D&E - convergence is the key

The spectrum of design and engineering (D&E) proposes the convergence of AEC and geospatial technologies. Earlier this year, estimates have been made that over 1.6 trillion USD will be spent in the US infrastructure market alone and about 21.7 trillion USD worldwide. It is being anticipated that due to the financial meltdown, most of the resources will be issued for building new and sustainable infrastructure.

As technologies evolve, their original goal to help in timely and cost-effective management of processes is realised. Some of the trends, where geospatial technologies have been noted to play a part in the recent years, are in the field of engineering software, equipment automation, tracking-surveying-monitoring and project management.

ENGINEERING SOFTWARE

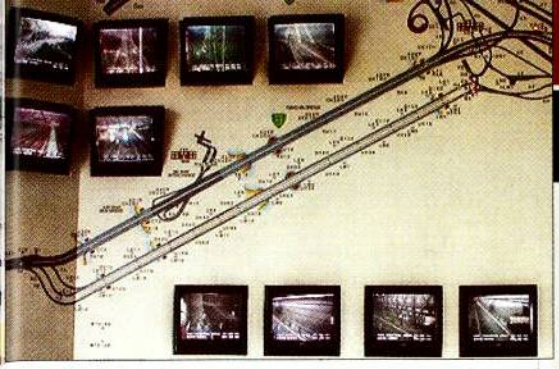
Amongst the many engineering applications that have been developed, 3D visualisation and simulation are the most sought after technologies in this industry. Design visualisation plays a critical role in achieving an accurate, shared understanding of the design, which then leads to the actual build. Conventional 2D CAD (Computer Aided Design) technologies are gradually being upgraded to 3D CAD models, which are designed to help designers and engineers to understand a complex structure easily.

New systems like BIM (Building Information Modelling), the process of generating and managing building data during its life cycle using 3D, real-time, dynamic building modelling software, is being used to increase productivity in building design and construction. The process produces the building information model (also abbreviated BIM), which encompasses building geometry, spatial relationships, geographic information, and quantities and properties of building components. It has an underlying GIS application that allows the integration of geospatial data with engineering data. This integration helps in major time-cost reductions as it provides a common platform for designing and engineering applications along with database-based decision support system.

Complex visualisation techniques like augmented reality, which in real time superimposes virtual images on the real world, are also being developed. Augmented Reality Computer Aided Drawing (AR CAD) helps users to comprehend a space more effectively by letting users visualise and interact with designs in an intuitive way.

EQUIPMENT AUTOMATION

Recent advances in IT, GPS receivers, real-time data processing algorithms and availability of rugged touch screen computers have enabled GPS based machine guidance system or grade control system. Site design in the form of plans or a digital terrain model, developed based on GPS data, is downloaded to the on-board computer which then works out where the machine is and how much cutting or



filling is needed at that point by referring to the site gird. The computer makes the decision based on GPS data of the blade. This is transmitted to the operator via the monitor or the light bars. This leads to fast and accurate decision and control due to real time information of position and grade displayed in the cab. It also reduces the rework caused by the lack of correct information in the field which ultimately leads to lower operating cost.

TRACKING, SURVEYING AND MONITORING

Accurate and timely identification and tracking of construction components are critical to operating a well-managed and cost efficient construction project. It is also important to know the progress of monitoring the construction process as it is to conduct a preliminary survey. Geospatial surveying companies like Leica, Trimble, Topcon and SOKKIA have realised the potential of this sector and made many acquisitions and mergers to improve the quality of their existing line of products or to develop new solutions.

Developments have been made in this field by integrating field sensors, portable computers, wireless communication and real-time kinematic GPS (RTK-GPS). Radio Frequency Identification (RFID) tags are being used on objects scheduled for arrival on the construction site. Scanning of these tags through wireless computer network queries a database that returns graphical representations (For example CAD

'GIS getting subsumed into engg workflows'

Richard Zambuni, Global Marketing Director, Bentley Systems Inc.,

Q. There has been an increasing need to integrate CAD and GIS solutions. What is the reason for this trend?

Within infrastructure engineering workflows, organisations are no longer willing to tolerate the inefficiencies of having GIS and CAD workflows disconnected. Disconnected workflows lead to data being created in silos, and this in turn means that there is often data loss or data re-creation, when ideally the data would simply flow through the workflow being accessed or enhanced, and then posted back to the spatial data store as the workflow progresses without any loss of integrity. At the end of the day, the integration of CAD and GIS technology is all about being more efficient with limited resources and organisations are increasingly less tolerant of any area within IT that is disconnected and isolated. This is not an issue of whether either CAD or GIS is more important than the other; it's simply an issue of integrating CAD and GIS seamlessly within engineering workflows. This is at the heart of Bentley's approach to GIS technology under our strategy of 'advancing GIS for infrastructure'. We have created Bentley Geospatial Server to ensure both seamless access to GIS data at an enterprise level & to ensure that non-spatial engineering data of whatever nature can be associated with objects and locations that can be browsed spatially.

Q. How has this integration facilitated/bettered the design and engineering processes?

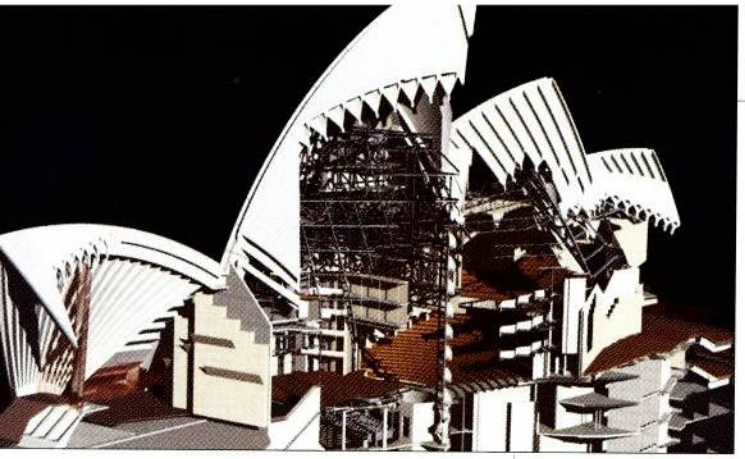
There is no doubt that where GIS technology is made available seamlessly within engineering workflows, organisations achieve higher levels of efficiency and they typically end up with the holy grail of higher data integrity. GIS data are often the basis of any project so this integration is fundamental to a project getting started quickly with accurate data

Q. How is convergence of technologies from architecture, engineering, geospatial and 3D simulation contributing to sustainable environmental, economic and socio political developments?

Infrastructure is at the very heart of economic progress and so the ability to be able to move seamlessly between GIS technology, BIM models, other civil engineering models, or between modelling and analysing the likely behaviour of new infrastructure and the original designs is vital. And, complex new infrastructure will require designs for multiple classes of infrastructure where this kind of convergence is vital. The ideal situation is to be able to design this entire infrastructure using a single or at least a limited number of file formats that are capable of persisting data throughout the workflow from planning to design, construction, and operations. Twenty-first century will be the century of infrastructure as we tackle the problems of ageing infrastructure on the one hand and the need to help people achieve higher standards of health and a higher overall quality of life in developing countries. We should add to this the need to develop infrastructure for a post fossil-fuel society - a society that will have to be a reality by the second half of the century as we reach and pass peak oil production and begin to lower our carbon emissions to forestall further climate change. Technology convergence will be necessary to empower the engineers who will be at the forefront of solving these knotty problems.

Q. What is the emerging trend in the use of GIS for design and engineering?

Those software vendors who began as CAD vendors are increasingly building core geospatial capabilities into their products and making it easier to access GIS data, since they are critical in most workflows. However, this is an applied approach to GIS technology and there will continue to be a need for generic GIS technology in academia and elsewhere that has nothing to do with the world of infrastructure design and engineering. In particular, Bentley is putting geospatial technology into all of its solutions as part of its platform technology. With the release of Bentley's V8i generation of technology, MicroStation now offers intrinsic geo-coordination for all projects, and ProjectWise Integration Server now comes with a map-based interface for access to heterogeneous engineering documentation. Bentley now has GIS technology to support both individual practitioner and enterprise workflows, whatever the source of data. We do not believe that it is a question of CAD versus GIS any more, that is an old and sterile argument, it's simply a question of how GIS data are introduced into the engineering workflows and how easy it is for designers to access those data as part of their everyday work. In a way, GIS technology has become more important in the engineering world and at the same time less visible as a separate 'department' as it becomes subsumed within the higher level engineering workflow. Finally, a future trend that has a long way to run in this context is the growing role of formal industry standards like WMS, WFS and CityGML on the one hand, and on the other, there is a growing role for de facto standards like Oracle Spatial as a spatial data repository and e.g. GeoPDF for the easy exchange of files rich in GIS data.



information), guiding the field workers to determine an object's position and orientation. This helps in eliminating delays and errors of manual data collection and also automatically identifies locations and tracks assets.

Traditional methods of measuring and modelling the surface geometry of large, complex structures or sites that require engineering or survey-grade accuracy are often inaccurate, incomplete or expensive. They have now been replaced by the use of LASER SCAN Stations, portable, auto-scanning laser and PC system that lets users economically obtain accurate, complete and timely as-built geometry information. Remote sensing hardware and software package based on GPS for monitoring construction structures are also available in the market. It provides real-time GPS - based systems for monitoring civil infrastructures and natural hazards. The systems are used for monitoring the structural integrity of dams, bridges, buildings, oil platforms and power facilities as well as the movement of landslides, volcanoes and other natural hazards. It is also capable of the alarm and data transmitting to the users through a modem, wireless radio or network connection to a personal computer which processes the data in real-time. The 3D positions are displayed through an easy-to-understand graphical-user-interface (GUI) in real-time. Underground site surveying can now be implemented through GPiR (ground-penetrating imaging radar), technology for mapping the shallow subsurface. GPiR helps in locating underground infrastructure reliably and accurately through non-invasive management of underground infrastructure, avoiding the hazards and inconvenience of digging; it will also improves construction planning and engineering by showing what lies below the surface before the shovels hit the ground.

This technology has incorporated a complete system for underground imaging: 1) an array of antennas to make underground mapping by radar feasible on a large scale; 2) advanced signal processing-using 3D imaging techniques adapted from seismic imaging in oil exploration-to convert radar echoes into 3D underground images; 3) precise positioning of the images relative to ground features by monitoring sensors with a survey geodimeter (laser theodolite) and 4) advanced image processing to extract and display underground features in 3D and archive the results in CAD or GIS.

PROJECT MANAGEMENT

It has been noted that GIS is used to manage infrastructure assets outside and up to the buildings, while CAD and BIM are related to the management of the building database.

Recently introduced building interior space data model (BISDM) by ESRI will allow companies to more effectively share facilities data and collaborate with other technologies commonly used for real property portfolio, asset and facilities management with its base technology as GIS. The model can be easily extended for a variety of other purposes, for example, landscape-level planning and site selection, building-level energy and environmental management and security and emergency preparedness.

The BISDM was created for facility and real property managers who find it difficult to query, analyse and report information about buildings and assets because it is not stored in a common database. BISDM overcomes these challenges by creating a foundation for a seamless "all-buildings" data source, making the information available throughout an organisation.

CONCLUSION

Design and engineering is a promising vertical for the use and advancement of AEC and geospatial technologies. Future will see improved accuracy in monitoring the sites and surveying capabilities. It is not farfetched to think that soon an integration of augmented reality, BIM and GIS will happen and that will turn out to be an ultimate in engineering and project management.

This will give an informed decision support system to planners, designers and engineers to analyse and visualise many aspects of a construction project. These intelligent systems will support computer-based analysis of schedules with respect to cost, time, interference, safety, etc., and improve the overall communication flow from design to build to management. ■

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