uCampus
a web-based 3D interactive visualisation modelling platform to effect participative and collaborative planning and design of future learning spaces.

uCampus - a weCAMP core project output.

FINAL REPORT
31.03.2010
ACKNOWLEDGEMENTS

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The project was funded by the JISC Institutional Innovation Programme (Phase 2). We wish to acknowledge the following people for their comments, assistance and feedback received at various stages of the project externally: Dana Raydan and Jack Klinck, RMJM; John Allan, Avanti Architects; Harshada Deshpande, Urban Design and Conservation Team, Sheffield City Council; Simon Harrison, Yorkshire Forward; Phil Poole, Director of Learning and Teaching, Canterbury Christ Church University; Adrian Wheal, University of Lincoln and Wheal Ltd; Sara Eriksén, Professor of Computing, Blekinge Institute of Technology, Sweden; Richard Jones, Head of Flexible and Distributed Learning Centre, Buckinghamshire New University.

We are fortunate to have Ms Diane Hart and Dr James Pinder working closely with us throughout the project as the External Evaluators.

Thanks also to the following people who have advised and comments on the project progress internally at the University of Sheffield: Professor Keith Burnett, Vice Chancellor; Professor Paul White, Pro-Vice-Chancellor for Learning and Teaching; Professor Dominic Shellard, Pro-Vice Chancellor for External Affairs; Neil Cameron, Head of Estates; Jackie Gresham, Director of Learning and Teaching Services, Prue Chiles, Director of BDR; Dave Speake and Patrice Panella, CiCS; Lisa Scanlon and Phil Middleton, Union of Students; Keith Dean, Assistant Director and Head of Corporate Services; Wendy O’Connor and Jeff Ingram, Estates; Richard Yates, Head of Security Services; Dewi Thomas, Head of Safety Services; Cliff Alcock, Timetable and Space Manager, CiCS; Profesor Robert Gaizauskas, Department of Computer Science; Dr Bridgette Wessels, Department of Sociological Studies.

We are grateful for the hard work of keeping the JISC project account by Pat Hodgkinson, Finance Secretary, School of Architecture; and Liaqat Ghafoor, Finance Department.

Last but not least, we would never have achieved the extent of 3D modelling content on uCampus, within the project lifetime, without the enthusiastic participation and skills of the following students: Binh Nguyen, Anish Sharma, Preeti Preeti, Dhananjay Mote, Saurabh Agrawal, Vishalakshi Subedar, and Sektya Ageng Armanda.
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THE MAIN AIM OF THE WECAMP PROJECT IS TO DEVELOP AN OPEN ACCESS WEB-BASED PLATFORM THAT ALLOWS USERS TO VIEW AND INTERACT WITH THE BUILDINGS AND SPACES OF A UNIVERSITY CAMPUS.

Users can freely choose to view the whole of the campus at once or just an individual floor or even a space within a specific building.

The platform delivered by the weCAMP project is called uCampus - a visualisation of the University of Sheffield Campus. uCampus is openly available to everyone at: www.wecamp.group.shef.ac.uk

The main objective of the project is for uCampus to act as a tool to aid the collaborative and coordinated design of learning spaces [both informal and formal], by a range of university stakeholders. Although uCampus focuses on the University of Sheffield, it is the intention that the system and platform created can be adapted and utilised by other institutions.

Why don’t we just use Google Earth and Street View instead? Whilst working with different stakeholders this has been a question that has been asked regularly. uCampus offers both the interior and exterior of buildings and information on how individual spaces are used, allowing different perspectives to be gained and explored in 3D. The uCampus 3D building models are accurate to within 5mm, which means they can be used for a variety of purposes. Users can upload models in real time and decide whether their designs should be private or in the public domain.

EXECUTIVE SUMMARY

We have worked closely with a series of stakeholders throughout the project including practicing architects that are commissioned by the university, local authority planning department, Regional Development agency, members of the university estates, computing, learning and teaching, library services and students union. This has helped us develop uCampus over several versions that have taken into account the user requirements and expectations.
On the way to realising the project we have established new benchmark in the use of open-source 3D modelling standards. This has enabled us to build models with small file sizes, but with maximum flexibility and adaptability, so that they work online and users don’t require particularly high-end computers to access and interactive with the X3D models.

In uCampus we have developed a platform that other HE/FE institutions can potentially ‘roll out’. This could be with the weCAMP team acting as a consultancy service to aid this process, but the software framework and methodology established by the team should enable other institutions to develop a similar system with their own on-site expertise.

uCampus can be seen as a framework onto which many different sets of data and information can be integrated and visualised. This means that it has numerous different applications depending on different stakeholder priorities. On a simple level, for instance, every building on a campus could be colour-coded to show the energy efficiency rating for comparison. Zooming in, every space within a building could represent the energy usage of a space or computer suite. Wi-fi could be mapped and represented across a campus. Funded by a Benefits Realisation award, we are currently applying the uCampus software and the modelling methodology to the visualisation of portable netbook computer usage in Augustine House, a new learning hub at Canterbury Christchurch University.

uCampus facts:
- 48+ Hectares of terrain
- 70+ University building complexes
- 120+ University building floors
- 40+ spatial taxonomy profiles

The weCAMP project blog can be accessed at: www.wecampus.blogspot.com/
The weCAMP project builds on the previous work on the AHRC-funded SUCoD (Sheffield Urban Contextual Databank) project that investigated 3D Web-based visualisation modelling of buildings and landscape at an urban scale. How learning spaces of Higher Education/Further Education institutions can be digitally modelled in 3D form as addressed by the weCAMP project has been influenced by “Designing Spaces for Effective Learning: A guide to 21st century learning space design”, published by JISC, 2006.

The University of Sheffield (UoS) has undergone an intense period of campus regeneration over the past 10 years. The various capital projects planned and implemented on the UoS campus have prompted the need for innovation at institutional level:

- The need for the University to be able to interlink its Learning and Teaching Strategy with its Estates Strategy more effectively.
- To better manage the creative tension between allowing for open participative planning and design processes and the imperative of meeting financial constraints.
- To keep accurate and up-to-date records of its estates assets over time and to make them assessable as the institution’s collective intelligence for effective planning and design of future spaces.
- To coordinate future developments whilst meeting current funding streams and their implications on space development.
The project has the following aims:

- To produce an online visualisation modelling platform to facilitate collaboration and participation across a wide range of stakeholders engaged in the planning and design of learning spaces in higher education.
- To identify mechanisms by which the learning and knowledge acquired during such planning initiatives is captured and archived for future reference.
- To become an integral element of the communication process for large projects undertaken by the institution.
- To share the software outputs, the lessons learned and the experiences gained from the project with the JISC community.

The objectives of weCAMP are:

- To develop a generic extensible Web-based interactive campus visualisation modelling framework (weCAMP) that can be adapted to implement interactive campus visualisation modelling platforms of specific institutions.
- To populate weCAMP with real estates data sets and deploy the University of Sheffield campus visualisation modelling platform (uCampus).
- To develop exemplars of using uCampus to explore planning and design scenarios of future learning spaces not only in terms of how they may look like but also in terms of how they may function.
- To develop exemplars of applying uCampus to the participative and collaborative planning and design processes of specific campus building projects involving real users from different perspectives.
- To report on the lessons/experiences of weCAMP and uCampus as institutional exemplars on effective planning and design of future learning and other campus spaces.

The aims and objectives above are the same as the weCAMP Project Plan submitted to the JISC. The only minor change is that shefCAMP is now renamed as uCampus in order to achieve a better effect of institutional embedment.
METHODOLOGY

The overall project methodology can be described in three interwoven strands:

1. Software Development (SD)
2. Content Development (CD)
3. User Engagement and Evaluation (UE)

From an early stage of the project (February 2009), the project team worked on SD, CD and UE in a highly coordinated manner. As soon as the first version of uCampus (0.03a) was released in early March 2009, SD, CD and UE have been in close contact with one another, leading to rapid cycles of the uCampus Platform development, refinement and 3D campus model deployment.

1. Software Development (SD)

From the outset the project team decided to adopt a standardised approach to the requirements, analysis and design phases of the project. Elements of The Unified Modelling Language (UML)1 and Structured Systems Analysis Design Method (SSADM) methodologies were adopted where appropriate. It was recognised that an exhaustive analysis stage would greatly improve the efficiency of the implementation process all round.

The creation of a specification provided the basis for the software design and development and the choice of platform and infrastructure necessary to support the intended user base. It was clear that in order to satisfy all requirements the application needed to be web-based with both a client and server side implementation. The salient factors influencing the choice of platform proved to be interoperability, concurrency, a unified development language and scalability. It was envisaged that there may be several hundred users at a time so scalability through concurrency was particularly important.

For these reasons, the Java Enterprise Edition (Java EE)2 platform seemed the best fit. Its Servlet based architecture would provide the concurrency that was required and we would benefit from both the client and server sides being developed in a common language with the potential for the use of a common source-code base and shared libraries.
2. Content Development (CD)

Central to the weCAMP research methodology is to address the question of how to visualise spaces of a University’s estate in such a way that a wide range of stakeholders and end users could access the visualisation with ease and flexibility. We have since been experimenting with a generic methodology of achieving the interactive 3D visualisation as envisaged:

a. Contextual Architectural Modelling
b. Domain-Specific Data Visualisation Modelling
c. Overlay of a and b

In weCAMP, the domain of data visualisation is specific to the spatial uses currently recorded at the University of Sheffield.

a. Contextual Architectural Modelling
The uCampus map is the main interface to the platform and a primary piece of content. This is the first thing the user sees when they log into uCampus and is the means by which they can visualise the area covered by the system and then go on to navigate within it. Therefore while designing the map interface it was crucial to keep in mind user friendliness and clarity in illustration.

The uCampus map covers the entire area of the University of Sheffield estate. A generic digital model of landscape and building skins was brought from Z-mapping and acted as the base layer for further modelling. This area is then divided into terrain squares pertaining to
the national Ordinance Survey grid system. Each square covers an area of 100m x 100m and follows the geographic naming system. These grid squares also represent the geographic terrain respective to the area which is selectable through the interactive map.

The University buildings have individual selection properties whereas the non-university buildings within close proximity of the campus have been grouped together per terrain square. This decision was taken as it overcame problems generated from naming individual buildings and privacy issues within the local community.

The modelling of 3D building structures was undertaken in two phases. The first was a less detailed phase, which allowed us to populate the entire uCampus area, create a prototype for demonstrations, and progress with other areas of the project that were dependent on the building modelling system.

The second phase were more detailed models of the university building (up to 5mm accuracy level), which were constructed from drawings available from the University’s Estates Department. These models were completed, the models from phase 1 were updated.

The models of university buildings created a significant volume of data sets, which called for the introduction of external contributors. These were typically post-graduate students from the University of Sheffield School of Architecture. A number of prototype models, covering the basic building typologies, were developed by the project team. The development methodology was standardized in a number of technical specification documents which, in combination with a number of workshops, allowed the students to contribute effectively. Finally, the work submitted by the students was corrected in-house and integrated into the system. In order for the platform to communicate with the data sets, a
data-feed structure had to be set.

The chosen format for the data-feed structure was XML due to its usability and adaptability, as well as its compatibility and similarity in design philosophy to X3D. The use of XML demanded two key elements: a database structure and an XML Schema.

b. Domain-Specific Data Visualisation Modelling

Creating Spatial data for room usage was seen as a continuation of the detailed building modelling, however it involved developing a new methodology. Categories for different rooms uses were then colour-coded and a key created. The specification for making the colour-coded boxes to fit into the database was simple to follow, and required basic modelling skills.

3. User Evaluation (UE)

The importance of user evaluation in the development of the platform was realised as part of the original bid document. The early stages of the project were largely theory based, however it was realised that due to the visual nature of uCampus that an early development release of the digital platform would facilitate easier user engagement. The first releases were used within the development team to explore basic interface issues as well as helping to discuss potential uses and user groups.

Following the release of uCampus 0.03a the user groups were focused in order of priority engagement through a discussion session between the project team and the external evaluators. This allowed the development of a programme for consultation that responded to the specific development needs of the platform, helping to refine the next stage of development.
METHODOLOGY

while keeping an overview of the overall aims of uCampus.

The Project Team met regularly with various stakeholder group to discuss their requirements and expectations of the project. The stakeholder base was relatively wide with a number of interests that needed to be addressed. Presentation and interviews have been deployed when we have needed to engage users with limited time available to them. The team has presented the platform at its current stage of development and asked a series of questions based on predetermined issues that required external guidance whilst responding to other in line with the questioning arising during the session.

This pattern of analysis and development lead to an integrated approach to evaluation and implementation that has enabled a rapid and responsive approach to evolution of the platform. In this way it was identified that there were several main common requirement strands that should be focused upon. Corresponding use-case scenarios were developed which then fed into the development specification.

User scenarios have been established to explain the various potential uses and users of the platform:

**Potential Student**
- A secondary school pupil who wants to see the union and faculty buildings at the University of Sheffield before visiting on an open day.
- An overseas student who would like to explore the facilities at the University before applying and cannot visit in person.

**Existing Student**
- Way finding
- Wanting to locate lecture theatres and learning spaces
- Identifying spaces for group work
- Using the models of university spaces for project work
- A landscape architecture student group that wants to showcase a project
- An architecture student wanting to use the model to develop proposals for a design project

**Administrative Staff**
- Identifying, locating and organising learning

Stakeholder conservation event at the Student’s Union
space facilities within the department
• Looking at possible changes to departmental space use
• Identifying rooms to book around the university campus
• LeTS [Learning and Teaching Services] – identifying spaces and planning new facilities to facilitate and support learning opportunities such as IBL [Inquiry-based learning]
• CICS [Corporate Information and Computing Services] identifying possible new ICT facilities and organising existing provision to improve learning opportunities

Academic Staff
• Identifying learning spaces whilst planning and organising learning and teaching programmes
• Rethinking learning practices and identifying spaces and places that support new learning and teaching practices.

Estates Department Staff
• Create a strategic university campus development plan
• Develop reference scheme proposals for new buildings
• Plan for future development on building and landscape projects
• Manage existing buildings and develop refurbishment proposals
• Analysing existing learning facilities for reorganisation and use
• Use as an engagement/consultation tool within the university management system or externally

External Architects
• Illustrating how a new university building inside the campus would look and be used
• Representing building projects at various stages for the university clients to assess and review

Local Authority
• A member of the City Council who wants an overview of the entire campus
• Looking at and reviewing the University’s development plan and initial consultation on new building projects

University Neighbours
• To view a proposal for a new university building prior to a consultation process
• To locate where opportunities for lifelong learning take place
1. Software Development (SD)

The SD strand focuses on what we call a Java-based X3D Delivery (JX3DD) framework that is adaptable, extensible, portable and scalable. The X3D standard was chosen as it is the most advanced open-source technology currently available on the Web for creating 3D content, which is also most cost effective in comparison with other proprietary 3D graphic technologies. The CD strand has invested in developing 3D modelling standards that can be applied to any campus estates, and also lays the foundation for a large-scale postgraduate student participation in creating the 3D models at a later stage. Given the outputs of SD and CD at various phases, user engagement and evaluation were carried out both internally and externally to inform the continuous growth in uCampus software capabilities and content design. Based on the uCampus outcome, we then work to produce the weCAMP Software, Consultancy and Research as three identifiable products that other institutions could buy in.

The Project Team worked closely establishing the interplay between the main project elements. These were; the application code; SVG components; the XML meta-data and the X3D model data. Key at this stage was the design and implementation of the project database as it would dictate the bounds of the project. Since it was so crucial, considerable effort was expended in getting this right and a number of potential designs were evaluated before arriving at the final solution.

Evaluation of the suitability of the database design involved leveraging the work already done at the analysis stage. In particular the user scenarios analysis that had been performed in partnership with the stakeholders was particularly instructive. It allowed us to identify and eliminate some potential inconsistencies at an early stage. Encountering these mid-project would have been far more costly and could have been a serious source of delay. This approach proved its worth in the number of features that were subsequently exploited.

The actual implementation of the database required the authoring of a corresponding XML parsing toolkit which also allowed for SQL transcription should we need to interface to internal/external databases. This was done using the standard SAX and DOM class libraries that are made available to the Java application developer.

It was also acknowledged that these should be developed in such a way as to also allow for the direct processing of X3D in the future. This is another example of where the project has benefited from a structured design which allows for open-ended extension through code re-use. The consistent choice of XML based formats (SVG/X3D) greatly enhanced the exploitable interoperability throughout the project development cycle.

Most of the software development effort was directed towards the development of bespoke client and server applications. In the case of the
client application, a significant fraction of this effort involved the integration of 3rd party plug-ins and libraries. This was in order to provide the means to display a 2D SVG based interactive map and also to embed an X3D renderer seamlessly into our application.

The 2D interactive map was built from an SVG interactive template placed over a background image. The SVGSalamander3 package was used to couple the map to our application with selections being picked up through a standard event based interface model. The 3D visualisation of our models was achieved by integrating a commercial standard X3D plug-in viewer into our application. By far the best was BS Contact and this was adopted as our recommended standard. All this was integrated seamlessly into the client graphical user interface (GUI) which also took a lot of careful user-interface design and testing. An early prototype of the project was required as a focal point to further the consultation process with our stakeholders in order get their impressions for positive feedback. This could then be acted upon while the implementation process was still underway. In addition, the availability of an early prototype greatly enhanced the potential for external contributions to the project. Achieving this so early in the project proved to be extremely technically demanding but nevertheless was beneficial over the entire project and is to be recommended where possible in future projects.

Following the initial resolution of the major technical unknowns the project implementation continued unhindered. It was added to and developed in a modular fashion over the entire project lifetime with constant reference to the original design documents and artefacts. The initial investment in time spent in design and analysis returned itself many times over.
2. Content Development (CD)

i. Mapping & Modelling

The uCampus base map was designed to enable quick download load and smooth user navigation. With this in mind, it has been constructed in 2 layers; the GIF background image layer and the changeable SVG (Scalable Vector Graphics) layer. The high resolution GIF layer along with the SVG layer ensured that the map did not pixelate during navigation. The components of the map were then sorted to sit on either layer depending on their level of interactivity. The elements that are non selectable (e.g. Trees, roads etc) were put on the image layer whereas the selectable elements such as outlines of buildings, terrain squares etc. were on the SVG map. The SVG map was then overlaid with precision on the GIF image so that both were in perfect coordination when the user zoomed in and out of the interactive map.

Another strategy used with the SVG map was to keep its file size as small as possible. In order to achieve this, only “live” objects were updated onto the SVG file from whereas the main master file for the interactive map remained on Adobe Illustrator file. This worked very well as while Illustrator provided the perfect visual platform to make changes and updates, it also allowed us to convert updated files into the SVG format, from which we were able to pick out additions to the live SVG map and incorporate them in the online version.

The building models were built with the help of a Z-mapping 3D base file bought specially for this project specific to the area covered by uCampus. The models for the individual buildings were extracted from the overall 3D master-files and were edited accordingly to fit into the uCampus platform. This was done by targeting different zones within the university campus which had maximum population of university buildings e.g. The Western Bank area, the Jessops quarter etc. In the first phase of modelling the extracted models for university and non university buildings were saved and individual files from the main 3D CAD master-file which were then imported into 3D Max and saved out as VRML files. These files were then converted to X3D format by using a VRML to X3D convertor. The X3D format was used because being a word based 3D file format it is very adaptable and has minimal download time. The X3D files were then edited to fit the colour coding and XML structure of the uCampus system before being uploaded onto it. In the second phase of the building modelling system which was only applied to the University buildings, the models were constructed on a floor by floor basis from available CAD drawings from the university’s estates department. These were assembled using various 3D modelling packages which were ultimately converted into the X3D format and can be viewed individually or as a whole using the uCampus XML structure.

ii. Modelling & data

The database structure was developed with the
The aim of allowing a clean hierarchical structure, solid interactions between each level, and encapsulation of the properties of each element. Also, there was the requirement for a clear mapping of the database levels to real-life concepts. The latter added some complexity on the design stage, as the perception of the properties of each element varied among users of different backgrounds. A list of possible use-case scenarios was compiled early in the project allowed for a clear delineation of the relationships between individual elements.

The database structure was realised in XML, using standard procedures for such a task. An XML Schema was set up, allowing for enumeration of individual properties and shielding the structure against potential future appendages that do not conform to its design philosophy.

The creation of the data sets started with the identification of a number of buildings as characteristic of the typologies to be encountered throughout the project. These were modelled in various ways until an agreement for a paradigm was reached. As the bulk of the modelling work was to be done in industry standard packages (such as Autodesk AutoCAD® and Autodesk 3Ds Max®), the process of transforming the models from the applications’ proprietary formats to the open-source X3D standard was of vital importance. A number of technical issues ensued, as the supporting software for X3D is limited and of experimental / non-commercial nature. In the end, the team created its own uCampus-specific extension to the X3D standard, specifying a particular document structure while allowing for additional attributes to program specific object behaviours. Additional problems had to do with the collaboration and translation between file formats and the limitations of hardware and software for very heavy and detailed models that were to be transmitted via the web. These were solved with a variety of strategies, typically by analyzing how the modelling software created the models and calibrated the modelling methodology.
IMPLEMENTATION

to achieve optimization of the end-product.

Once the modelling strategies were finalized, the aforementioned buildings, indicative of the whole, were modelled and uploaded on the platform. During this process, additional problems and conflicts were identified and dealt with, and proof of concept was achieved and distilled into a set of detailed technical specifications. These fell into three categories: floor modelling specifications, taxonomy modelling specifications, and new feature design specifications. The latter is largely intended for internal use, and provides a common standard for discussion for the introduction of new features, not only for the lifetime of this project, but for any possible extensions of the platform in the future. The first two deal with the creation of the data sets and are meant for the external contributors, providing step-by-step instructions for the creation of new models.

The last major part of the creation of the data sets, was the production of those by the external contributors. What became apparent early in the process was that the work has demanding in technical skill, calling not only for a specialization in the finer points of 3D modelling, but also for some competency in IT, namely mark-up languages, and computer graphics. Despite most of the students already being familiar with X3D, having taken a relevant module during their post-graduate studies, additional workshops and tutorials were required, so their work could conform to the standards of the platform. Due to the wide variety of modelling tools and strategies employed by the students, quality control became necessary for a wide-variety of issues, from modelling accuracy to specification conformance and viewer compatibility. Finally, for reasons of security and complexity, the development of the required accompanying XML files for integration with the platform, were dealt with directly by project team.

3. User Evaluation

The evaluation engagement has been conducted throughout the course of the project. The engagement programme have been carried out internally and externally. These have taken four key strands:

Inter team development has been evaluated through regular progress meetings to the project board. The project board has been able to offer an external perspective of the platform and suggest potential avenues of development. Internal team meetings have allowed the development team to present progress and design ideas to the project director, project manager and lead platform use-ability evaluator, further helping focus development.

External evaluation monitoring has been undertaken at key points in the project. The external evaluation team has met the core project team to discuss and identify key user groups as
well as approaches to engaging with them. Diane Hart and Dr James Pinder have also undertaken a series of interviews with the wider user groups to understand the impact of the platform on the project’s wider audience.

End user engagement has included working with users on theoretical approaches and real time projects. These have been based within the University of Sheffield but have also included inter JISC benefits realisation collaboration with Canterbury Christ Church University. This has allowed the testing of the platform to improve adaptation possibilities for specific end user requirements.

Three key projects have run through the course of the platform development. Early on MArch level architecture students were asked to use the platform to develop their own design projects in an accurate 3D environment. Many of these students were then engaged in the modelling of the wider campus, utilising their knowledge base to work as part of the development team. This has helped to facilitate a more rapid growth of content development than originally anticipated. The second project has been a close collaboration with University of Sheffield Students Union. The Student’s Union building is undergoing extensive renovation and has been actively engaged with uCampus to illustrate the impact of the changes to the wider student population. Thirdly, Benefits Realisation funding has enabled close collaboration with the iBorrow team from Canterbury Christ Church University. ‘The Augustine House Experiment’ has been modelled the new campus building as a base for exploring iBorrow’s data collection and analysis project.

uCampus being used by Student’s Union to show temporary access during construction works
One of the key outputs of the weCAMP project is the uCampus 1.1 which is now accessible on the Web. uCampus 1.1 is a portal hosting X3D models of the Sheffield central campus (covering 48+ hectares, 70+ University buildings, 120+ University building floors, and 40+ spatial taxonomy profiles). The uCampus User Guide is built inside the portal. On the basis of uCampus, a generalised weCAMP software framework and documentation will be made available to the JISC community, allowing rapid adaptation into specific institutional contexts. For instance, a different version of uCampus can be quickly adapted and deployed to fit the specific context of a different institution.

For 3D model content development, we have produced two specifications of modelling standards: uCampus 3D Architectural Modelling X3D Standards and uCampus 3D Spatial Taxonomy Modelling X3D Standards. These standards are in essence the knowledge bases acquired through the project that give detailed accounts of how to model a University’s campus, buildings, and spaces. Like the weCAMP software framework, the two standards are written to be reusable by other institutions to set up their own 3D modelling task forces.

User engagement and evaluation have been an important part in project progress ever since the first release of uCampus onto the University’s campus network. This strand of work was carried out both internally and externally. The final version of the weCAMP External Evaluators’ Report authored by Diane Hart and Dr James Pinder will be made publicly available via the weCAMP website.

The weCAMP Blog1 and Web sites2 maintained throughout the project lifetime present a history of how the project has progressed from the beginning, which we find it useful not only internally to the project team but also externally to our collaborators. The weCAMP website hosted by the University’s central computing services will
be substantially updated for disseminating the project outputs and outcomes.

Lastly, two conference papers have been published reporting the project outcomes to an international audience in Barcelona and Eindhoven. The project has generated a large amount of data, evidence and related resources for writing up more journal and conference papers.

1 http://wecampus.blogspot.com/
2 http://www.wecamp.group.shef.ac.uk/

The full proposal for the Students Union and how it is being used can be seen at: www.sheffieldstudentsunion.com/category/future-union/
OUTCOMES

The development of uCampus has achieved far more than originally anticipated. The platform is more extensible and extendable, with a greater level of complexity and scope than first envisaged. Options such as a photo bank of buildings have been superseded by integration with Google Streetview, again an option not available at the start of the project. The extensibility of the platform means that a wide range of data can be plugged into the platform, enabling new features to be developed, continually enriching the experience of the platform. This is a direct result of the close links between Software and content development and user evaluation.

Overall, the weCAMP project has laid down the foundation for piecemeal growth of the University of Sheffield Virtual Campus into the future. We believe that the University is now better equipped to engage participative and collaborative institutional learning about planning, design and uses of existing and future learning and other spaces in a cross-campus holistic manner which has been lacking in the past. The methodology developed through the project has allowed the weCAMP team to create several exemplars of how the individual learning and other spaces can be accurately modelled and visualised in the campus context. We believe that this methodology is applicable to any institution geo-location and to any domain of data visualisation such as energy uses among many other possible applications.

1. Working within the University

Earlier versions of uCampus have been presented to members of the University’s Senior Management Group including the Vice Chancellor, Pro-Vice-Chancellors, Heads of Estates, Learning and Teaching Services, Corporate Services, Security Services, and Safety Services. Presentations were also made to the Department of Computer Science, the Interdisciplinary Research in Social-Digital Worlds...
(IRiS) at the University of Sheffield. The Pro-Vice Chancellor has shown interest in uCampus and has asked that the project be presented to the University Executive Board later this year to prompt discussions about its future embedding and wider use by the University.

In recent years the University of Sheffield has engaged in intense campus regeneration. This has generated the need for improvement with respect to flexibility of learning spaces and accessibility of IT and media. UCampus can be used to aid this process by the University's internal Estates Department and also stakeholders associated with the planning and design of university spaces. This open platform can be the basis of a sustainable green campus proposal and be used to monitor the campus’ environmental presence.

As part of the user engagement activities, we have worked with the architects from RMJM who designed the Information Commons and the new Teaching Hub projects. These conversations have helped to refine the scope of use of the platform amongst professional users in their work with the University.

We see that uCampus has the potential to provide a very simple but sophisticated portal for a variety of users to view and experiment with the quality of physical space virtually, from booking a room to finding out where a space might be. It differs from other virtual world applications like Google Streetview, Secondlife etc. In that it is a very flexible and interactive database and allows the user to view, access and edit the 3D data in any and every combination they require. With keeping fancy visual graphics to a minimum and using small file formats uCampus is easily accessible over the browser without requiring the user to download any complex applications or process high level video cards, and also allows them to view changes that they have proposed thus making it a very versatile platform to work with.

The Sheffield City Council has also been kept informed of the outcome of the weCAMP project in relation to the Council’s Sheffield 3D Model Service.

2. Working with Student Groups

In December 2009, the Union of Students commissioned us to develop staged 3D models of the redevelopment of the Union Building in which uCampus has been put into real use in a live project situation. For three months, we have collaborated with the Union team on the 3D modelling entirely over uCampus. The results from the collaboration are now published on the Students’ Union website. These 3D models were built to inform students and staff about the changes to come as well as to serve the Union team as a basis for planning and design of the new spaces. The collaboration is set to continue after the weCAMP funding ends.

UCampus can serve as a basis of experimental
learning for students of architecture and urban design as was experimented with the Masters students at the University of Sheffield's School of Architecture. However, the future potential of uCampus can be extended to other areas as well. Similar methods of teaching can be extended to other disciplines like the teaching of Landscape Architecture where the terrain provided within uCampus can serve as an important basis of teaching. Also with accurate tree survey information vegetation can be mapped and tree species tagged which can then be made accessible to student users for study and analysis. Eventually, uCampus can be introduced to people from other departments like civil, mechanical, psychology etc. and their comments on various spaces can be tagged and archived making this a universal platform for everyone using university spaces. UCampus provides an interactive learning platform where students can upload models, enabling instant monitoring and feedback.

3. Working within the JISC Community

From an early stage, the weCAMP team has been in close contact with the i-Borrow team due to the shared common interests in better understanding of how ICT-Rich Learning Spaces actually perform. Following two mutual Assembly events, the SSBR team awarded a Benefits Realisation grant for the weCAMP-iBorrow direct collaboration to undertake the Augustine House Experiment from January to June 2010.

Following the Innovation Exchange Conference in Birmingham (28-29 Jan 2010), Chengzhi Peng, weCAMP Project Director, was invited by Rob Bristow, Programme Manager JISC Executive, to present uCampus at the first Greening ICT Programme Meeting (25-26 Feb 2010). It is expected that further links between weCAMP and project teams working on the Greening ICT Programme will be developed.

In general, it can be said that the database structure has proven successful. At the same time, the modelling and information-gathering process illustrated the lack of attention to 3D, and its importance to the management of estates, by most big organisations.

The development of the data sets showed a number of limitations of the X3D file format. It is mainly aimed towards 3D authoring instead of modelling, while the support by the industry is extremely limited, both in professional-level software and educational/training material. Also, its practically non-existent use in the design industry makes it very difficult to find personnel to work on it -the project team had to train the external contributors it employed, and even then there was a significant drop-out rate.

6 http://www.sheffieldstudentsunion.com/2010/02/02/3d-model-2/
The uCampus platform has proved robust, adaptable and extensible. It has been deployed across The University of Sheffield Managed Desktop Computer system and is successfully available on the world wide web.

The platform has proved of interest to a wide range of stakeholders, with each person seeing opportunities to store, access and visualise specialist data that could have a direct impact on the efficiency and effectiveness on their work within an HE institution.

The basic design methodology of the data structures has stood the tests imposed on it so far, and there is ample room for additions.

The interaction with the external contributors made clear the importance of highly detailed specifications, and extensive quality control to support the longevity of the platform.

The X3D format has a number of advantages on the IT/programming. However, its limited support by the industry is an obstacle for its wide application, certainly within commercial architectural uses.

The X3D viewer that is required as a plug-in to view the building models has been developed as open source software by a third party. Whilst it is very useful tool, it also has limitations, particularly with ease of navigation around the 3D models.

Adopting standard approaches to the software project development proved invaluable with the proviso that the ones chosen were flexible enough to be adapted to our project. It was essential to be able to discard processes that were of no value to our working method. Though time consuming and difficult in the beginning the standardised approaches more than paid off during the lifetime of the project. There were no costly dead-ends or U-turns mid, or worse, late project delivery.

A direct result of our approach is also the open-ended extensibility of the platform that we have developed. The choice of open standards such as XML, X3D and SVG further emphasises this and it has been a unifying philosophy throughout. Consequently, the platform that we have developed opens up numerous exciting potential future applications and further development prospects.
As a visualisation platform for any 3D objects, uCampus acts as a fundamental tool that can be utilised in many different ways. In addition, the geo-referencing of objects in 3D space means that data can be visualised with very high levels of accuracy. The flexibility of the system means that it has the potential to be able to visualise objects in real time and be able to handle temporal data.

- **Towards a virtual campus:** Although not one of the aims of the project uCampus has the potential to be the foundation of a virtual campus, enabling students to learn remotely but feel part of a campus and place. Users could potentially be able to select and view different layers of information. For example, a student could locate a learning space, meet a lecturer through a video clip and find out where their office is. A member of staff may be able to identify and book a learning space dependent on a range of criteria, from room availability to the energy rating of the room! Layers of information could be overlaid according to user requirements.

- **Project evolution:** The development of our platform represents a step-function in the projects that now become possible in the future, whether by this project team or by other parties at other institutions. Opportunities to visualise an array of information about the use of buildings is a huge area of development for uCampus. The current benefits realisation proposal for Augustine House at CCCU is the starting point of integrating and visualising different types of data and information in real time and space. This project could be expanded to other institutions and rolled out as a consultancy if appropriate.

- **Plug-ins and mixed media potential:** At its most basic level this project could be considered as a starting point should other unrelated projects require a template for the
development of web-based applications. The 3D models of buildings and spaces within uCampus act as a blank canvass, and have the potential to integrate images and videos, as part of the surface planes. This has a number of implications in terms of the mixed media that can be represented spatially.

• **Supporting wider software development:** Epigenesys [a University of Sheffield spin-off computer programming company] will be developing a Mac compatible version of uCampus, to enable cross-platform functionality, enabling a wider user base of the platform.

• **uCampus for mobile devices:** The opportunity to make uCampus an application for mobile devices would enable the platform to be used ‘on the move’ and further enhance the range of uses for the system. Being able to use GPS to track a device and even visualise its location within a space on uCampus could aid way finding and navigation as well as the possibility of locating a specific book on a shelf in a library.

• **Tapping into Green ICT programme:** Chengzhi Peng is working with the Green ICT programme manager and The University of Bolton to integrate uCampus in to projects that are looking into areas of energy and resource conservation. These subjects are difficult for lay-people to engage with as energy usage is not a visible operation. By utilising uCampus to present data visually, more people can understand and see for themselves how to conserve and use resources more effectively.

• **Research and innovation:** Opportunities for working with other building types in areas of Arts and Humanities research have also presented themselves. A recent enquiry from the Pro Vice Chancellor for Research and Innovation has highlighted an interest in developing the system for the analysis of stately homes.
REFERENCES

Project Outputs

uCampus 1.1 Platform - Download from: www.wecamp.group.shef.ac.uk/

uCampus User Guide - uCampus 1.1 [download from www.wecamp.group.shef.ac.uk/]

weCamp Blog - http://wecampus.blogspot.com/

Publications


On X3D: Brutzman D, Daly L, X3D: Extensible 3D graphics for web authors, San Francisco: Morgan Kaufmsan; 2007

Web Resources


Recommended players and support material

Octaga AS - http://www.octaga.com/

Bitmanagement - http://www.bitmanagement.com/


SVGSalamander – SVG engine for Java https://svgsalamander.dev.java.net/
APPENDIXES

A  Internal Evaluation Report
B  External Evaluation Report
C  Technical Schema