Here's how young people decide when they're drunk 'enough,' according to math

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A unique research project at The Ohio State University aims to analyze drinking behavior the way engineers might analyze a mechanical system. Researchers in social work and engineering are using the data they gather to construct mathematical models to help explain the factors that drive alcohol consumption. Here, an Ohio State student of legal drinking age is fitted with a trans-dermal blood alcohol monitor to participate in the study. Credit: Danielle Ruderman, courtesy of The Ohio State University.

Young people decide whether they've had enough to drink the same way the cruise control on a car "decides" whether to accelerate or hit the brakes.

That's a preliminary finding in an unusual new study that aims to analyze drinking behavior the way engineers might analyze a mechanical system.

In two papers to appear in the journal *IEEE Transactions on Cybernetics*, a team of social workers and engineers at The Ohio State University used mathematical models to help explain the factors that drive alcohol consumption.

They found that college students drank until they attained a certain level of drunkenness, and then adjusted the pace of their drinking—sipping versus gulping, for example, or switching to a non-alcoholic beverage—at different times throughout the night to maintain that level.

John Clapp, a professor of social work and director of the Higher Education Center for Alcohol and Drug Abuse Prevention and Recovery at Ohio State, has been gathering data on high-risk drinking among college students for more than a decade. He and his colleagues believe that analyzing all that data via engineering methods might reveal relationships among complex factors that would otherwise remain hidden.

"We're looking for the best points to intervene strategically, so that we can aid a person in their decision-making and potentially derail problematic behaviors," Clapp said.

As a first test of their idea, Clapp asked Ohio State engineer Kevin Passino to re-analyze data that Clapp and his former research team at

San Diego State University collected on students at parties and bars in San Diego. They performed portable alcohol breath tests, and over several studies, they accumulated blood alcohol content (BAC) data on nearly 1,500 students.

Passino, professor of electrical and computer engineering and director of Ohio State's Humanitarian Engineering Center, searched the data for patterns that might resemble a typical engineering problem. He and former doctoral student Luis Felipe Giraldo were surprised by what they found.

"The way the students made decisions about drinking actually resembled the single most common feedback controller that's used in engineering," Passino said. "It's called a proportional-derivative controller, and it measures how far a system has moved from a particular set point and adjusts accordingly. It's the same as cruise control on a car."

At the start of the evening, the researchers quizzed the students about how drunk they intended to get, and then they tested the students' BAC several times over the following hours. The data showed that students who reported wanting to feel "buzzed" adjusted their consumption to maintain a BAC around 0.05, while those who said they planned to get "very drunk" averaged around 0.1.

BAC is a percentage measure of alcohol in the blood, and in Ohio as in California and the rest of the United States, it's illegal to drive a car with a BAC of 0.08 or higher.

To Clapp, knowing that the patterns fit a particular engineering controller means that the researchers can apply new types of equations to dig deeper into the data they've already collected, and take a more dynamic view of students' drinking behaviors in the future.


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"We have a sense of what factors influence drinking behavior as is occurs naturally, but we don't really understand how it all works together. It's as if we've been taking Polaroid snapshots of these really complex behaviors, and now we'll be able to capture high-definition movies," he said.

This first study provides a proof of concept for a new study about to begin on the Ohio State Columbus campus, one that will create very large and complex data sets on the scale of "big data."

Sixty Ohio State seniors—belonging to several different social groups consisting of friends who go out drinking together on the weekends—will wear trans-dermal blood alcohol monitors so that the researchers can get more precise data on how their BAC varies over an entire night out. The monitors are being provided by SCRAM Systems, a company that supplies similar ankle bracelets to law enforcement. The sensors are about the size of a hockey puck, and measure BAC through the wearer's sweat.

The students, who are all of legal drinking age, will wear the ankle bracelets when they go out on the weekends. But for the entire two-week study, they will also wear personal fitness monitors so that researchers can track data such as their sleep and exercise habits. In surveys

transmitted to their cell phones at random times throughout the study, the students will answer questions about their health and well-being, such as their emotional state at that moment.

"We could track as many as 5,000 different variables per person during that two-week period, plus all the social interactions between the people in the different groups," Clapp said. "We're hoping to get a very rich, complex dataset, and most social science methods wouldn't lend themselves well to untangling all of that."

Passino described how an engineer might untangle it.

"One approach would be to take this complex system, which is composed of a set of people with their drinking habits and their social interactions with each other, and try to make a model that's as realistic as possible, and then analyze that model for something called controllability," he said.

"Controllability is just what you'd think: How easy is it for you to change this system? You can test for controllability with mathematics, and we're hoping that doing so will suggest some ideas for an intervention."

Their ultimate goal is to develop a smartphone app that will alert a young person—or anyone else, for that matter—when they've had enough to drink.

Clapp envisions that users could tell the app whether they want to moderate their drinking on a particular evening. Based on transdermal BAC, the app could then send an alert to suggest that the user eat something or drink a non-alcoholic beverage before they have another alcoholic one. Smartphones already know a user's location and whether they drove to get there, so the app could also remind a drinker not to drive home and help with calling a cab.

Soon, law enforcement-style ankle bracelets won't be necessary for such an app to work.

The National Institute of Alcohol Abuse and Alcoholism recently sponsored a design competition for an easy-to-wear commercial BAC biosensor. The winner, called the BACtrack Skyn, will go on sale in January 2017 for around $99. It resembles a fitness monitor and communicates with a smartphone via Bluetooth.

While such devices could potentially provide researchers with an abundance of data, there are very few universities currently equipped to analyze it with a hybrid social work-engineering approach. Clapp knows of only two other research groups—one at Washington University at Saint Louis and the other at the University of Southern California—with similar collaborations.

Provided by The Ohio State University