Data-rich 3D information models will add significant value throughout the bridge lifecycle, from concept to demolition. When bridge construction is driven by a traditional two-dimensional design workflow, the 2D deliverables are of limited value to those responsible for the structure's long-term operation and maintenance. Bridge owner-operators see the latest generation of bridge design and analysis software as the key to more efficient project delivery in the form of three-dimensional deliverables. To get the full value of 3D modelling technology, project participants are standardising on the same platform, collaborating across disciplines, sharing data between interoperable products, and using a common data environment as a single source of truth.

Unlike 2D deliverables that bury asset data in hundreds of documents and retain little asset history, 3D deliverables contain a wealth of easily accessed, always up to date, spatially referenced information to support timely decision making. This extends the return on technology investment from design-phase productivity improvements to lifetime cost savings.

It is no secret that traditional 2D design is fraught with inefficiencies that can result in errors, rework, delays, and cost overruns. With a design workflow distributed among multiple disciplines, the limited integration and lack of automation of the data exchange process, combined with each discipline using specialist software, often from different vendors, which is focused on delivering just one aspect of the project, the design process can become fragmented by software incompatibilities.

The transfer or re-entry of data that this demands often causes errors, omissions and inaccuracies. When the design is passed over to construction engineering in the form of 2D drawings, it is often dissected and reassembled into 3D models for construction. Hence, the resulting 2D deliverables offer little intelligence for the bridge lifecycle operation and maintenance. Unfortunately, 2D drawings are still the predominant deliverable required by transportation administrations, agencies and owner-operator contracts.

Owner-operators are under pressure to do better. Various industry initiatives are raising expectations for improved performance. In the USA for example, the Moving Ahead for Progress in the 21st Century Act steers federal funding towards more streamlined, performance-based programmes. The Federal Highway Administration’s Every Day Counts state-based model calls for innovative approaches that shorten the project delivery process, and FHWA is backing the use of building information modelling methods to accelerate transportation projects. Many European projects have proven to be successful by adopting a BIM methodology. For example Crossrail, Europe’s largest construction project, has been designed in a virtual environment for 3D, 4D, and 5D BIM, powered by Bentley’s modelling software. Other expected benefits include minimising risk by making fewer allowances, and limiting errors and omissions. Bridge designers are being held accountable for constructability and cost control, and their designs are expected to inspire smarter, safer construction methods. Throughout the project lifecycle, data is expected to be interoperable and accessible for project participants and stakeholders.

Meeting these challenges will require a sea-change in how bridge projects are designed and delivered. Government agencies have identified the potential of 3D intelligent modelling technologies to improve project performance. In the latest poll of US state departments of transportation, nearly 75% planned to implement 3D modelling by 2019. Front-runners who formed public-private partnerships or design-build joint ventures have made headway along these lines, largely by implementing BIM methods. Participating bridge design firms are eager to introduce 3D modelling workflows and delivery to contractors on these joint venture teams.

These organisations will discover an end-to-end solution in purpose-built...
SOFTWARE THAT CAN SHEPHERD THE DATA FROM PLANNING, TO ANALYSIS AND DESIGN, TO CONSTRUCTION, AND FINALLY TO ASSET LIFECYCLE MANAGEMENT. INTELLIGENT 3D MODELLING WILL PROVIDE CONTINUITY THROUGHOUT A SEAMLESS WORKFLOW, AND INTEROPERABILITY AMONG ALL DISCIPLINES. BY SHARING INFORMATION IN DATA-RICH 3D MODELS, USERS WILL IMPROVE THE QUALITY OF THEIR DESIGN DATA, AND ENHANCE COLLABORATION WITH COLLEAGUES WHEREVER THEY ARE LOCATED. GEOSPATIAL Referencing WILL CONNECT THE STRUCTURE TO ASSOCIATED PROJECTS, SUCH AS HIGHWAYS, AND POTENTIAL CONFLICTS SUCH AS SUBSURFACE UTILITIES, ENSURING MORE ACCURATE ALIGNMENTS AND REDUCING COSTLY RELOCATIONS.

COLLABORATIVE 3D DATA EXCHANGE, COMBINED WITH ROUTINE REVIEWS OF CONFLICT AND CONSTRUCTABILITY, WILL ENSURE THAT DESIGNS ARE ACCURATE AND ERROR-FREE. AN INTELLIGENT MODEL WILL ENABLE DESIGN AND CONSTRUCTION ALTERNATIVES TO BE CONSIDERED EARLIER IN THE PROCESS, AS WELL AS EXPLORING VARIOUS CONSTRUCTION METHODS. THE 3D MODEL WILL ELIMINATE CLASHES, EVALUATE CLEARANCES, OPTIMISE RESOURCES, GENERATE QUANTITIES AND VISUALISE CONSTRUCTION SEQUENCES SO THAT ONLY AN OPTIMAL DESIGN IS TAKEN AS FAR AS THE CONSTRUCTION PHASE.

AN INTELLIGENT 3D MODEL WILL REFERENCE PAST, PRESENT, AND FUTURE CONDITIONS, SO IT CAN CONVEY INFORMATION ABOUT EACH DESIGN PHASE WITHOUT RE-ENGINEERING. THE 3D MODEL WILL EVOLVE FROM PRELIMINARY DESIGN, TO ANALYSIS, TO AS-DESIGNED, TO AS-BUILT, TO AS-MAINTAINED, GIVING OWNER-OPERATORS INSIGHT INTO BRIDGE CONDITIONS AT EACH POINT IN ITS HISTORY. AN 'AS-MAINTAINED' MODEL, WHICH IS USED TO SUPPORT BRIDGE INSPECTIONS, PROVIDES INTERACTIVE, SPATIALLY-LOCATED REFERENCES LINKED TO DATA FROM THE INSPECTION AND REPAIR HISTORY, INTRODUCING THE DIMENSION OF TIME. THIS 4D MODEL WILL ALLOW USERS TO TRACK DEFICIENCIES OVER TIME AND PROVIDE MORE RAPID, RESPONSIVE MAINTENANCE. IN THIS WAY, 3D DELIVERABLES ADD VALUE TO ASSET LIFECYCLE MANAGEMENT.

IN 2016, BENTLEY INTRODUCED OPENBRIDGE MODELER AS A SOLUTION FOR DEVELOPING INTELLIGENT 3D PHYSICAL BRIDGE MODELS WITHIN THE CONTEXT OF AN OVERALL TRANSPORTATION PROJECT. PARAMETRIC MODELLING WITH THIS SOFTWARE SUPPORTS RAPID, SIMULTANEOUS DESIGN OF MULTIPLE BRIDGE TYPES. THE SOFTWARE IS INTEROPERABLE WITH BENTLEY'S OTHER BRIDGE ANALYSIS AND DESIGN APPLICATIONS AS WELL AS CIVIL, GEOTECHNICAL AND SUBSURFACE UTILITIES SOFTWARE, ENABLING CLOSE COORDINATION AND COLLABORATION AMONG PROJECT PARTICIPANTS. MANY TRANSPORTATION DEPARTMENTS AND ENGINEERING DESIGN FIRMS ARE SEEKING SUCH PRODUCTS TO ENHANCE THEIR 3D BRIDGE MODELLING WORKFLOW.


OF COURSE, THE ABILITY TO CENTRALISE DESIGN DATA IN A COMMON DATA ENVIRONMENT WILL OPTIMISE PERFORMANCE. A COMMON DATA ENVIRONMENT STREAMLINES THE EXCHANGE OF INTELLIGENT DATA AMONG MULTIPLE PROJECT PARTICIPANTS AND PROVIDES A SINGLE SOURCE OF TRUTH. IN A COMMON DATA ENVIRONMENT-BASED WORKFLOW, DATA THAT FEEDS 3D DESIGN AND ANALYSIS IS ALWAYS CURRENT, ACCURATE AND COMPLETE, AND THERE IS NO NEED FOR DATA RE-ENTRY OR REDUNDANT REVISION. ANOTHER ESSENTIAL CAPABILITY IS SHARING INFORMATION-RICH MODELS, KNOWN AS I-MODELS, AMONG PARTICIPANTS AND STAKEHOLDERS, REGARDLESS OF THE SOURCE OR DATA FORMAT (XML, IFS, DGN, PDF AND SO ON). THESE MODELS PROVIDE INFORMATION MOBILITY, SO USERS CAN EXCHANGE INFORMATION ASSOCIATED WITH BRIDGE ASSETS EASILY, COMPLETELY AND ACCURATELY AMONG DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE.

TOGETHER, 3D MODELLING IN A COMMON DATA ENVIRONMENT CAN YIELD IMPRESSIVE RESULTS. THE JSTI GROUP ACHIEVED SIGNIFICANT COST SAVINGS ON A PROJECT WITH SOME 5KM OF BRIDGES ON AN EXPRESSWAY IN CHINA'S GUANGDONG PROVINCE. THE US$41 BILLION UNDERTAKING DEPLOYED BIM TECHNOLOGY THROUGHOUT THE PROJECT LIFE CYCLE. THE SOLUTIONS REDUCED PRELIMINARY DESIGN TIME BY TWO-THIRDS AND ERRORS BY 90%; COORDINATING DESIGN, VALIDATING CONSTRUCTABILITY, AND SEQUENCING CONSTRUCTION IS...
estimated to have saved almost US$500,000. Likewise the Danish Road Directorate applied BIM standards to improve data management and reduce risk on a 10km-long highway project with a 14km-long bridge. The US$300 million project used Bentley’s Projectwise collaboration platform; using BIM methods and the common data environment saved the project an estimated US$25 million.

As parametric modelling technology continues to evolve, vendors will expand their software integration to more allied products. In this collaborative environment, common data schema will allow data exchange among participants and stakeholders, regardless of product or vendor. The bridge industry is currently cooperating on the development of the Buildingsmart bridges extension, which will become an open standard for exchanging BIM data for bridges, using the specification of Industry Foundation Classes. Related work is also under way through the American Association of State Highway & Transportation Officials’ technical committee for software and technology. This subcommittee is working on a standardised format for bridge and structure information models. The Openbrim development platform was recently introduced as part of FHWA standardisation initiatives.

Once legal barriers are removed, owner-operators will be able to include 3D deliverables as a contract requirement, so they can use the information-rich data model for asset life-cycle management. Intelligent 3D models will produce quantities for bridge repair and maintenance, provide insights to existing deficiencies, track the evolution of defects over time, and guide timely scheduling of maintenance and repair. Asset managers will have access to multimedia documents and data, from analytical calculations to inspection photographs and reports. Time-consuming data searches will be a thing of the past.

Beyond the results achieved to date, how will future bridge design technology benefit project investors, owner-operators, designers and builders? The pressure to perform on these large-scale infrastructure projects is relentless. Going forward, project participants will receive a measurable return on investment in collaborative, interoperable technology regardless of project delivery method, be it the traditional design-bid-build or turnkey concept to commissioning. Modelling technology that interacts with more disciplines and references more types of facilities will resolve issues earlier, minimise errors and omissions more easily, and connect to related designs more seamlessly.

These projects will require less troubleshooting in the field, fewer requests for information, and near-zero rework. As more sophisticated applications extend modelling from 3D to 4D, 5D, and 6D (digital, time, cost, and lifecycle), the process of construction sequencing, cost control, and lifecycle management will become more proactive, timely and accurate. Project teams will have the opportunity to minimise, optimise, and rationalise design and construction decisions for improved results.

Data-rich 3D information models will add value throughout the bridge lifecycle, from concept to demolition. Reality modelling will be used to capture current conditions and overlay deficiencies on the 3D model, providing a continuously-updated resource. Over the 70- to 80-year lifespan of a typical bridge, intelligent 3D data will provide continuity for cost-effective operation and maintenance. The cumulative savings on lifetime asset management will rapidly outpace the near-term savings realised during design and construction. The total return on technology investment will be well worthwhile.

Lee Tanase is senior director of bridge product development with Bentley Systems.