Model mania

The realism of virtual training is frequently decided by the quality of a visual database's 3D models. There are a number of companies involved in the creation of such content and the quality keeps on improving. **By Trevor Nash**

Few would argue that the fidelity created by 3D modelling used in military training and simulation applications has never been better. There are a number of reasons for this – processing power within CPUs and GPUs are arguably top of the list, but this is closely followed by a vast array of intuitive and efficient modelling tools that are now available.

MTSN has previously examined terrain database creation (see Jan/Feb 2016 issue, p22) and noted a number of trends. These included the move towards more rapid database creation, availability of increased high-resolution source data and whole-Earth databases.

By contrast, this feature will look more closely at the 3D modelling aspects of the database, although it will touch on 3D terrain.

Part of the process

'3D modelling is an inherent part of the process of building a database for a visual image generator (IG) or for any other of the sensors used on a simulator for a complex aircraft,' explained Andrew Fernie, senior technical fellow at CAE in Montreal. 'The techniques used depend on the type of object to be modelled, the degree of fidelity needed to meet the training need and the types of [source] data available.

'As an example, most of our large area databases use our Motif technology that works with libraries of geo-representative models that are placed based on geographic vector data. The building models in these libraries were constructed based on publicly available data and are available for re-use when new databases are being built.

'Another technique used when buildings must be applied to satellite terrain imagery is extrusion. Building outlines are identified in the imagery and simple

A rendering of Nellis AFB, Nevada, highlighting 3D models of an F-22 and F-35 taken from Quantum3D's Facets library. (Image: Quantum3D)

geometric shapes representing the building structure are placed. Typical textures are then applied to the surfaces by automated tools.'

Fernie added that additional modelling techniques are required for buildings that need to be viewed from close up, for example to 'support tasks such as rooftop landings in a mission rehearsal scenario'.

Artistic abilities

As far as vehicle or platform models are concerned, the modeller works with 'the data to build the 3D structure and applies textures to provide the colour scheme and to represent smaller features'. This is where the artistic abilities of the modeller come to the fore.

Like all database design, there is much discussion about visual system standards within the synthetic virtual environment. Standards such as those proposed by the Simulation Interoperability Standards Organization (SISO); the Open Geospatial Consortium; PEO STRI's SE Core; the US Multi-dimensional, User-oriented Synthetic Environment (MUSE); Open Scene Graph; OpenFlight; NAVAIR Portable Source Initiative (NPSI); Combat Air Forces Distributed Mission Operations (CAF DMO) et al, all have common goals.

Industry, in the case of Presagis and its parent company CAE, has created the Common Database (CDB) format. Although deployed in a number of countries, CDB has its critics and they focus on its lack of real high-resolution geo-specific terrain content throughout and the difficulty to achieve a truly correlated database.

CDB aside, a standard is not a standard if it is not adopted by all users. Militaries have suffered from this for decades, and as well as visualisation it impacts more prosaic things such as ammunition calibres, frequency bands of radios and the size of refuelling nozzles.

'When you boil it down, there are four key elements that need to be addressed when you are trying to train across different simulators that have been built by different OEMs,' explained Jawahar Bhalla, CTO of CAE Australia. 'That interoperability success depends upon the fidelity of the models, the fidelity of the connectivity, interconnectivity standards [DIS/HLA] and synthetic environment commonality.'

Sundog Software specialises in the creation of highly realistic clouds and ocean modelling and has supplied its software to numerous large simulation integrators. (Image: Sundog Software)

In theory, standards are highly commendable. As well as supporting Bhalla's interoperability criteria, common standards can also assist in the re-use of synthetic environments and models across different simulations and therefore save repeated development costs and speed up the overall process.

Too proscriptive?

The question is, how open is the standard and who owns it? As well as this proprietary issue, there is also a consideration concerning standards limiting innovation because they are too proscriptive.

'For us, the portable source initiative, or NPSI, is the most practical standard, as it denotes source data in very heavily supported commercial formats, oftentimes by companies whose sole focus is not in the military space such as ESRI,' explained W Garth Smith, president and co-owner of MetaVR.

NPSI was developed by US Naval Air Systems Command (NAVAIR), as previous standardisation initiatives such as Project 2851, SSDB Interchange Format and Synthetic Environment Data Representation and Interchange Specification were never widely accepted or fully embraced within the community, according to NAVAIR's Kent Nichols back in 2004. This statement raises the other issue about standards, that of their longevity and usefulness.

Although pan-national organisations and national governments – the latter being exemplified by the UK's Defence Training & Education Coherence M&S Standards Profile – try to define common standards, it would appear that this approach does not really work for complex, fast-moving technologies such as visualisation. Instead, standards tend to evolve because they are robust, relevant and meaningful, and are generally not created by the military or major systems integrators.

Examples include OpenFlight, which is the basis for Presagis' 3D models and is widely used by companies specialising in visualisation. Another non-military S&T standard is X-Plane. As far as NPSI is concerned, however, MetaVR is convinced.

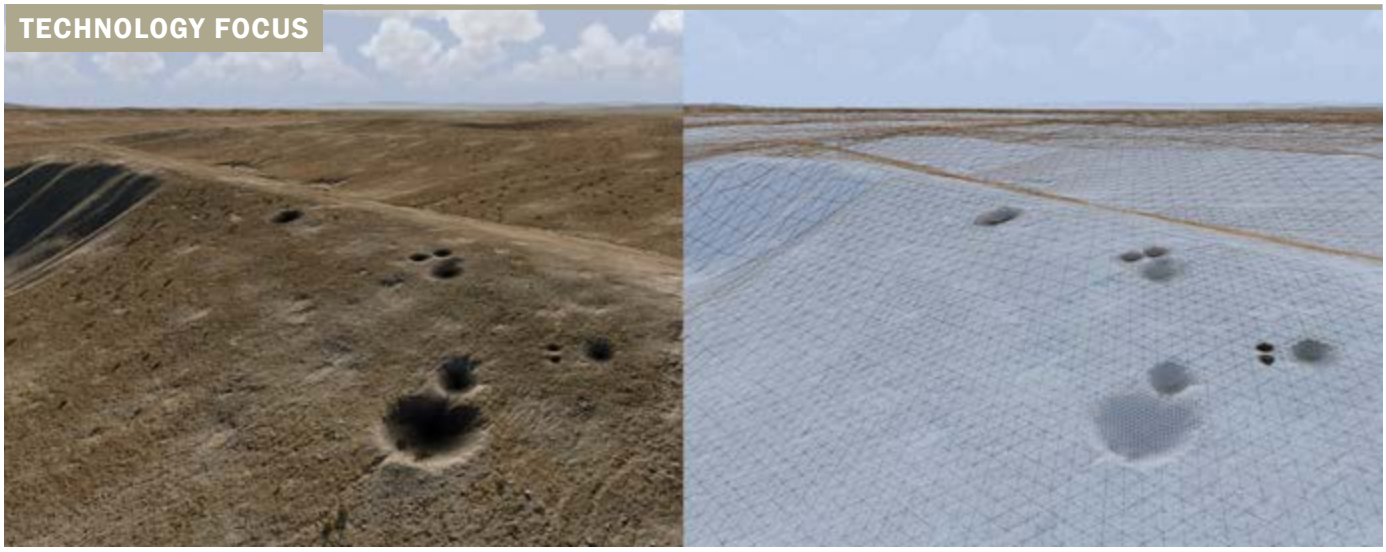
According to Smith: 'NPSI format provides source data in open commercial standards as it allows us greater control of the content.'

Greater flexibility

This of course, gives more flexibility and more realistic models. 'Shape files, geo TIFF and 3D models in FBX format would be the ideal and that really is NPSI,' he continued. '3D model creation is a major part of our company's output. Geo-specific buildings are crucial to realism such as seen in our Kismayo Somalia terrain. The area that is really intriguing to us is how important 3D models have become for vehicles. There is an enormous amount of vehicles being produced and developed and re-sold among different countries and that highlights the importance of combat vehicle recognition in simulation.'

This ability to recognise and identify is vitally important. Fellow US company Quantum3D develops its own models that come under its Facets product line.

'Facets models offer high levels of realism without sacrificing real-time performance,' explained Jan Bjernfalk, VP of products. 'Each model is delivered with multiple levels of detail (LOD), ►



3D modelling is not all about platforms and buildings, but also can include terrain. Shown here is a 2cm resolution dynamic terrain model of Yuma showing the 3D creation of craters. (Image: MetaVR)

realistic textures, damaged and destroyed states, articulated parts and, where appropriate, animations.'

Facets models are available from 50 to 4,000 polygons and material classified maps provide increased detail for users with requirements to simulate sensors. Model LOD is important and users need to be aware that highly detailed models need to have sufficient CPU/GPU capacity and iterative output to allow them to be viewed realistically.

'The big issue industry faces is simply not keeping pace with what our customers need – in particular, the Russians have a large amount of diverse and somewhat esoteric radar and jammer vehicles coming on line,' added Smith.

'Our customers need them and cannot wait for a "large detached group think forum" to decide that they are relevant, so we are often building models based on current events that come from customer requests. Sometimes we have to guess what will be important.

'Right now, we are building every major class of US ship as well as starting to focus on amphibious operations ships from allied countries,' he continued. 'We fund all our own model construction. If you look at our download 3D content site for, say, military vehicles, you will see very many vehicles built in the last 15 days, and updates to our library is an ongoing process.'

Human emulation

But it is not all about vehicle models. VT MÄK Technologies has a product line that concentrates on human emulation. Initially developed by Boston Dynamics, the DI-Guy range includes a number of different options and enhancements to the basic product.

Human modelling has become increasingly important as virtual simulations have become more sophisticated in recent years. They are frequently used in training for ground operations and cultural awareness. Such simulations not only feature life-like visual representation, but realistic behaviours that respond to the activities of the trainee or other simulated entities.

These behaviours are triggered through the use of AI and characters can be inserted into the visual environment through the DI-Guy software development kit (SDK), which also provides the tools to create new characters or modify the thousands that come with all DI-Guy products.

One thing that DI-Guy illustrates is the established process whereby certain companies specialise in developing discrete elements of the 3D visual database. For example, firms such as bDesign3D and PLW Modelworks specialise in buildings; Bionatics focuses on modelling shrubs, trees and rocks; and Sundog Software, volumetric clouds and dynamic sea states.

Sundog's SilverLining is used to create highly detailed skyscapes for any given time and location, fast and automatically. The company uses multiple volumetric rendering techniques to generate 3D clouds in any type of weather condition.

As far as 3D dynamic sea states are concerned, the company's Triton product creates a 3D ocean simulation. As well as weather conditions, ships, helicopters and projectiles can all disturb Triton's water with 3D wakes, waves and spray.

Versatile approach

Sundog says that its products will integrate into most engines with 'just a few lines of code' to provide rapid integration. The versatility of its systems can be seen by the number of integrators that use them, including Boeing, Camber, Cubic, L-3 Link, VT MÄK and URS to name just a few.

'Our own products create their 3D water and clouds algorithmically, avoiding the need to deal with standards for 3D models at all,' said Frank Kane, founder of Sundog Software. 'It's all math, not models. So we sort of work our way around these issues.'

That is not to say that Sundog Software is unaware of visualisation standards – it gets feedback from its customers on a regular basis.

'We talk with hundreds of companies who are integrating our software into their training and simulation systems, and so we get some insight into the common problems they face,' explained Kane. 'OpenFlight provides a good starting point for transportable 3D models, but individual companies like to put their own flair on top of them.

'OpenFlight is an older standard, and tools that export and import OpenFlight don't always keep up with the latest graphical capabilities, or capabilities of

individual image generators. So, you see a lot of people extending OpenFlight by embedding proprietary data into their models to take advantage of more modern graphical techniques, such as ambient occlusion, bump mapping and reflections – the stuff that makes modern 3D graphics more life-like.

'They might also re-process these models entirely to better fit how their graphics engine works. This is probably a good thing; it allows the fundamental geometry and textures of models to be shared, while giving vendors the flexibility they need to differentiate themselves in terms of technical capabilities.'

Kane makes an interesting point as far as standards are concerned and how they may be modified by proprietary 'fixes' to provide re-use and transportability to other platforms.

Incoming changes

In terms of collecting data to build models of buildings, Fernie believes that there are some changes under way to improve the process.

'The techniques [previously] described are commonly used in the simulation industry, and the quality of the available data, particularly geographic data, to support this modelling strategy is improving each year,' he noted. 'That being said, some companies are collecting data based on, for example, aerial surveys using LIDAR sensors. Others are using photogrammetric techniques to extract 3D information from aerial images. Both of these approaches could prove useful, particularly for regions for which the standard data sources are of lower quality.'

From Sundog Software's perspective, change is a natural state that leads to improved modelling processes.

'The current generation of image generators and model formats are built on something called a scene graph, but new developments in 3D rendering technology are pushing us away from scene graphs for the best performance,' said Kane. 'While the tools to create 3D models remain relatively constant, the formats in which they are exported and imported must change in order to take advantage of the new capabilities 3D hardware vendors are giving us.'

Another major player in the 3D model market is Canadian company Simthetiq. Founded in 2005, it produces a range of high-resolution 3D models that can 'seamlessly integrate COTS and custom 3D content into any scenario for any requirement', it states.

As well as its 3D models, Simthetiq also creates geo-specific airfields that can be integrated into OpenFlight-compliant image generators. The company says that it incorporates 'all major buildings such as terminals, hangars and, most importantly, control towers, ensuring an accurate and effective immersive experience'.

VT MÄK offers its range of DI-Guy human simulation figures along with associated software tools. Such models use AI for added realism. (Image: VT MÄK)

The company's client list is extensive and includes companies such as Adacel, BAE Systems, Boeing, Cubic, FAAC, Finmeccanica (now Leonardo), Lockheed Martin, Raydon, RDE, SAIC and Thales. This extensive list yet again indicates how larger integrators make the most of smaller subject matter experts when it comes to visualisation.

Leading the way

Turning to the tools that are used to create visual databases and 3D models, Presagis still leads the way. The company's latest offering is called M&S Suite 15, which the company says provides an open-standard simulation development framework designed to support a full range of simulation applications across the air, land, sea and public safety market segments.

Suite 15 comprises the company's Creator and Terra Vista content creation tools; Vega Prime and STAGE visualisation and simulations tools; FlightSIM and HeliSIM flight simulation tools, as well as Ondulus Radar – a real-time, high-fidelity and physics-based radar simulator.

The OEM says that Suite 15 has been upgraded with over 1,800 enhancements and fixes. One of the major enhancements has occurred to Creator and Terra Vista 15, with a new unified material classification workflow, which improves the ability to create 3D models and terrain images for sensors.

Reflecting the need to conduct military operations in urban terrain, Terra Vista 15 now integrates new procedural generation tools to allow users to build large urban environments much quicker than in previous versions. This process provides users with the ability to automatically generate complex raster source data from vectors. This not only aids the creation process for training, but also for mission rehearsal.

In answering a need for speed in creating new models and 3D content, users can utilise this new automatic process to get raster source data faster while maintaining correlation. The company says that for any area of the world, developers can create completely correlated imagery, cartographic maps, light maps and raster material. ■