UNITED INSTITUTE OF TECHNOLOGY

Learn research
Innovate

(Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai)
(An ISO 9001:2008 certified institution)

(Approved by AICTE,New Delhi and Affiliated to Anna University,Chennai)

ENGINEERING CHEMISTRY

A Case Study based on

What is E - Construction
How can it save our planet earth?

Name and year of the course:
1st year B.E.Computer Science

The Case Study has been submitted by:

Name of the Student	Register Number
SANGAVI.B	21RBCS043
SANJANA.K	21RBCS044
SANJANA.M	21RBCS045
SHARMILA.M	21RBCS046
SHONE.V.SAMUEL	21RBCS047
SHYAM.J	21RBCS048
SOUMESHVER.M	21RBCS049

CONTENTS

INTRODUCTION:

The Utah Department of Transportation (UDOT) had begun benefiting from an institutionalized partnering culture to advance in their innovations. The agency had implemented a new approach to construct their concrete contract documents also referred to as Digital Delivery of Model-Based Design and Construction (MBDC).Utah Department of Transportation's Digital Delivery initiative included the use of three-dimensional (3D) models as the initiative in this large – scale project.

- Insights on Programmatic Partnering that is necessary for resolving technological queries.
- Insights on Programmatic partnering which provides the support for the innovation road map.
- Insights on Project-level partnering that gives effective strategies to remove technological barriers.
- Insights on Institutionalized partnering which supports a culture of constant innovation.

UDOT 's partnering culture enables it to "Push the Envelope" of technological feasibility and adopt Digital Delivery of as a process that mutually benefits both the agency and its fellow partners .The Utah Department of Transportation had used Digital Delivery on 10 awarded construction projects since 2015. It had used Model-Based Design and Construction with both traditional and alternative procurement models..

KEY TAKEAWAYS

Model-Based Design and Construction is a technology-immersed process improvement with a steep learning curve. The Utah Department of Transportation had used both programmatic and project-level partnering to foster the collaboration needed to implement Model-Based Design and Construction and other digital delivery goals with an acceptable level of risk. Examples of the agency's partnering strategy included the following:

- **Programmatic partnering** with vendors to resolve issues on operation of data structures
- **Programmatic partnering** to guide and monitor MBDC implementation.
- **Project-level partnering** to resolve technical issues on projects.
- **Project-level partnering** to manage project risks proactively.

UDOT 'S PARTNERING APPROACH IN IMPLEMENTING DIGITAL DELIVERY

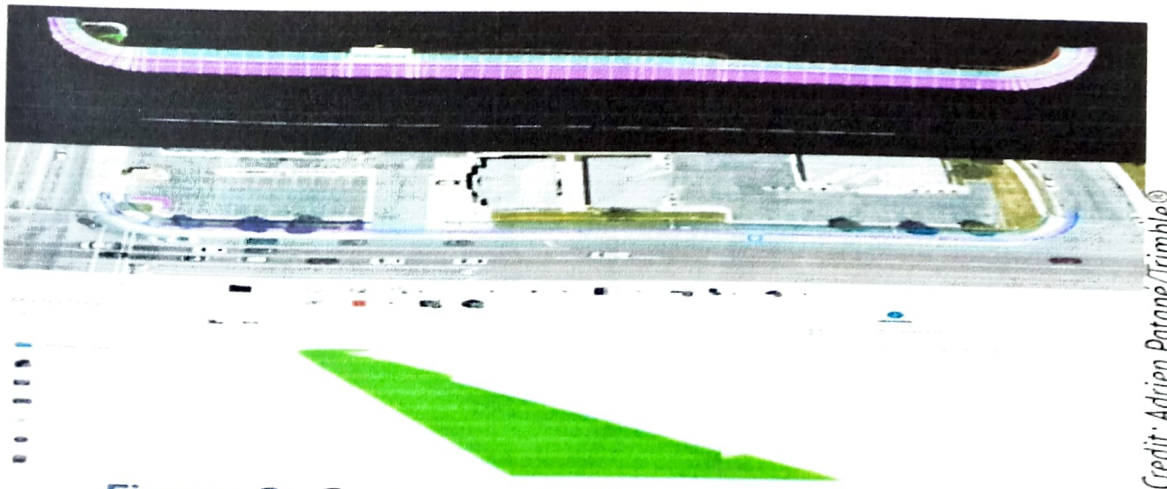
Earlier they used a combination of partnering and strategic Alternative Contracting Methods (ACM) had helped the Utah Department of Transportation institutionalize Accelerated Bridge Construction (ABC) methods. The Utah Department of Transportation with its introduction in April,2015 had developed a similar approach to institutionalize Digital Delivery of Model-Based Design and Construction. The agency had partnered with various other organizations at various levels and had undertaken and procured numerous alternative contracting methods to work towards their ambitious Technology-immersed Process Improvement goals.

DESCRIPTION OF THE PRACTICE:

When Utah Department of Transportation had implemented Accelerated Bridge Construction methods, the agency initially had used the construction manager/general contractor (CM/ GC) procurement. This enabled the designing consultant to receive input from a qualified contractor regarding construction of the design manually.Using this procurement, it also fostered collaboration that was nurtured through a good habitual partnering memorandum.

They had observed and understood from the CM/GC projects and applied them in numerous projects using design-build (DB) procurement and also in the design-bid-build (DBB) procurement. It had then incorporated Accelerated Bridge Construction into its *Structures Design and Detailing Manual* and from then onwards they have been using it successfully and routinely. They had also brought the warrant and incorporated patent rights to enhance in their constructional developments in October, 2015.

The agency commemorates their successful strategy of having implemented Digital Delivery, another high-impact innovation with subtle risks involving both themselves and their partners. The Digital Delivery system developed by Utah Department of Transportation also had brought a major change to the technology and software skills needed to access contractual information.



Credit: Adrien Patane/Trimble®

Figure 2: *Contractual 3D model information displayed for different applications.*

While developing the digital delivery approach, they needed to work with their partnering testimonials in a trusting and problem-solving environment, with appropriate amount of risk allocation. Using CM/GC procurement,they had enabled enabled the design team to interact transparently with a contractor to understand how they would use the 3D models to estimate the design and other necessities. CM/GC also gave the contractor an opportunity to help determine which contractual information would have to be in the form of 3D models.

Utah Department of Transportation initially chose roadway projects that were simple and of low risk, but used CM/GC to select a highly qualified team to prepare the Model-Based Design and Construction information,while CM/GC had inherently used a collaborative process, partnering that fostered good communication.

The concept of MBDC created a software fluency barrier that all parties had to scale to in order to completely access all the available contractual information.It stresses the fact that Partnering builds relationships and streamlines communication to avert situations where inequity could invoke suspicion. Using partnering, the Utah Department of Transportation and its partners had to work through technology and skill barriers where they had to resolve real-life applications to restore universal access to any available contractual information.

The Utah Department of Transportation had continued to refine the process through more complex scopes and use of Design-bid-build procurement. Model-Based Designing and Construction had then matured mainly in roadway construction,especially in construction of highways.The first MBDC bridge project, using CM/GC procurement, was under construction in late 2015.

NOTEWORTHY PROCEDURES AND METHODS

At UDOT, collaboration is the first strategy for solving problems, whether on the job site or on strategic initiatives that affects the business practices. Working with industries to set the road map,they had ensured that the Utah Department of Transportation and industry coordinated the pace and direction of their technology investments to balance the risks and maximize the outcomes for all the parties.

UDOT 's institutionalized partnering has evolved over two decades. By UDOT 's estimation, most—if not all—of its partners have completed both levels of the agency's partnering training. It is fully committed to forging effective partnering relationships in every project that it had undertaken over a period of tenure.

Selecting the Facilitation Mode :

In 2015, UDOT updated its field guide to define more partnering options in addition to formal partnering (where certified partnering facilitator that guides partnering meetings). Now, it can also can use semi-formal partnering or even informal, internally facilitated partnering (based on a collaborative approach to identifying and resolving the issues).

Choosing of the level of facilitation is one mandate and important method that the agency had used to streamline its partnering processes. They had worked with the Associated General Contractors (AGC) of Utah to create a score sheet approach in selecting the appropriate facilitation tier for each and every project. The short score sheet was mainly used to assess project risks, and the score would give them a clear and practical idea of the choice of type of facilitation. Only the most complex projects were to make use of the certified partnering facilitator. Most projects which were semi-formally facilitated, and a few were also simplest of projects that were internally facilitated.

Partnering For Risk Management :

Partnering had been a central element of their project risk management process.The agency had developed modified partnering processes for various contracting methods.These processes were used for CM/GC and Design Building because the risk allocation for those procurement models differed from that of Design Bid Building.

Programmatic Partnering :

When UDOT started the digital delivery initiative, the designers and contractors both had used 3D models, but exchanged the qualitative information with 2D plans. This process required designers to harvest their time in documenting the 3D designs in the 2D plans and required them to invest time in creating their own 3D models as well based on their interpretation of those already charted 2D structures. Conceptually, the designers and contractors could save their time if they could use these design models for large-scale planning and construction.

The designers and contractors of Utah Department of Transportation used different software products with different, incompatible data formats. Without a vendor-neutral data format, they had to rely on proprietary data and exchange format developed by one software vendor in collaboration with other vendors. It was supposed to enable reliable data exchange with the contractor's software. However, initially, it did not work as intended. They had reached out to the various vendors to help them in resolving technological issues on the first pilot project and included these and other vendors in a programmatic partnering process.

UDOT is proceeding with digital delivery by embracing willing partners. Model Based Designing and Construction is still reserved for selected projects only. This enables them to engage interested contractors who are very skilled personnel in demonstrating Model-Based Design and Construction and developing effective and sequential work-flows..

Initial industry input guided the designers and contractors to focus on MBDC intended development for Automated Machine Guidance (AMG) which also came across implementing a roadway construction method where an on-board computer had to successfully complete the construction .UDOT provided MBDC quantitative data on a handful of projects as supplemental, non-binding information. This gave the agency initial insights on processes for delivering data pertaining to model and construction. UDOT had held a Contractors Summit in 2017 where seven contractors met with agency staff and software vendors over 2 days.

Receiving honest feedback both positive and negative from contractors, coupled with the CM/GC procurement model had led to more contractors bidding on MBDC pilot projects. The Software industry partners had also gained an understanding of the voids and challenges of the designers and contractors of Utah Department of Transportation.

Digital Delivery Workshop :

Currently, UDOT is working on the as-built record process and improving the use of information for estimating managerial information. UDOT has held back on using MBDC on major inter-state projects because data utilization for estimating and quantity management is still low. Quantity management is an important part of project management for both contractors and UDOT. UDOT uses quantities to manage sampling and testing, while contractors use quantities for work planning and scheduling.

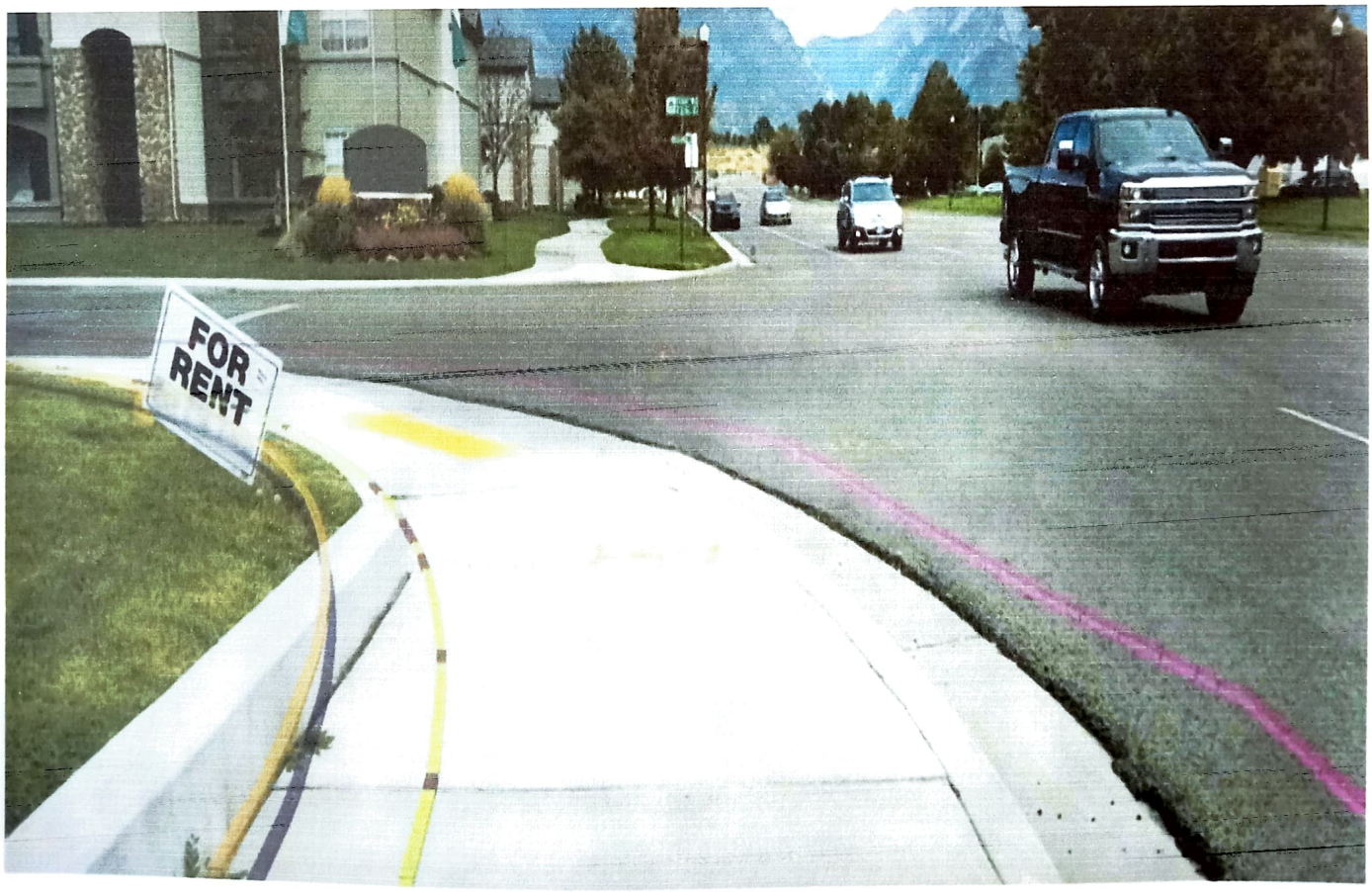
So far, there are at least six vendors are part of the MBDC paradigm shift, many traveling from other States. Its consultants, contractors, fabricators, and the officials of the Federal Highway Administration (FHWA) are also involved in developing a construction-borne digital delivery construction analysis.

UDOT visited participating contractors to delve into their estimating processes. The agency then held a workshop in February 2019 to further brainstorm how it can better support estimator work-flows with MBDC. The partners of UDOT had made up three-quarters of the workshop participants.

The workshop focused specifically on using MBDC data in the estimating process. Six contractors sent representatives from their 3D modeling and estimating departments. Consultants sent representatives from their design and construction inspection departments. Utah Department of Transportation invited estimating software vendors as well as the vendors it had partnered with since the beginning of the MBDC initiative with focus on designing and construction, AMG, and construction surveying uses.It brought representatives from its in-house design, contracts, and construction departments. The Federal Highway Administration and academics also participated.

The workshop used facilitated, interdisciplinary round-table discussions. Vendors were able to hear firsthand what features estimators need, while UDOT and its consultants heard what information estimators need and how they use it. The workshop's outcomes included the following:

- Less frustration with current limitations.
- Clearer understanding of estimator work-flows and information needs.
- Managed expectations for using 3D models for estimating at present.
- A commitment to accommodate the objectives of digital delivery.



Project-Level Partnering

Earlier in the digital delivery implementation process, UDOT 's contractor would work and compile all the details with the designer.This level of cooperation was possible because of the partnering culture. The technology and processes have matured over the course of five CM/GC and five Design Bid Building MBDC projects. Now, UDOT is working with consultants to improve processes for construction inspection

.

In 2018, UDOT started the 9000 South project (a $13.6 million Design Bid Building capacity improvement project) in Salt Lake County with MBDC requirements. UDOT provided the MBDC data as part of the request for qualifications for the Construction Engineering Services (CES) contract.

The agency alerted prospective firms that there were no plan sheets, that they would be required to use the MBDC data, and that the data would be updated throughout construction to reflect the as-built conditions accurately. UDOT required the CES firm to use survey tools to verify the contractor's survey and construction activities, as well as to capture feedback for the agency to update its Construction Engineering Management manuals

.

One of the vendors UDOT partnered with on MBDC used the project MBDC data to demonstrate Augmented Reality (AR) as a potential tool for CES. AR is a visualization technology that displays a 3D model over an image. The AR device demonstrated on the 9000 South project, shown in the figure could navigate through the 3D model in real time based on the location and the orientation of the device. The 9000 South projects involved widening five lanes to seven and included utility upgrades, intersection improvements, sidewalk reconstruction, new curb and gutter, signing and striping, and landscaping improvements. The AR demonstration showed stakeholders can use this technology to investigate disruptions likely to be caused from large projects such as this for residents, businesses, and motorists.

The benefit of AR for construction inspection is it lowers the level of software skill needed to navigate and interpret the MBDC data. UDOT 's inspectors are not experienced with the complex tools used for developing and reviewing design within a model. Finding a user-friendly tool for inspectors is a necessary step toward full-scale digital delivery.

CHALLENGES AND SUCCESSES

UDOT defines digital delivery of MBDC as an interconnected, fully electronic compilation of project assets that have detailed attributes. The intent is that the digital contract documents will include interlinked and/or embedded content that all parties access via a single master document. The embedded content would include 3D models, such as surface models representing existing conditions and the proposed top of final grade. Other interlinked documents might include design details, tables of quantities, and the relevant sections of the standard specifications.

Changing the Contract Medium :

Digital delivery of MBDC is a disruptive change. Previous changes affected the process of producing contract documents, but not the documents themselves. When the digital 3D model becomes the contract document, it changes the medium through which contracting parties communicate.

Supportive Technologies :

Previously, contract documents were paper based or used the open Portable Document Format (PDF) standard, which gave parties flexibility in choosing from a range of certified software products that could access contract documents reliably. There is not yet an open standard for MBDC information. Thus, supportive technologies are required to access the MBDC contract documents. These supportive technologies include the software and hardware needed to create, review, share, and read the contract documents. Supportive technologies are used both in the office and on the job-site.

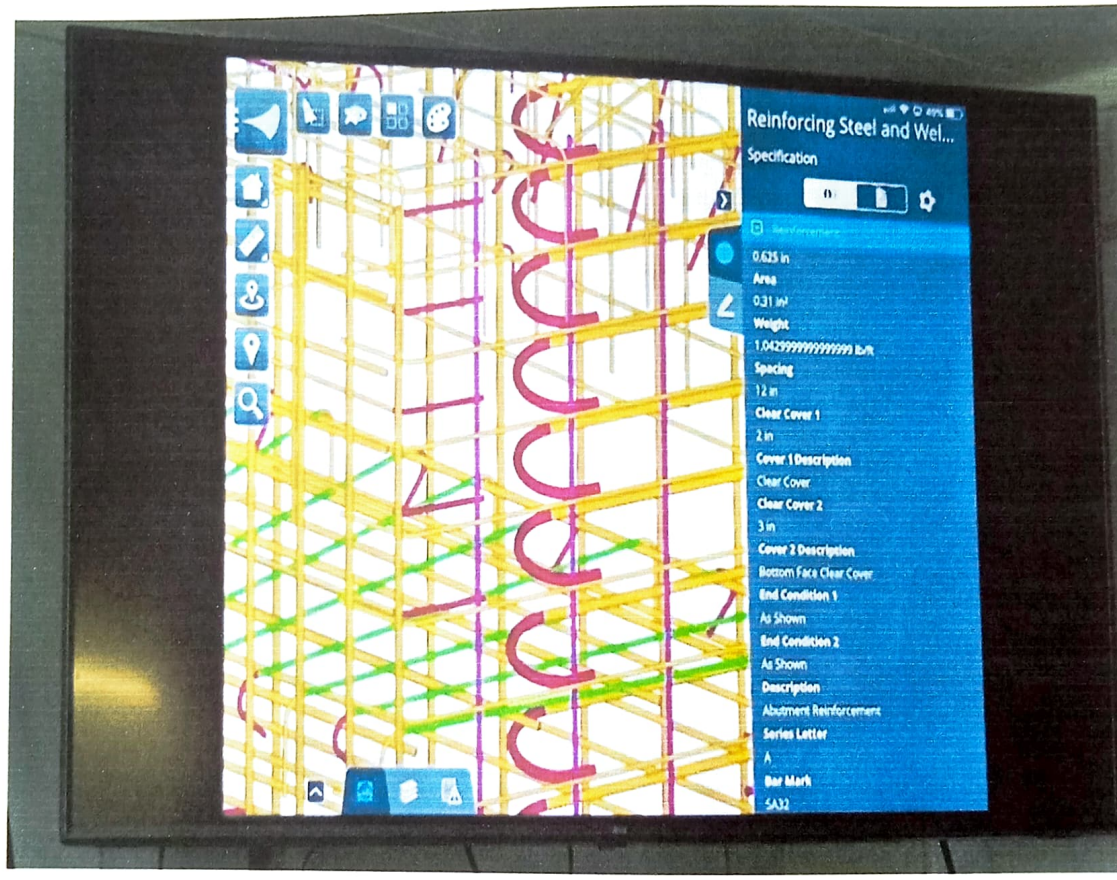
For example:

The contractor could use the 3D models directly with AMG equipment to grade and pave the road or with survey equipment to check the grade for quality control. UDOT 's inspection team could use the 3D models with survey equipment to measure quantities for interim or final payments.

When the contract medium changes, the as-built medium changes, too. UDOT has been piloting survey technologies, such as unmanned aerial systems (UAS), to collect point clouds to extract as-built features to store in its asset inventory.

FUTURE OUTLOOK

Digital delivery of MBDC affects every aspect of the construction process because the contract documents use a new medium. Not all of UDOT's partners are ready for digital delivery. Each MBDC project spreads the capability further into UDOT's network of subcontractors and into peer agencies such as railroads and canal companies. Figure 5 provides an example from a model review meeting where different project stakeholders explored the model together. Institutionalized partnering creates the atmosphere that fosters an organic transfer of skills within and across organizations in Utah.



Credit: FHWA

Working through the challenges of reliable information exchange requires enhanced collaboration and a strong commitment to both the project goals and the broader objective of process improvement. UDOT will continue to use programmatic partnering to develop a road-map with which to engage vendors to resolve technical issues with the appropriate urgency.

Conclusion:

Internationally and nationally, industry is developing data standards for 3D models for roads and bridges. These standards will create an open data format that will enable vendor-neutral access to the MBDC contract documents. Ultimately, contracting parties may have the same user experience with 3D model information as they currently have with PDF and designing based contract documents. The intention is to create a means to use the contractual information directly, without needing to extract and convert contractual information manually.It has made transportation safe and economical.

Using MBDC is a high-impact innovation, but it comes with modern-day risks and reinforcements to Utah Department of transportation and its business partners. Its digital delivery process improvement will not be final until industry adopts open data standards. In the meantime, UDOT is successfully using project-level partnering in combination with ACM to make leaps in efficiency in how information is exchanged from design to construction.This shall help in allowing people to travel over longer distances in shorter spans of time.It can also be concluded that it provides us with a bright and sustainable future.