Planned Presentations for 2024-2025 Jahn's Lectureship

Dr. John Kemeny

Presentation No. 1 – Innovative Monitoring and Characterization Technologies (with the help of AI) for Combatting Geologic/Hydrologic Hazards Associated with Climate Change

Monitoring and characterization of natural and manmade geologic environments are important aspects of applied geology, and can include monitoring water flow or rock movement, or characterizing the condition of a rock slope or debris flow path. I am currently involved with utilizing neural networks to develop some new monitoring and characterization strategies to help combat the increasing geologic and hydrologic hazards associated with climate change. This is particularly needed in third world countries, where utilizing technologies developed for the mining/petroleum/civil industries is often cost prohibitive. The lightbulb moment for me was listening to a podcast in 2021 given by Pete Warden, who was then the head of Google Brain, a deep learning artificial intelligence research division at Google. He spoke about TinyML, which is the concept of embedding sophisticated neural net routines on very small microcontrollers that are highly energy efficient and can form the basis for field sensors that not only collect data but also analyze, classify, and communicate the results (flood warning for example). The Jahns talk will cover the kinds of AI used in TinyML, the potential applications of TinyML to monitor and characterize geologic and hydrologic hazards, and hands-on examples of how easy it is to train a neural net routine and embed it on a small microcontroller. An example we are currently developing is a small sensor that only utilizes sound to characterize water flow in a stream or urban environment, with installations as simple as hanging the sensor from a tree or light pole.

Presentation No. 2 – Everyday Geospatial: New Technologies and Methods that Anyone Can Afford for 3D Field Scanning, Point Cloud Processing, Rock Mass Characterization, and Slope Stability

Geospatial includes remote sensing 3D imaging technologies such as Lidar, photogrammetry, and multispectral and thermal imaging. These technologies can produce high resolution 3D point clouds, from which point cloud processing software is used to extract detailed and in some cases automated rock mass characterization and slope stability outputs. When I started in this field in the early 2000s, 3D imaging and point cloud processing was expensive and time consuming. Lidar scanners cost $100k-$200k, a Lidar survey required numerous surveyed ground control points, and point cloud processing was a manual and time-consuming process. This limited its use to companies that could afford the time and expense. Today, high resolution registered point clouds can be obtained in minutes using iPhone lidar or smartphone pictures, and semi-

automated point cloud processing procedures in open-source software are now routinely used to extract rock characterization information. Photos from inexpensive drones can produce very high quality point clouds of large areas, and these surveys can be repeated to monitor degradation and movement. In this Jahns lecture I will discuss modern “everyday” geospatial tools that are transforming many aspects of applied geology, and give examples of the step by step process involved to go from field imaging to final rock mass characterization and slope stability. I will also mention an online class that I teach to students around the world, where students conduct field scanning and point cloud processing in the area where they live. I invite students and young professionals in the Jahns lectures I give to participate in this class, at no cost.

Presentation No. 3 - Why is that Unstable-Looking Rock Slope Still Standing, and When Can We Expect It to Fail: a gentle introduction to time-dependent rock fracturing and rock bridges

Rock slope stability and rockfall are very interesting subjects, and traditionally involves terms like plane and wedge failure, joint friction angle, pore pressure, freeze-thaw. We also use terms like factor of safety and probability of failure. A term often missing in traditional slope stability is time: when will the slope fail, or how will the factor of safety change with time. If we monitor a large rock slope or hanging rock block using surveyed prisms or radar, when the slope is close to failure we can sometimes predict time of failure using inverse velocity techniques. But in such a rock slope or hanging block, what is changing with time that is causing the inverse velocity behavior? In this Jahns talk I will first of all briefly review traditional slope stability, including plane and wedge failure and the subjects of factor of safety, probability of failure, and the inverse velocity technique for predicting time-of-failure. I will then discuss two concepts that are central to the time dependence of rock failure: time-dependent crack growth and rock bridges. Rock bridges are intact sections along a discontinuity that must be broken in order for slope instability to occur. Rock bridges are often under high stress, and these bridges can fail due to time-dependent crack growth. Talking about these subjects requires discussing the complex subject of fracture mechanics, which I will do as carefully as I can (and with examples). I will show several interesting cases studies such as the example of rockfall in Yosemite where hanging blocks held up by intact rock bridges have been monitored using thermal imaging and the stability analyzed using fracture mechanics.

Presentation No. 4 - Entrepreneurship in Applied Geology: Why your next career move could be an innovative small business startup

This is a great time to start an innovative geo-based small business. First of all, the occurrence of geologic and hydrologic hazards around the world is rapidly increasing, requiring creative thinking and the rapid development of new useful tools and methods, for which a small startup is well suited. Secondly, technologies that could form the basis of a geo-based company are now booming, such as geospatial technologies, drones, and software tools such as point cloud processing, finite element modeling, and web tools. Thirdly, it has been shown that AI can reduce the funding required to produce a working proof of concept (POC), meaning that a small business can get to market much quicker and with less capital investment by integrating AI in

various ways. In this Jahns talk I will discuss what geo-based companies do today, what they could do in the future, and the overall climate for geo-based startups in the next few years. I will then talk about some entrepreneurship basics that include startup valuation, equity splits, raising capital, and making an effective pitch. I will encourage students to take an entrepreneurship class if such a class is available at their college or university. I will also discuss some strategies for partnering that are important in building a successful team. I will give several examples of successful geo-based startups, including my own experience with the two startups I have been involved with.

Presentation No. 5 - Rock Mechanics, Geomechanics, Rock Engineering: What's It All About?

Rock mechanics, also referred to as geomechanics and rock engineering, is an exciting applied geology topic that is central to geological, mining, civil, and petroleum engineering. It is about how and why rocks fail, at both the field scale (rock masses), as well as laboratory, and with important applications to surface slopes, underground excavations, and dam and bridge foundations. This Jahns lecture is an introduction to rock mechanics that I have given to newly entering Mining and Geological Engineering students at the University of Arizona. It includes the topics of rock strength, stresses in rock masses, discontinuities, field characterization, rock mass classification, factor of safety and probability of failure, and some slope and underground examples. It will also cover the important topics of new field technologies and numerical modeling. This talk would be of interest to students in college or university departments that do not offer a full rock mechanics course (other than topics offered in a structural geology class). I also talk about job opportunities for students with skills in rock mechanics, and mention important rock mechanics conferences that they can attend, as well as the student chapter sponsored by the American Rock Mechanics & Geomechanics Association (ARMA).

To schedule a Jahns Lecture for the 2024–25 season email John at kemeny@arizona.edu