HBIM for Heritage Projects

Abstract

Most of BIM we see in the construction workplace is aimed at modern construction, with a consistency of materials, from well established manufacturers complying with a heap of British Standards on manufacture, quality control, record keeping, delivery storage and installation, that make for a known construction that BIM is able to record. But heritage buildings with materials that were often made 100's of years ago with little of no control are at the other end of the consistency we now enjoy with modern materials. Walls made of bricks may look the same but a single linear length may well have many variants on thickness, density, colour and performance that is difficult for modern CAD to record. This paper looks at a way to overcome this problem with a grid aligned to the Easting, Northings and Y axis, and allow planning to add to this several layers of planning law protection to the buildings from unwarranted alteration and repair.

A working model is currently in production using Guys Cliffe fire upgrade as a current live working model.

Keywords: CAD,HBIM, Data, Digital Asset, Architectural Heritage, 3D Grid, Easting & Northings, Uniclass, NBS, Sensor,Backscatter,

Article

One of the many problems in surveying and recording accurate surveys of existing heritage buildings is to record, with sufficient precision, the various materials used in the original construction and subsequent extensions and repairs.

When drawing up surveys its very difficult to record the variance particularly in a single wall, whether its a single skin or some form of cavity, modern CAD programs are built to draw using and element made up of a layering of materials that are consistent along its length The NBS Unicode is the national standard for naming of the elements, and a BIM tag showing the material used,

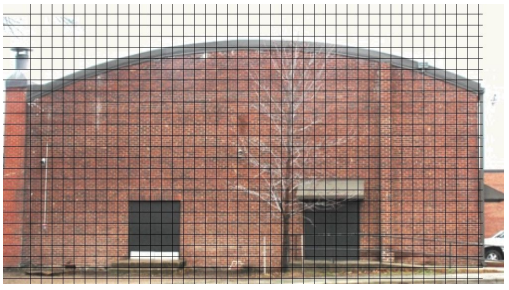
But older buildings did not have a supply of consistent materials, because materials used pre 1900 are often manufactured in questionable ways resulting in materials that had a large variance in performance. The further back in time you go, the bigger the problem and variance, and it is this single point which requires great care in assigning digital data to materials used in CAD models.

In contemporary buildings with materials made under controlled manufacturing conditions recording them within most if not all CAD programs is a simple process, but variances along that element such as manufacturing weathering from sun damage, plant and chemical attack, wind scour, rain and natural damage, can and do take their toll on the fabric of the building. (Douglas-Jones, R. et al. 2016. Science, value and material decay in the conservation of historic environments. *Journal of Cultural Heritage*, *21*, pp.823-833.)[5]

Manual inspection of the wall often on an infrequent basis often results in a manual paper based report at worst with a possible written digital report attached to the CAD drawing at best, This latter method has the benefit of digitising the process but leaves the data uncontrolled and difficult to append with updates, although adding specific damage location data as a header one might record a specific position and use that as a means of location.

The creation of a structured 3D model is essential in the control and modification of any Heritage style building, but it must be sufficient to allow the model to be extended into a crucial reference frame for the understanding, and future monitoring of the building, with any sort of reference data, from simple digital reports, photo, voice recordings to simple paper pdf notes and scans(López, F.J., Lerones, et al. 2018), to a more sophisticated Sensor data collection of individual components within any element.

By adding a 3 dimensional grid to a model (Nieto, J.E.,et al 2016) but one that's aligned to easting and northings, single cells or combination of cells can accurately and consistently be described as to position within a cloud database away from the main model, and because of its reliance on a national reference, UK national Ordnance survey grid, not a manufacturers program or model, it can be used to collate any evidence as to damage or condition, the cloud basis allowing for and format of digital data to be uploaded and shared and read by anyone, written, photograph, video or text based report, with specific values such as colour, pattern, density, thermal performance and general over all condition, this can affect not only the external facade but the internal elements as well, sub grids can easily be added for elements not aligned to the main grid, straight, curved, internal, external, sloping, or horizontal.



This can easily be done in a variety of well established surveying techniques currently used, and opens up the development of digital sensors, that might be deployed, together with new digital surveying techniques now being seen more frequently such as point cloud scans, which are being used to survey the outline of any building and to some level the visual appearance of the fabric, both internal and external. Point Cloud surveying is increasingly becoming available to even the smallest Architectural practice, offering almost instant surveys of buildings to form the basis of a working vector based drawing. But, as with most of the current digital surveying and point cloud surveying, it is very difficult for computers to interpret the data for anything but building “an as is model” , there are as yet no “smart

Algorithms, capable of extending the pictorial picture built up by a point cloud laser scan to produce possible performance data.

The addition of a 3D graph might well allow algorithms to compare sensor data to the point cloud and given enough data come up with realistic numbers.

Add to this, the increasing development of AR (Augmented Reality) CAD and the ease at which we can use it onsite, to overlay the grid to any element, adds to the need and use of this style of material data capture. Both written and video recorded data may be attached to specific points on any element (Pärn, E.A. and Edwards, D. et al, 2017)[6]

Any elevation internal or external can benefit from the grid, internal or external, plus and floor or roof, pitched or flat. From the instant a point cloud survey is taken.

An area of post original survey, is the use of sensors to record the living building its use and how the fabric deals with the day to day variances of use and inflicted weather.

Sensors grow in use and size on an almost daily basis, and can be installed easily on any surface, until recently placing them within an element might prove difficult to install and above all power.

That has now changed, the size of sensors has dropped, together with their power needs and supplying the power has gone beyond simple battery technology, with the development of backscatter technology (Liu, V., Parks, A., Talla, V.,et al., 2013) [3] taking power from the ambient radio signals replacing the batteries inevitable limited life and its often difficult replacement.

By installing sensors into or onto the fabric of the building extra data may well be gathered, but unless the internal embedded sensor can easily be fitted without any damage to the fabric of the building, external sensor placed on the surface of scanning sensor might well prove a real alternative.

By careful positioning of sensor in relation to the new grid , specific datasets may be obtained to measure a host of differing performances enabling contours of the new data to be displayed accurately and often in real time.

It is quite possible that each sensor may be scanning perhaps one cell or a series of cell, relating to the 3D grid. The reduced size and new power supplies reduce any damage to the minimum. WiFi or bluetooth adds the final link to any sensor station,to both receive sensor data, and in sending unlimited data to the cloud,

Ridged data structure so often limiting by structured datasets can now be freely saved and used by cloud based servers that are not limited in this way. Google's newly launched Dataset Search[7], a specialist search engine, similar to Google Scholar, to look for and catalogue open data sets. Now allows searches of open source dataset, similar to scholar search.

Sensor stations located to both internal rooms and externally as part of perhaps powered security cameras who are already supplied with power feeds or adequate batteries will scan for sensors, waiting for backscatter enabled sensors to wake up and to transmit.
Each sensor station will need to understand the new grid and its relation to it, to enable accurate positioning of each sensor. A printed QR code and or an RFID with an exact Easting & Northing & delta y position supplied by the CAD model would be sufficient for a sensor station to locate itself. (Ilkovičová, Ľ., Erdélyi, J. and Kopáčik, A., 2014.)[4]

It's quite possible that any sort of sensor might not be easy to install, so thermal imaging is easily adapted to use a grid and accurately isolate problem areas for more detailed study / reports, and perhaps sensor use. Variances in material will produce differing performance, by recording the visual differences on the element elevation grid an immediate understanding of damage can easily be seen.

The vast collection of data any group of sensor will generate needs to be located away from the normal model files, to enable easy access and add to the general populous of data from other buildings, in this was bloated working model files will be avoided. Google have published guidelines on a dataset structure (Noy N 2018)[8] To allow easy location by the Google search bots, simple data structure with clear matatabs are suggested (Noy N 2018)[9]

AR or augmented reality is quickly becoming a usable tool, to locate the viewer, most of the major manufacturers are investing in this technology, which opens up real model overlay to an existing building with simple tools to add all of the digital notes, video and audio recordings

In our trials utilising and iPad as an augmented viewer location of the model to its overlay surroundings was via a built in QR code reader with simply printed QR codes located onto known locations that contained the exact easting & northing, proved very successful.

Guys Cliffe, a grade 2* and scheduled monument, a large almost derelict building to the north of Warwick will be used to test this method of working starting with a set of 3D point cloud surveys using a BLK360 Leika point cloud survey unit. With later additions of sensors.

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BIM for Heritage, Historic England

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