- poor definition of lower building parts</td>
</tr>
</tbody>
</table>

**Terrestrial LiDAR**

<table>
<thead>
<tr>
<th>Pros:</th>
<th>Cons:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- simultaneous LiDAR and imagery</td>
<td>- less access to rear side of buildings</td>
</tr>
<tr>
<td>- efficient mobile (vehicle) capture</td>
<td>- may require entering private property</td>
</tr>
<tr>
<td>- good definition of lower building parts</td>
<td>- lower accuracy in urban canyons</td>
</tr>
<tr>
<td>- high point density available</td>
<td>- poor definition of upper building parts</td>
</tr>
<tr>
<td>- lower startup costs</td>
<td>- buildings obscured by fences or trees</td>
</tr>
<tr>
<td></td>
<td>- facades obscured by traffic</td>
</tr>
</tbody>
</table>

**Terrestrial Imagery**

<table>
<thead>
<tr>
<th>Pros:</th>
<th>Cons:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- inexpensive GPS/attitude cameras</td>
<td>- provides poor building geometry</td>
</tr>
<tr>
<td>- skilled labor not required</td>
<td>- less access to rear side of buildings</td>
</tr>
<tr>
<td>- can access buildings by foot or vehicle</td>
<td>- may require entering private property</td>
</tr>
<tr>
<td>- lower startup costs</td>
<td>- buildings obscured by fences or trees</td>
</tr>
</tbody>
</table>
### 3. Data Acquisition

#### Existing Building footprints

**Pros:**
- no site access required
- low cost
- ensure consistency with other data layers

**Cons:**
- footprints may have variable accuracy
- no shape in the building upper stories
- building height required from elsewhere
- building texture required from elsewhere

#### As built Plans

**Pros:**
- no site access required (for this project)
- lower cost

**Cons:**
- rarely complete dataset available
- often inaccurate building location
- building texture required from elsewhere

#### Design Plans

**Pros:**
- no site access required
- allows proposals to be assessed
- good for maintaining existing city models

**Cons:**
- doesn’t support building existing cities

#### UAVs

**Pros:**
- small areas can be updated inexpensively

**Cons:**
- Public safety / liability concerns of UAVs in cities
- Can become expensive over larger areas
3. Data Acquisition

Aerial versus Terrestrial Cityscape Capture

1. Aerial Capture provides:
   1. Greater access to more building facades
   2. Greater efficiency in data capture
   3. Definition of rooflines
   4. More perspectives on more facades
   5. Required perspective for more planning purposes

2. But is limited by:
   1. Shadows
   2. Building awnings
   3. Vegetation
   4. Urban canyon.

3. Data Acquisition

Aerial versus Terrestrial Cityscape Capture

1. Terrestrial Capture provides:
   1. Clearer access to prominent facades
   2. Higher resolution

2. But is limited by:
   1. Facades accessible by vehicle or on foot
   2. Poor building geometry definition (other than streetscape)
   3. Building awnings
   4. Vegetation
   5. Less efficiency in data capture over large areas
3. Data Acquisition

Aerial versus Terrestrial Cityscape Capture

Capture geometry and overall textures from the air
Supplement aerial geometry with terrestrial textures.
4. Visualisation

Viewing on workstation, web or kiosk

Overlay 3D planning envelopes

Overlay 2D planning schemes

Interrogate building attributes from internal or external source (e.g., ArcGIS)

Visualize proposed buildings

Add street level photography

Overlay and visualize cadastral parcels

Consume web services
4. Visualisation

- Turn surface opaque to view underground assets
- Add realistic water modelling & reflections
- Wave modelling with wind direction & speed
- Accurate cloud and light modelling

Visualisations from K2Vi software
5. Functionality

- Shadow analysis of proposed developments
- Measurement: linear, areal, slope, aspect
- Display sky visibility from nominated point
- Conduct line of sight analysis

- Overlay external statistics, e.g., population
- Search models by SQL Query
- Visualise water inundation
- Screen capture and movie making
5. Functionality

Allows stakeholders to understand complex environments and attributes:

6. Maintenance

Need to maintain confidence in Urban Model:

1. Planning Process
   mandate planning applications include new models

2. Specific Update
   use planning process to identify changes for survey

3. Complete Remap
   remap city at periodic intervals

4. Partial Remap
   remap highly dynamic areas (between complete remap)
7. Proposal Dissemination

City of Melbourne uses Facebook to help disseminate planning schemes to stakeholders:

Case Studies

Managing Urbanisation
Case Studies

Urban Landuse Planning

Closing

Work from the Whole to the Part:
so that each component can play an appropriate role in
achieving the agreed result.

Process:
- uncover and clarify the needs to be met
- design a Virtual World to meet those needs
- define the functionality to utilise the Virtual World
- outline the data to support the functionality
- establish maintenance programs to provide enduring confidence in the Virtual World

Thank You