

# Welcome to the UCA and UC&T Fall Kick-Off and Info Session!

WEDNESDAY, August 26th

#### UC&T = Caverns + Shafts + Adits + Excavations + Tunnels



Manhattan Caverns New York City (10 blocks long; under Grand Central Terminal)

#### Olympic Cavern Hall (Gjøvik, Norway)



#### UC&T = Caverns + Shafts + Adits + Excavations + Tunnels



#### UC&T = Caverns + Shafts + Adits + Excavations + Tunnels



#### **Tunnels: Water Conveyance**



#### **Tunnels: Wastewater**



#### **Tunnels: Transportation**

#### Road

#### **Transit**





#### **Tunnels: Multiple Use**



SMART Tunnel – Stormwater Management & Road Tunnel (Kuala Lumpur, Malaysia)



## What is Underground Construction and Tunneling and what is UCA?







# What is Underground Construction and Tunneling and what is UCA?



#### https://www.youtube.com/watch?v=hvDhlSpfjC0





## Center of Excellence in Underground Construction & Tunneling (UC&T)

#### Developing Leaders. Advancing Knowledge.



## A Little Bit about Us...

OLORADOSCHOOLOFMINES

We are a collaborative, interdisciplinary group of faculty and students from:

- Civil and Environmental Engineering
- Geology and Geological Engineering
- Mining Engineering

Additional involvement from: Geophysics, Mechanical Engineering, Electrical Engineering, Computer Science, Economics and Business



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Developing Leaders. Advancing Knowledge.

#### **UC&T Core Faculty**





**Mike Mooney** Grewcock Chair **Center Director** Professor, Civil Eng.

**Eunhye Kim** Assistant Professor Mining Eng.



**Reza Hedayat** Assistant Professor Civil Eng.



Fall 2015

**Gabe Walton** Assistant Professor Geological Eng.



**Rennie Kaunda** Assistant Professor Mining Eng.



Wendy Zhou Associate Professor Geological Eng.



Back Jan 2016

**Marte Gutierrez** Paden Professor Civil Eng.



**Priscilla Nelson** Professor and Head Mining Eng.



Paul Santi Professor and Head Geology & Geological Eng. Civil Eng.



**Sheiling Pei** Assistant Professor

#### **UC&T Center Staff**



Yong Fang Visiting Faculty



Begoña Ruiz Center Administrator



Jacob Grasmick PhD Student and Research Associate



Rick Bearce Post Doc



Nathan Toohey Post Doc



## **Mike Mooney**

**Grewcock Chair & Professor, UC&T Center Director** 

Teaching: Tunnel Design & Construction; Earth Retaining Structures

Research:



#### **TBM Vibration**



#### Soil Conditioning



#### Learning from Data



#### Jet Grout Monitoring



### **Reza Hedayat**

- **Teaching Interests:**
- Mechanics of Materials
- Civil Engineering Materials
- Earth Retaining Structures
- Tunnels in Hard Rocks

#### **Research Interests:**

- Geomechanics
- Rock Mechanics
- Fracture Mechanics
- Ground-Support
   Interaction
- Geophysics
- Flow in Porous
   Media

## Priscilla P. Nelson

## **Teaching:**

CSM Courses:

- Tunneling
- Underground Engineering and Construction
- Earth Materials and Resources
- Education Innovation at CSM:
  - Development of a Tunnel "Geo-Wikipedia"
  - Development of graduate field course in geological engineering
  - CELERY a web site for kids to write their own books about engineering (mycelery.org)
  - Develop new short courses for the construction and mining industries
  - STEM+C: Pathways to the Future for K-12 Education

## **Research:**

- Sustainability of Urban Infrastructure
- Surface and Underground Excavation
- Geologic Uncertainty and Risk
- Subsurface Research in Geothermal Energy
- Microwave damage of rock
- History of underground infrastructure development and the growth of the United States

### Rennie Kaunda Teaching:

- Rock Slope Engineering
  Computational Neural Networks in Mining
- Mine Water & Environment
- Mining Equipment Maintenance and Automation

## **Research:**

- Mining Geotechnics and Rock Mechanics
- Artificial Neural Networks
- Slope Stability and Internal Erosion
- Rock Fragmentation Optimization
  - Mechanical Excavation and
    - Tunneling
  - Environmental
    - aspects in Mining

## Eunhye Kim (Ph.D., PE) Teaching philosophy

- 1. Promoting inquisitiveness and teamwork with utilizing hands-on experience.
- 2. Strengthening basic principles with employing real life problem-solving exercises.
- 3. Advising students under interactive environment.

Also, interested in undergraduate research program on campus supervising students on various rock mechanics topics

## Main research topics

- Topic 1: Stability of geo-structures
  - Tunnels
  - Slopes
- Topic 2: Mechanical and hydraulic properties of geomaterials
  - Fracture toughness
  - Dynamic mechanical behaviors of geomaterials
  - Interactions of geomaterials with fluid
- Topic 3: Mechanical interactions between cutting tools and geomaterials (cutting tool design)
  - Frictional ignition
  - Dust and noise generations

Also, interested in working with industry people to contribute to resolve local and national UCT problems and difficulties.

#### Undergraduate research opportunity (with Dr. Kim)

- 1. EMI database analysis (Students initiates their own ideas)
  - The Earth Mechanics Institute (EMI) was established in 1974 to improve academic research and education at the Colorado School of Mines (CSM).
- During last four decades, a number of innovative rock mechanics researches have been conducted through various rock mechanics tests, which are recorded in a database for research purposes.
- This database includes over 20,000 tests from over 1,000 different research projects.
- We anticipate that the database analysis obtained from EMI will reveal comprehensive information for understanding the mechanical properties and responses of numerous rocks.
- 2. Tunnel lining system (Colorado Department of Transportation)
- Developing a new standard test for slip-lining system for culvert regarding structural stability of the lining system.
- Improving effectiveness of structural stability evaluation for lining materials, pipes, and new shapes of the culvert system.

### **Gabriel Walton**

## **Teaching:**

Site Investigation Engineering Geology Rock Mechanics Applied Numerical Modelling

## **Research:**

Post-yield behaviour of hard rock Lab-field relationships Rockmass characterization Applications of LiDAR in UC&T





## **Shiling Pei**

## **Teaching:**



 CEEN 433/533: **Matrix Structural Analysis**  CEEN 443: **Steel Design** • CEEN 445: **Timber and Masonry Design** • CEEN 598: **Reliability and Statistical Methods for Engineering** Design

## **Research:**

 Earthquake Engineering and Structural Reliability
 Advanced Timber Engineering: Future cities with wood skyscrapers



#### **UC&T Grad Students**



Shrey Arora PhD, UC&T



Wendy Belcher PhD, Comp Sci.



Carolyne Bocovich PhD, Geotech



Jacob Grasmick PhD, Geotech



Lisa Mori PhD, Mining



Ali Nazem PhD, UC&T



Simon Prassetyo PhD, Geotech



Kevin Schaeffer PhD, Geotech



Yuanli Wu PhD, Geotech



Hongjie Yu PhD, UC&T



Jessica Buckley MS, Mech. Eng.



Joy Foley MS, Civil



Noah Kimmes MS, UC&T

## How Can U Get Involved in UC&T??

- Courses and Degrees
- Research Projects and Positions
- Field Trips
- Scholarships: Information and Deadlines at uct.mines.edu
- Internships: Career Center and Diggernet



## Education

- 20+ UC&T Courses
- Undergraduate Minor
- M.S. (Thesis and Non-Thesis)
- Ph.D.

(Only UC&T advanced degrees offered in North America!)

• See CSM Bulletin

(link on uct.mines.edu)

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Advanced Drilling and Geological Site Invest	Blasting igation	Analysi		



#### Area of Special Interest - ASI

The Underground Construction & Tunneling ASI consists of a minimum of 12 credit hours

#### Required Courses

CEEN312	SOIL MECHANICS
MNGN321	INTRODUCTION TO ROCK MECHANICS
MNGN404	TUNNELING

#### **Electives Offered This Semester**

CEEN314	STRUCTURAL THEORY
CEEN415	FOUNDATIONS
CEEN523	ANALYSIS AND DESIGN OF TUNNELS IN SOFT GROUND
GEOL309	STRUCTURAL GEOLOGY AND TECTONICS
MNGN408	UNDERGROUND DESIGN AND CONSTRUCTION

3.0	*Offered This Semester
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### **Undergraduate Minor**

#### The Underground Construction & Tunneling minor consists of a minimum of 18 credit hours

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#### Required Courses

CEEN312	SOIL MECHANICS
MNGN321	INTRODUCTION TO ROCK MECHANICS
MNGN404	TUNNELING
GEGN466	GROUNDWATER ENGINEERING
or GEGN467	GROUNDWATER ENGINEERING
GEGN/68	

#### **Electives Offered This Semester**

CEEN314	STRUCTURAL THEORY
CEEN415	FOUNDATIONS
CEEN523	ANALYSIS AND DESIGN OF TUNNELS IN SOFT GROUN
GEOL309	STRUCTURAL GEOLOGY AND TECTONICS
MNGN408	UNDERGROUND DESIGN AND CONSTRUCTION

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- 4.0 \*Offered This Semester
- 3.0 \*Offered This Semester
- 2.0 \*Offered This Semester



## **Required Minor Courses this Fall**



- Soil Mechanics (CEEN 312) Alexandra Wayllace
  - MWF 9-9:50 + Lab
  - Prerequisites: Mechanics of Materials



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- Intro to Rock Mechanics (MNGN 321) Ugur Ozbay
  - MW 9-9:50 + T 1-3:50
  - Prerequisites: Statics or Dynamics for Mining Engineers



- Groundwater Engineering (GEGN466) Kamini Singha
  - TR 11-12:15

- Prerequisites: Calculus, Differential Equations, Structural Geology,
  - Sedimentology & Stratigraphy, Geologic Fluid Mechanics or Fluid Mechanics

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- Engineering Geology and Geotechnics (GEGN468) Jerry Higgins
  - MWF 10-10:50 + R 1-3:50
  - Prerequisites: Intro to Rock Mechanics and Soil Mechanics









Elective Minor Courses this Fall • Underground Design and Construction (MNGN408) – Eunhye Kim

- TR 9:30-10:45
- Prerequisites: Soil Mechanics or Intro to Rock Mechanics
- Grouting in Underground Construction (MNGN598C) Ray Henn
  - F 1-3:50
  - Prerequisites: none
- Analysis and Design of Tunnels in Soft Ground (CEEN532) Kevin Schaeffer
  - MW 3-4:15
  - Prerequisites: Soil Mechanics or similar, Structural Analysis, Reinforced Concrete Design (preferred)
- Structural Theory (CEEN314) Susan Reynolds
  - MWF 11-11:50
  - Prerequisites: Mechanics of Materials
- Foundations (CEEN415) Vaughan Griffiths
  - TR 12:30-1:45
  - Prerequisites: Soil Mechanics
- Structural Geology and Geotechnics (GEOL309) Bruce Trudgill

- MW 1-3:50
- Prerequisites: Earth and Env. Systems, Engineering Terrain Analysis, Geologic Principles & Processes, Adv.
   Physical Geology Lab, and Earth Materials or Intro to Geophysics

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## MS and/or PhD in UC&T

#### Required Courses for M.S. Thesis, M.S Non-Thesis and Ph.D. Degrees

The following 21 credit hours are required. Students are required to attend the UC&T seminar series and **M.S. non-thesis and Ph.D. students must complete an internship-related project**, registering as an independent study in the home department of the faculty advisor (CEEN 599, GEGN 599, or MNGN 599)

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GEGN468	ENGINEERING GEOLOGY AND GEOTECHNICS	4.0	*Offered This Semes
MNGN504	TUNNELING	3.0	*Spring 2016
MNGN508	ADVANCED ROCK MECHANICS	3.0	*Offered This Semes
MNGN509	EXCAVATION PROJECT MANAGEMENT	2.0	*Spring 2016
CEEN512	SOIL BEHAVIOR	3.0	*Offered This Semes
CEEN520	EARTH RETAINING STRUCTURES / SUPPORT OF EXCAVATIONS	3.0	*Spring 2016
CEEN523	ANALYSIS AND DESIGN OF TUNNELS IN SOFT GROUND	3.0	*Offered This Semes



## MS and/or PhD in UC&T

#### **Example Elective Courses**

CEEN510	ADVANCED SOIL MECHANICS	3.0 *Offered This Semester
CEEN541	DESIGN OF REINFORCED CONCRETE STRUCTURES	3.0 *Offered This Semester
GEGN466	GROUNDWATER ENGINEERING	3.0 *Offered This Semester
GEGN573	GEOLOGICAL ENGINEERING SITE INVESTIGATION	3.0
GEGN581	ANALYTICAL HYDROLOGY	3.0 *Offered This Semester
GEGN673	ADVANCED GEOLOGICAL ENGINEERING DESIGN	3.0
MNGN424	ADVANCED MINE VENTILATION	3.0 *Offered This Semester
MNGN506	DESIGN AND SUPPORT OF UNDERGROUND EXCAVATIONS	3.0
MNGN507	ADVANCED DRILLING AND BLASTING	3.0
		2.0 *Offered This Semester



#### Required UC&T Grad Degree Courses this Fall



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- Engineering Geology and Geotechnics (GEGN468) Jerry Higgins
  - MWF 10-10:50 + R 1-3:50
  - Prerequisites: Intro to Rock Mechanics and Soil Mechanics
- Soil Behavior (CEEN512) Ning Lu
  - R 10:00-12:30
  - Prerequisites: Soil Mechanics
- Advanced Rock Mechanics (MNGN508) Ugur Ozbay
  - MW 9-9:50 + T 1-3:50
  - Prerequisites: Intro to Rock Mechanics
- Analysis and Design of Tunnels in Soft Ground (CEEN532) Kevin Schaeffer
  - MW 3-4:15
  - Prerequisites: Soil Mechanics or similar, Structural Analysis, Reinforced Concrete Design (preferred)



#### Elective UC&T Grad Degree Courses this Fall

**Design of Reinforced Concrete Structures (CEEN541)** – Joseph Crocker









Prerequisites: Design of Reinforced Concrete

Groundwater Engineering (GEGN466) – Kamini Singha

- Prerequisites: Calculus, Differential Equations, Structural Geology, Sedimentology & Stratigraphy, Geologic Fluid Mechanics or Fluid Mechanics
- Grouting in Underground Construction (MNGN598C) Ray Henn
  - F 1-3:50
  - Prerequisites: none

MWF 1-1:50

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- Advanced Mine Ventilation (MNGN524) Juergen Brune
  - M 5-7:50
  - Prerequisites: Mine Ventilation



#### Elective UC&T Grad Degree Courses this Fall





- MWF 11-11:50
- Prerequisites: Engineering Geology and Geotechnics, Soil Mechanics, Rock Mechanics

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- Analytical Hydrology (GEGN581) David Benson
  - TR 2-3:15
  - Prerequisites: Groundwater Engineering
- Advanced Soil Mechanics (CEEN510) Vaughan Griffiths
  - TR 9:30-10:45
  - Prerequisites: Soil Mechanics
- · Four
- Foundations (CEEN415) Vaughan Griffiths
  - TR 12:30-1:45
  - Prerequisites: Soil Mechanics



#### Earth Mechanic Institute Mining Engineering Department Brian Asbury

Mechanical Excavation Tunneling, Mining, Drilling, etc. Rock Mechanics Testing Laboratory Full-Scale Testing Machine Performance Modeling



Novel Excavation Methods (water jet, thermal/chemical/laser



#### Research Projects – UC&T Undergraduates Fall 2015

- Jet Grouting
- Slurry Infiltration
- Big Data
- Characteristics and Physics of Foam
- TBM Performance in Weak Rock
- Geological Controls on Rock Strength
- Modelling Mine Pillar Behavior for Brittle Rock
- Development of Geophysical Measurement System
- EMI Database Analysis
- Tunnel Lining System
- Thermal Imaging of Shotcrete



#### Research Projects – UC&T Undergraduates Fall 2015

Undergraduates in Civil, Geological, Mining, Mechanical, Electrical, Geophysics, Computer Science, etc. - join us and participate in applied research such as site investigation and characterization, ground imaging, numerical modeling, tunnel boring machine performance prediction and more!

5-15 hours per week; \$11-\$14/hr; flexible schedule; possible site visits

See flyer for full information, sign up for email notification or email uct@mines.edu

#### **Applications due September 4, 2015**











#### Previous Undergraduate Researchers - Examples



Justin Downs Major: Civil Engineering Project: Application of geophysical techniques to model/image jet grout columns



Stephanie Ecker Major: Civil Engineering Project: "Zero carbon" tunnel concept



**Conor Lenon** Major: **Civil Engineering** Project: *4D visualization of underground data; relating TBM data to geotechnical parameters* 

Heather Mergentime Major: Civil Engineering Project: Soil conditioning for EPB TBMs



(Richard) Adam Moore Major: Civil Engineering Project: Soil conditioning agent interaction with project soils



James Halverson Major: Geological Engineering Project: Identifying parameters needed from cuttings logs for TBM design and developing guidelines for logging protocol



**Austin Wilkes** 

**Stephen Semmens** 

tunnel project

Major: Geological Engineering

Major: Geological Engineering





Andrew Eberle Major: Mechanical Engineering Project: Soil conditioning equipment development

Project: Wear monitoring/estimation on Mexico City

Project: LiDAR imaging/scanning to characterize

geological conditions in hard rock tunnels



Michael Hanaoka Major: Mechanical Engineering Project: Vibration analysis of individual disk cutters on tunnel boring machines



John Kuyt Major: Civil Engineering Project: Predictive modeling of ground settlement due to TBM excavations

#### Scholarships – UC&T Students

Scholarships related to the field of UC&T will be listed on the website at **uct.mines.edu**.

Examples:

#### UCA of SME Scholarship - Application Deadline January 8, 2016

Established to encourage undergraduate and graduate academic pursuits and careers in the field of tunneling and underground construction and associated disciplines involved in the development, planning, design, and construction of underground infrastructure.

#### <u>ASA Graduate Scholarship – Application Deadline November 3, 2015</u> The purpose of the ASA Graduate Scholarship Program is to attract, identify, and assist

outstanding graduate students pursuing careers within the field of concrete with a significant interest in the shotcrete process.



#### **Civil Engineering** Mining Engineering Kamyar Mosavat Lisa Mori **Summer 2014 Interns MS Civil Eng** PhD Mining Eng **Seattle Tunnel Partners** Jay Dee Seattle, WA **Undergrads: 8** Seattle, WA **SR99 Northgate Link** Grads: 5 **Kevin Hart Christian Karns BS Civil Eng BS** Mining Eng **Kiewit** Portland, OR USGS Lakewood, CO Simon Prassetvo Laura Porras PhD Civil Eng MS Mining Eng **Golder Associates** Moretrench Lake Oswego, OR Rockaway, NJ Mark Sundstrom **BS** Civil Eng **Geological Engineering** UC&T J.F. Shea Construction Los Angeles, CA **Brock Rysdahl Stephen Semmens** Crenshaw/LAX Corridor MS UC&T **MS** Geological Eng **Mechanical Engineering Traylor Bros.** J.F. Shea Construction Washington, D.C. Los Angeles, CA **Justin Downs Blue Plains Tunnel** Crenshaw/LAX Corridor Jessica Buckley **BS** Civil Eng **MS Mech Eng** Atkinson **Jay Dee** Construction John Kuyt Seattle, WA Golden, CO **James Halverson** MS UC&T **Northgate Link BS** Geological Eng Arup **CTL** Thompson San Francisco, CA Lakewood, CO **Central Subway**

#### Internships

#### Ten UC&T students were employed this summer by ten companies!

- Kiewit
- J.F. Shea Construction
- Jay Dee
- Traylor Bros.
- Arup
- Golder Associates
- Atkinson Construction
- Moretrench
- USGS
- CTL Thompson



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Please work with the CSM Career Center and our UC&T Center Coordinator to find your opportunity, and let's increase that number!



#### Next Seminar: Wednesday 9/2 @ Noon



#### Dr. Gabe Walton



## What is the UCA?

- UCA is the Underground Construction Association
- Subsection of the Society for Mining, Metallurgy and Exploration (SME)
- CSM has the only student chapter in the nation
- Through the UCA student chapter you can:
  - Learn about projects and technologies in the tunneling industry

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- Network with industry professionals
- Learn about tunneling research at CSM



### New UCA officers for the 2015-2016

### school year:

- President: Yuanli Wu
- Vice-president & Outreach: Simon Prassetyo
- Treasurer: Samuel Lolon
- Secretary: Lucila Dunnington





## Plans for the 2015-2016 school year:

- Celebration of Mines
- Field trips to underground construction and tunneling projects
- 2 Community service events
- Tunneling short courses
- Networking events
- Biweekly seminars





#### Visit us at our table at Celebration of Mines!

Join us on OrgSync! (search for UCA)

Learn more about the UCA: <a href="http://uca.smenet.org/">http://uca.smenet.org/</a>





