WORKSHOPS AND SHORT COURSES

Workshop on Education in Underground Engineering and Science in the United States—TENTATIVE

This one-day workshop is being proposed for a National Science Foundation grant; it is listed as tentative until the grant is approved. The *Workshop on Education in Underground Engineering and Science in the U.S.* will address the state of underground engineering and science education in this country and to recommend curriculum improvements or modifications. The proposed Deep Underground Science and Engineering Laboratory (DUSEL) plans to undertake many underground engineering and science projects, and the U.S. rock mechanics community must be ready to make the most of this new opportunity. The U.S. rock mechanics community must have the proper education foundation to answer the challenges ahead.

The workshop will bring together many faculty members from disciplines that use rock mechanics, to discuss the state of underground engineering and science education in this country and to recommend curriculum improvements or modifications. The purposes of these deliberations are:

- To address new technologies and new problems;
- To assess the teaching of underground engineering and science at the undergraduate level; and
- To better prepare graduates to serve the objectives of their future employers such as universities, industry, consulting companies, or research laboratories, and to improve their capability to interact with many other professionals such as illustrated in Figure 1.

Workshop Organizer: Peter Smeallie, Executive Director, ARMA
June 27, 2008—One Day- No Cost

Workshop on Laser and Photogrammetric Methods for Rock Tunnel Characterization

In the last decade, there have been tremendous advances in the techniques and technologies for the characterization of rock tunnels. The general procedure is as follows:

- Collect information on rock exposed in a tunnel (e.g., using high-resolution cameras or laser scanners);
- Produce a digital-3D surface draped with photographs (DTM) of the tunnel surface; and
- Analyze the DTM to characterize the rock mass (e.g., take dip direction and dip measurements, joint spacing, etc.), and calculate over/underbreaks.
- After shotcreting, collect new information, create a DTM, and compare with previous DTM to calculate shotcrete thickness.

Advantages of using these technologies are several:

- The ability to acquire information from a safe spot, without the need to venture under unsupported ground;
- The ability to identify features that are otherwise not apparent when working close to the rock face;
- The use of quick methods;
- Minimal impact on construction activities; and
- Permanent documentation of the rock and shotcrete thickness for reporting and legal issues.

Workshop participants will learn the issues involved in developing such techniques, the possibilities offered by the new technologies, the difficulties and pit-falls the end-user must be aware of in the different stages (data collection, rendering, and rock mass analysis), how to

address these problems, and various systems developed to this purpose. Practical demonstrations will be carried out in a tunnel in the San Francisco area, and participants will subsequently analyze the data to characterize the rock mass.

There will be three major sessions organized around a Saturday/half-day Sunday workshop:

1. A Saturday (June 28th) morning session on theory with presentations addressing:
    - Issues involved in developing techniques;
    - The possibilities offered by specific techniques;
    - The difficulties and pit-falls the end-user must be aware of (data collection, rendering, and rock mass analysis), how to address them, and various systems developed to this aim) including:
        - Why is camera calibration so important and how does it effect the results?
        - What is the best measure of the quality of one's results?
        - What is the advantage of mixing cameras of different focal lengths?
        - What are the critical components of a system (calibration tools, automatic point cloud generation, detailed bundle adjustment and error checking, post processing tools and connection to high quality cad systems).

2. A Saturday afternoon demonstration/data collection session at an outcrop (the location to be determined).

3. A Sunday (June 29th) morning session on data analysis including rock mass characterization.

Workshop participants are encouraged to attend the short course *Lidar for Rock Engineering Design and Geoengineering Research* to be held on Sunday afternoon. Separate registration is required to attend this short course.

Workshop Chair: Fulvio Tonon, Assistant Professor, University of Texas at Austin
June 28-29, 2008--1 1/2 Days--$150

Short Course on Earth Stresses, Borehole Stability, Well Design

Borehole stability problems lead to direct losses of several billion dollars per year worldwide. Also, excessively conservative casing programs can be very expensive, particularly in offshore situations where operating costs are high. Drilling near salt domes, in high-pressure, high-temperature (HPHT) areas, and in massively depleted sequences presents particular challenges.

This course focuses on rock mechanics and natural stresses and pressures, as applied to wellbore design and drilling strategies. It is also an introduction to the principles and use of rock mechanics for drilling, completions and reservoir engineers. Attendees will learn how to reduce the incidence of borehole stability, how to manage risk in drilling in difficult areas, and how to reduce the number of casing strings. They will gain a clear understanding of how various drilling mud systems work, allowing better design and management of drilling operations. Drilling in underbalanced or overbalanced conditions will be introduced, along with strategies for preventing mud losses, particularly in drilling depleted reservoirs and difficult cases.

Those taking this course will find that they can help their companies save money in drilling operations by reducing lost time and by making better decisions in cases of instability or difficult conditions. We will look at issues such as drilling through depleted zones, drilling in salt, hydraulic fracturing as a completions approach, as well as hydraulic fracturing during drilling operation. Shale mechanics is a vital part of borehole stability, and we will explore the mechanics of shale in the borehole wall in substantial detail.

The course is not intended to provide a "cookbook" approach to drilling. The complexity encountered in drilling is so large that a cookbook approach is likely to be either overly conservative or actually dangerous. A process of intelligent reassessment is recommended, based on rock mechanics principles and knowledge of the geology and the stresses. Areas that are well-handled in the industry or by service companies, such as drilling hydraulics, pumping, LWD, geosteering and mud mixing, are not discussed because they are routine and well-understood. The course instead focuses on physics and mechanics so that geoscientists, engineers and drillers can better plan for conditions *in situ*, and also be prepared to look critically at data and make decisions based on a proper understanding of the issues.

The course material comprises all the PowerPoint files used during the presentations, plus a number of typical solved problems. The course material contains many new ideas and novel approaches, and will be a resource for years to come. The PowerPoint slides are provided in paper form so that you can make notes on them in the discussions.

All the presentations are provided on a CD, with all files accessible for future use. Participants are encouraged to use the author's materials for their own engineering work (with acknowledgements). A collection of a number of articles from the author's files and from the literature is included on the course CD. These references are useful sources of additional material that can be used to broaden and deepen your knowledge of various issues.

List of Topics

1. Geoscience and Rock Mechanics
2. Stresses and Pressures in the Earth
    a. Gravitational Stresses and the Source of Lateral Stress
    b. Tectonic Conditions and Departure from Gravitational Stresses
    c. Typical Stress Regimes, Faulting
    d. Diagenesis and Stresses (Fractured Shales, Limestones, Sandstones)
3. Mechanical Properties of Rocks
    a. Strength Properties: What is Cohesion? What is Friction?
    b. Deformation Properties of Rocks
    c. Measurement of Properties in the Laboratory
    d. Estimation of Properties Using Other Data Sources
4. Stresses Around a Borehole I: Calculations and Models
    a. Introduction to Linear Elastic Stress Analysis Around a Hole
    b. The Effects of Rock Yield and Ductile Behavior
    c. Is a Complex Analysis Approach Useful in Petroleum Geomechanics?
5. Stresses Around a Borehole II:
    a. Effects on Hole Stability
    b. Circulation Temperatures: Cooling and Heating Effects
6. How to Estimate and Measure *In Situ* Stresses
    a. Geological Inference
    b. Direct Measurements (LOT, XLOT, HF)
    c. Indirect Measurements (Cores, Logs…)
7. Drilling in Unusual Pressure Regimes I: Overpressure
    a. Overpressured Regimes
    b. Drilling with Overbalanced Conditions at the Shoe
    c. Drilling Below Overpressured Zones – the Stress Reversion Domain

8. Unusual Pressure Regimes II: Underpressure and Overbalance
    a. Sources of Low Pressure and Calculations
    b. Drilling Depleted Reservoirs
    c. Underbalanced Drilling
    d. Avoiding Formation Damage
9. Drilling Strategies in Wells with Mud Loss Problems
    a. The Nature of the Mud Loss Phenomenon
    b. Techniques for Natural and Induced Fractures
    c. Mud Measurement Measurements While Drilling
    d. Better Design of LCM Pills and Cements for Lost Circulation
10. Shale Drilling and Rock Mechanics
    a. Types of Shale (Smectitic, Quartz-Illite, Fractured Shales)
    b. Geochemical Reactivity of Shales
    c. How Oil-Based Mud Works in Shale
    d. Filtrate Chemistry and Water-Based Muds
    e. Pore Pressure Changes in Shale While Drilling
11. Special Topics in Shale Behavior
    a. Measurement of Shale Properties using Index Testing
    b. Osmotic Pressure Development
    c. Drilling Fractured Brittle Shales
    d. Monitoring Cuttings on the Shaker Screen: Chip Geometries
    e. Dielectric Properties
12. Borehole Stability and Casing Programs in Salt Drilling
    a. Stresses Around Salt Structures
    b. The Behavior of Salt as a Function of Stress and Temperature
    c. Mud Management in Salt Drilling
13. Drilling Shallow Horizontal Multi-Lateral Wells
    a. Real Time Well Trajectory Control
14. Other Rock Mechanics Issues in Drilling Activities
    a. Drilling in Geothermal Areas
    b. Drilling in Highly Tectonic Areas: Trajectories and Strategies
15. Waste Disposal and Environmental Factors in Drilling
    a. Cuttings and Waste Annular Injection (Offshore)
    b. Waste Disposal Onshore Using Slurry Fracture Injection
16. Introduction to Rock Mechanics Issues in Well Completions
    a. Damage from Drilling (Mechanical, Chemical, Capillary Damage)
    b. Cementing and Stresses: How to Avoid Cement Losses
    c. Perforating and Cavity Completion Approaches

Daily Schedule

Each day will approximately follow this schedule:

8:30 am	Start presentations
10:00	Coffee and discussions

10:15	Presentations
12:00	Lunch
1:00 pm	Presentations
3:00	Coffee and discussions
3:15	Presentations and discussion of issues arising
4:30	End of day's activities.

Instructor: Maurice B. Dusseault is a professor of Geological Engineering in the Earth Sciences Department, University of Waterloo, Ontario, Canada. He spent three years as a roughneck and drilling mud technician prior to completing his BSc (1971) and PhD (1977). From 1977 to 1982, he occupied a Research Professor Chair at the University of Alberta funded by the Alberta Oil Sands Technology and Research Authority. During this period, he began his interest in new production technologies and drilling rock mechanics. In 1982, Maurice became Chairman of the Geological Engineering Program at the University of Waterloo and was also Director of the Porous Media Research Institute from 1995 to 2000. He carries out research in petroleum geomechanics (drilling, hydraulic fracturing, reservoir geomechanics), new production methods, and deep waste disposal. He has co-authored two textbooks and over 370 professional articles in conferences and journals, and works with industry as an advisor and instructor. He has developed courses in *Introduction to Petroleum Rock Mechanics, New Oil Production Technologies, Drilling Rock Mechanics and Earth Stresses for Petroleum Engineers, Hydraulic Fracturing Geomechanics, Reservoir Geomechanics*, and *Oilfield Waste Disposal*. Dr. Dusseault was a SPE Distinguished Lecturer in the year 2002-2003, visiting 19 different countries and speaking about new oil production technologies to 28 separate SPE Sections. He has presented his short courses in 12 different countries over the years, and has a reputation for giving clear presentations based on simple but useful material.
June 28-29, 2008--2 Days--$495

Short Course on Applications of Block Theory for Surficial and Underground Rock Excavations

The objective of the short course is to show the applications of block theory for rock mass surficial and underground excavations. The course lecture notes that is equivalent to about 250 pages will be produced on a CD and will be distributed at the start of the course. A few computer programs will be applied to joint data from Three Gorges dam site, China and a mine in Arizona to illustrate the applications.

Course Content

Part 1: Block Theory and Applications to Surficial Excavations (1day): Basics of stereographic projection; stereographic projection of a joint pyramid; projection of sliding direction; types of blocks; theorem for finiteness; theorem on the removability of a finite, convex block; symmetry of block types; jointed blocks in 2D and 3D; stereographic solution for jointed blocks; conditions for removability of blocks intersecting surface excavations; identification of key blocks in surficial excavations using stereographic projection; procedures for designing rock slopes; modes of sliding; sliding force; kinematic conditions for lifting and sliding; stereographic projection for the joint pyramid corresponding to a given sliding direction; comparison of removability and mode analyses; application of block theory for surficial excavations using discontinuity data from the Three Gorges dam site and a mine in Arizona to find maximum safe slope angles; computer demonstration on applications of block theory.

Part 2: Block Theory Applications for Underground Chambers (2/5 day): Key blocks in the roof, floor and walls; blocks that are removable at edges; blocks that are removable at corners; applications for an underground chamber; choice of direction for an underground chamber; intersections of underground chambers; pillars between underground chambers.

Part 3: Block Theory Applications for Tunnels (3/5 day): Geometric properties of tunnels; blocks with curved surfaces; tunnel axis theorem; types of blocks in tunnels; the maximum key block; computation of the maximum key block using stereographic projection methods; removable blocks of the portals of tunnels.

Who Should Attend: Civil, mining and geo-engineers and geologists who are involved in surface and underground excavation analysis, design and construction activities associated with jointed rock masses will benefit from the short course.

Daily Schedule (each day)

8:30 am	Lectures/computer demonstrations
10:15	Coffee break
10:30	Lectures/computer demonstrations
12:15 pm	Lunch
1:15	Lectures/computer demonstrations
3:00	Coffee break
3:15	Lectures/computer demonstrations

Instructor: Pinnaduwa H.S.W. Kulatilake, Ph.D., P.E., F.ASCE, is a Professor of Geotechnical Engineering at the University of Arizona. He has over 28 years of experience in rock mechanics, geotechnical engineering, and application of probabilistic and numerical methods to geotechnical engineering. He has written over 145 papers and is a member of several technical committees. He has delivered 12 keynote lectures and 32 other invited lectures throughout the world on topics related to fracture network modeling, probabilistic geotechnics, mechanical properties of joints, rock slope stability and mechanical and hydraulic behaviour of rock masses. He is a research paper reviewer for 16 technical journals and an editorial board member for the *International Journal of Rock Mechanics & Mining Sciences* and the *International Journal of Geotechnical and Geological Engineering.* He has taught short courses on stochastic fracture network modeling, rock slope stability analysis and block theory in Sweden, Mexico, Austria, United States, Canada, Hong Kong, Poland, Finland, Australia, South Korea and Sri Lanka. He served over 20 years either as the primary or the sole examiner for the geological engineering professional exam conducted by the Arizona State Board of Technical Registration. He was a Visiting Professor at the Royal Institute of Technology and Lulea University of Technology in Sweden as part of his sabbatical leave. Also, he was a Visiting Research Fellow at the Norwegian Geotechnical Institute, for another part of his sabbatical leave. Due to the contributions that he made on teaching, research, consulting and service activities, he was elected to the Fellow Rank of the American Society of Civil Engineers at the relatively young age of 45. In 2002, he received distinguished Alumnus Award from the College of Engineering, Ohio State University and Outstanding Asian American Faculty Award from the University of Arizona in recognition of his achievements and contributions made to the advancement of his profession. In December 2005, Eurasian National University, Kazakhstan conferred him “Honorary Professorship”. In August 2007, he organized a very successful International Conference on Soil & Rock Engineering in Sri Lanka.

June 28-29, 2008--2 Days--$495

Short Course on Applied Rock Mechanics and Reservoir Geomechanics

This short course includes introductory content, background material, case studies and topics of primary importance. The preliminary agenda follows:

Day 1: Primer in Geomechanics and Rock Properties

Stresses, Reservoir Scale, Features

- Introduction to Rock Mechanics and Definition of Stress, Strain and Strength

Structural Properties for Deepwater, Shelf and Onshore Fields

- Reservoir Types and Interaction with Geomechanics

Data Requirements

- Rock Behavior Types
- Conditions of Load and Deformation Applications
- Rock Failure Criteria

Mechanical Properties Determination

- Laboratory-Scale Rock Mechanics Measurements
- Field-Scale Mechanical Properties
- Reservoir Identifications

Day 2: Geomechanic Applications

Reservoir Scale Geomechanics

- Reservoir Characterizations
- Reservoir Depletion
- Wellbore Integrity During Production
- Injection Mechanics

Injection Mechanics

- Injector Completion
- Injection Performance
- Partitioning
- Field Applications (DCI, Waterflooding, Acid Gas Injection, etc.)

Instructors: Dr. Ahmed Abou-Sayed, Ph.D. is the founder, President and CEO of Advantek, International. Dr. Abou-Sayed has extensive petroleum industry experience in the areas of production geomechanics, fracturing/stimulation, well integrity and stability, sand control, produced water management and waterflooding. He is an accomplished individual and classroom instructor. Dr. Abou-Sayed specializes in deepwater reservoir exploitation. He possesses a strong knowledge of techno-legal issues related to environmental permitting of subsurface waste disposal and injection. He is an effective lateral thinker and problem solver with track record of successfully contributing to increased production and reduced cost through innovative solutions. Dr. Abou-Sayed initiated, developed and implemented the FRACPACK technology in Alaska (1986) and large-scale solids injection projects. He is the holder of five U.S. patents and the recipient of two Chairman Outstanding Achievement Awards in both BPX and ARCO. He currently serves on the Board of Directors of ARMA and is a Distinguished Member of the Society of Petroleum Engineers. Dr. Abou-Sayed is the author and/or co-author of 60 publications, over 90 conference papers, and 150 technical reports on Reservoir Engineering, Hydraulic Fracturing, Well Completions, Rock Mechanics, Log Interpretation, Wellbore Stability, Viscous Oil Recovery, Produced Water Management, Waste Disposal and Environmental Evaluation and Permitting.

Mr. Karim S. Zaki is the Director of Operations and Technical Lead for Advantek, International Corp in Houston, Texas, and serves as the Chief Technology Officer for Informateks International Inc. in Cairo, Egypt. He holds a MS in Mechanical Engineer from Texas A & M University. Mr. Zaki began his career in 2000 as a reservoir geomechanics engineer. He quickly progressed to Senior Engineer and then Technical Lead just after four years where he performed analysis and design of geomechanics projects specifically those pertaining to associated waste stream management. He developed technical software to improve analysis schemes and methods and developed and deployed best practice websites on Produced Water and Drill Cuttings Injection. After seven years, Mr. Zaki is responsible for the day-to-day operations of the engineering staff, oversees technological advances in proprietary software and is the assurance lead for both Advantek and Informateks. He has over 15 publications to his credit including an article in the Journal of Nonlinear Dynamics and currently serves as an editor for SPE publications.
June 28-29, 2008--2 Days--$750

International Workshop on the Application of Geophysics to Rock Engineering

The International Society for Rock Mechanics Commission on the Application of Geophysics to Rock Engineering presents 8th workshop on the application of geophysics to rock engineering. The workshop will cover several topics on geophysical applications in rock engineering such as seismic and EM wave propagation in a rock and geophysical imaging and modeling of rock masses. Ten to fifteen technical papers will be presented in the one-day session. The workshop is open to all, and the registration fee includes a copy of the proceedings.

Workshop Chair: Professor Toshifumi Matsuoka, Civil and Earth Resources Engineering, Kyoto University, Japan; Workshop Secretary General: Dr. Toru Takahashi
June 29, 2008--1 Day--$70

Short Course on Lidar for Rock Engineering Design and Geoengineering Research

Ground-based Lidar (also called 3D laser scanning) is being used more and more for rock engineering applications and rock mechanics and geoscience research. Applications include semi-automated rock mass characterization for surface slope stability and underground stability, monitoring of rock slopes and tunnels for displacements and rockfall occurrences, and detailed site characterization for engineering and geoscience research.

This Sunday afternoon (June 29th) half-day short course follows the *Workshop on Laser and Photogrammetric Methods for Rock Tunnel Characterization* Separate registration is required to attend the workshop. The short course will provide detailed information and hands-on training on how to utilize Lidar for the applications mentioned above. The focus of the short course will be on "best practices" for the use of Lidar in the field and the use of semi-automated point cloud processing software for analyzing the Lidar data. All participants will receive a 6-month license for the Split FX point cloud processing software (www.spliteng.com). Participants will also receive a CD containing numerous tutorials from actual field case studies. The short course will start with an overview of rock mass characterization and rock mass monitoring using Lidar, followed by a series of demonstrations and hands-on tutorials. The short course will conclude with discussions on the various applications, and expected improvements in the technology (hardware and software) in the future.

This short course should be of interest to practicing engineers as well as university faculty and graduate students. The short course can also serve as an FX users group meeting for those already using Split FX. The short course schedule (preliminary) is as follows:

1:00 pm

- Introductions
- Overview of rock mass characterization and monitoring using Lidar
- Make sure everyone has Split FX software installed on their laptops

1:30

- Demonstrations and hands-on tutorials on basic FX features, including point cloud manipulation and editing, meshing, auto fracture extraction and editing, stereonet plotting, line/area/volume measurements, and data export

3:00 Break

3:15

- Demonstrations and hands-on tutorials on advanced and new FX features, including photo-draping, trace delineation on draped photos, change detection for displacement and rockfall monitoring, and advanced image processing analysis

4:30

- Discussions on current and future applications, expected future improvements in the technology (hardware and software), Q & A

5:00 End

Instructor: Dr. John Kemeny, Professor, University of Arizona. Dr. Kemeny is a professor in the Department of Mining and Geological Engineering at the University of Arizona, and also partner and Director of Research at Split Engineering, LLC. Dr. Kemeny has over 25 years of experience in rock mechanics and over 15 years experience with using new technologies such as digital image processing and Lidar for rock engineering applications.
June 29, 2008--1/2 Day--$125