Calling Rube Goldberg: Bridge Design Conference Likens Projects to Complicated Machines

For the hundreds attending the ninth annual INDOT Bridge Design Conference either in person or virtually, it was the ultimate “aha moment.” INDOT’s Director of Bridge Engineering Stephanie Wagner, the conference’s moderator, had just compared Indiana’s bridge projects to an overly complicated Rube Goldberg contraption.

Genius!

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“Our process to deliver successful projects is kind of like a Rube Goldberg machine,” said Wagner. “We’re dependent on steps to be completed in the way that it was designed. If all the marbles don’t fall in the bucket, that bucket doesn’t drop. Small changes throughout the development of a project can make a big difference in the success of the project at the end.”

A Rube Goldberg machine, of course, is a complex device designed to complete a simple function, using a set of steps that work in succession and trigger one event after another until the final task is completed (*see an example on Page 2*). Some of the machines designed by cartoonist Rube Goldberg involve dozens of complicated steps to complete a simple task. Similarly, bridge designers meticulously account for many details of a project, but various problems inevitably emerge, causing a chain reaction of events.

Stephanie Wagner (from left, top photo) and Jim Lesh.

Donald Shaw (right photo).

Senior Pavement Design Engineer Tony Jones latched onto the complicated machine theme.

“As part of this Rube Goldberg machine, pavement design approval has several intricacies that impact you,” said Jones, who educated audience members about the ins and outs of Indiana Design Manual Memo 22-03 concerning pavement design for bridge and small structure projects.

And so, it continued throughout the Feb. 21 conference: Various speakers educated attendees on lessons learned, policy updates, research, and practical design concepts to help navigate the challenging world of bridge design.

Bridge Design Team Leader Jim Lesh, who organized the conference with Wagner, urged the audience to account for thermal movements — where heat expands and coldness contracts bridge elements. Example: Don’t design a terminal joint to hit a bridge rail because that’s concrete on concrete; provide room for the bridge to move.

“The topic of thermal movement is boring because it’s slow and methodical, taking years to happen,” said Lesh. “But beware; just like the tortoise always beat the hare, thermal movements always win. If we don’t allow room for our bridges to move, they will make room.”

Bridge Engineer Donald Shaw engaged attendees with details of a continuous bridge pour sequence (instead of a sequenced bridge pour sequence) for prestressed

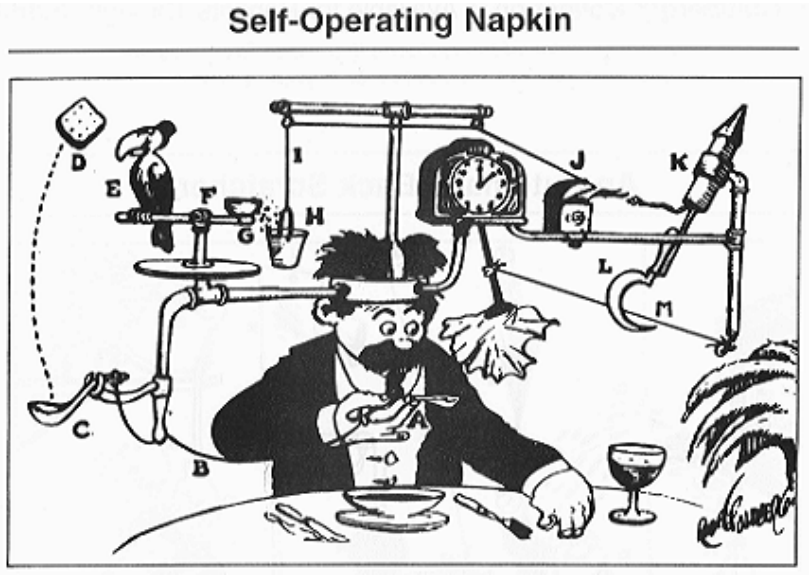
beam superstructures. INDOT has created a Bridge Design Aid (BDA 404-01) for contractors and INDOT to better understand the process. It includes a spreadsheet that helps determine if such a bridge pour is possible under criteria that aims to minimize the likelihood of excessive early deck cracking. The BDA creates uniformity between the industry and INDOT's engineer of record for the project. It also reduces surprises and cost.

Geotechnical Consultant Design Group Manager Mir Zaheer outlined the advantages and disadvantages of using drilled shafts instead of driven piles on bridge projects. Derek Merida, a bridge operations vice president for a major contractor, pinpointed when a contractor might like to use drilled shafts — including on projects that eliminate the requirement of cofferdams and at close-quarter locations that require limited vibration (example: the U.S. 27 bridge project in downtown Richmond).

Other INDOT speakers were Managing Director of Project Delivery Jessica Miller, Standards & Policy Director Subhi Bazlamit, Pavement Design Manager Kumar Dave, Bridge Design Manager Pete White, Bridge Load Rating Engineer Jennifer Hart, Seymour District Highway Engineer Supervisor Terry Summers, Bridge Asset Manager Adam Post, Bridge Asset Engineer Erich Hart, and Greenfield District Bridge Engineer Darryl Wineinger.

The conference, which took place at the Indiana Government Center South building, is a joint venture between INDOT and the Indiana section of the American Society of Civil Engineers. It attracted 130 in-person attendees and 174 virtual participants.

"We are all one big Rube Goldberg machine," said Wagner, "meaning we all have to work together to ensure success with our state's bridge assets."



"Professor Butts and the Self-Operating Napkin" (1931) is a classic Rube Goldberg cartoon. A soup spoon (A) is raised to mouth, pulling string (B) and thereby jerking ladle (C), which throws cracker (D) past toucan (E). Toucan jumps after cracker and perch (F) tilts, upsetting seeds (G) into pail (H). Extra weight in pail pulls cord (I), which opens and ignites lighter (J), setting off skyrocket (K), which causes sickle (L) to cut string (M), enabling pendulum with attached napkin to swing back and forth, thereby wiping chin.

A terminal joint abuts a bridge rail, something that INDOT's Jim Lesh says to avoid in the design process.