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

Niagara Falls Hydroelectric Tunnel
Tunnels: Wastewater

Deep Rock Tunnel (Indianapolis)
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?

https://www.youtube.com/watch?v=KBgvBEtzQq4
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…

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

Developing Leaders. Advancing Knowledge.
UC&T Core Faculty  

**Fall 2015**

- **Mike Mooney**  
  Grewcock Chair  
  Center Director  
  Professor, Civil Eng.
- **Eunhye Kim**  
  Assistant Professor  
  Mining Eng.
- **Reza Hedayat**  
  Assistant Professor  
  Civil Eng.
- **Gabe Walton**  
  Assistant Professor  
  Geological Eng.
- **Rennie Kaunda**  
  Assistant Professor  
  Mining Eng.
- **Wendy Zhou**  
  Associate Professor  
  Geological Eng.
- **Marte Gutierrez**  
  Paden Professor  
  Civil Eng.
- **Priscilla Nelson**  
  Professor and Head  
  Mining Eng.
- **Paul Santi**  
  Professor and Head  
  Geology & Geological Eng.
- **Sheiling Pei**  
  Assistant Professor  
  Civil Eng.
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 Look Ahead
- Soil Conditioning
- Jet Grout Monitoring
- TBM Vibration
- Learning from Data
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
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)
## Area of Special Interest - ASI

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

### Required Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEEN312</td>
<td>SOIL MECHANICS</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN321</td>
<td>INTRODUCTION TO ROCK MECHANICS</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN404</td>
<td>TUNNELING</td>
<td>3.0</td>
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</table>

### Electives Offered This Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEEN314</td>
<td>STRUCTURAL THEORY</td>
<td>3.0</td>
</tr>
<tr>
<td>CEEN415</td>
<td>FOUNDATIONS</td>
<td>3.0</td>
</tr>
<tr>
<td>CEEN523</td>
<td>ANALYSIS AND DESIGN OF TUNNELS IN SOFT GROUND</td>
<td>3.0</td>
</tr>
<tr>
<td>GEOL309</td>
<td>STRUCTURAL GEOLOGY AND TECTONICS</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN408</td>
<td>UNDERGROUND DESIGN AND CONSTRUCTION</td>
<td>2.0</td>
</tr>
</tbody>
</table>
# Undergraduate Minor

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

## Required Courses

<table>
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<th>Course Name</th>
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</thead>
<tbody>
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<td>CEEN312</td>
<td>SOIL MECHANICS</td>
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<td>INTRODUCTION TO ROCK MECHANICS</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN404</td>
<td>TUNNELING</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN466</td>
<td>GROUNDWATER ENGINEERING</td>
<td>3.0</td>
</tr>
<tr>
<td>or GEGN467</td>
<td>GROUNDWATER ENGINEERING</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN468</td>
<td>ENGINEERING GEOLOGY AND GEOTECHNICS</td>
<td>4.0</td>
</tr>
</tbody>
</table>

## Electives Offered This Semester

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<tr>
<th>Course Code</th>
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</tr>
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<td>GEOL309</td>
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</tr>
<tr>
<td>MNGN408</td>
<td>UNDERGROUND DESIGN AND CONSTRUCTION</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Required Minor Courses this Fall

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

- **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

- **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
# 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)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEGN468</td>
<td>ENGINEERING GEOLOGY AND GEOTECHNICS</td>
<td>4.0</td>
<td>*Offered This Semester</td>
</tr>
<tr>
<td>MNGN504</td>
<td>TUNNELING</td>
<td>3.0</td>
<td>*Spring 2016</td>
</tr>
<tr>
<td>MNGN508</td>
<td>ADVANCED ROCK MECHANICS</td>
<td>3.0</td>
<td>*Offered This Semester</td>
</tr>
<tr>
<td>MNGN509</td>
<td>EXCAVATION PROJECT MANAGEMENT</td>
<td>2.0</td>
<td>*Spring 2016</td>
</tr>
<tr>
<td>CEEN512</td>
<td>SOIL BEHAVIOR</td>
<td>3.0</td>
<td>*Offered This Semester</td>
</tr>
<tr>
<td>CEEN520</td>
<td>EARTH RETAINING STRUCTURES / SUPPORT OF EXCAVATIONS</td>
<td>3.0</td>
<td>*Spring 2016</td>
</tr>
<tr>
<td>CEEN523</td>
<td>ANALYSIS AND DESIGN OF TUNNELS IN SOFT GROUND</td>
<td>3.0</td>
<td>*Offered This Semester</td>
</tr>
</tbody>
</table>
## Example Elective Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEEN510</td>
<td>ADVANCED SOIL MECHANICS</td>
<td>3.0</td>
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<tr>
<td>CEEN541</td>
<td>DESIGN OF REINFORCED CONCRETE STRUCTURES</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN466</td>
<td>GROUNDWATER ENGINEERING</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN573</td>
<td>GEOLOGICAL ENGINEERING SITE INVESTIGATION</td>
<td>3.0</td>
</tr>
<tr>
<td>GEGN581</td>
<td>ANALYTICAL HYDROLOGY</td>
<td>3.0</td>
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<tr>
<td>GEGN673</td>
<td>ADVANCED GEOLOGICAL ENGINEERING ENGINEERING DESIGN</td>
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<tr>
<td>MNGN424</td>
<td>ADVANCED MINE VENTILATION</td>
<td>3.0</td>
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<tr>
<td>MNGN506</td>
<td>DESIGN AND SUPPORT OF UNDERGROUND EXCAVATIONS</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN507</td>
<td>ADVANCED DRILLING AND BLASTING</td>
<td>3.0</td>
</tr>
<tr>
<td>MNGN598C</td>
<td>GROUTING IN UNDERGROUND CONSTRUCTION</td>
<td>3.0</td>
</tr>
</tbody>
</table>
Required UC&T Grad Degree Courses this Fall

- **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
  - MWF 1-1:50
  - Prerequisites: Design of Reinforced Concrete

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

- **Advanced Mine Ventilation (MNGN524)** – Juergen Brune
  - M 5-7:50
  - Prerequisites: Mine Ventilation
Elective UC&T Grad Degree Courses this Fall

• **Advanced Geotechnics (GEGN672)** – Paul Santi
  - MWF 11-11:50
  - Prerequisites: Engineering Geology and Geotechnics, Soil Mechanics, Rock Mechanics

• **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

• **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

<table>
<thead>
<tr>
<th>Name</th>
<th>Major</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Justin Downs</td>
<td>Civil Engineering</td>
<td>Application of geophysical techniques to model/image jet grout columns</td>
</tr>
<tr>
<td>Stephanie Ecker</td>
<td>Civil Engineering</td>
<td>&quot;Zero carbon&quot; tunnel concept</td>
</tr>
<tr>
<td>Conor Lenon</td>
<td>Civil Engineering</td>
<td>4D visualization of underground data; relating TBM data to geotechnical parameters</td>
</tr>
<tr>
<td>Heather Mergentime</td>
<td>Civil Engineering</td>
<td>Soil conditioning for EPB TBMs</td>
</tr>
<tr>
<td>(Richard) Adam Moore</td>
<td>Civil Engineering</td>
<td>Soil conditioning agent interaction with project soils</td>
</tr>
<tr>
<td>James Halverson</td>
<td>Geological Engineering</td>
<td>Identifying parameters needed from cuttings logs for TBM design and developing guidelines for logging protocol</td>
</tr>
<tr>
<td>Austin Wilkes</td>
<td>Geological Engineering</td>
<td>LiDAR imaging/scanning to characterize geological conditions in hard rock tunnels</td>
</tr>
<tr>
<td>Stephen Semmens</td>
<td>Geological Engineering</td>
<td>Wear monitoring/estimation on Mexico City tunnel project</td>
</tr>
<tr>
<td>Andrew Eberle</td>
<td>Mechanical Engineering</td>
<td>Soil conditioning equipment development</td>
</tr>
<tr>
<td>Michael Hanaoka</td>
<td>Mechanical Engineering</td>
<td>Vibration analysis of individual disk cutters on tunnel boring machines</td>
</tr>
<tr>
<td>John Kuyt</td>
<td>Civil Engineering</td>
<td>Predictive modeling of ground settlement due to TBM excavations</td>
</tr>
</tbody>
</table>
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.

**ASA Graduate Scholarship – Application Deadline November 3, 2015**
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.
Summer 2014 Interns

- Undergrads: 8
- Grads: 5

Civil Engineering
- Kamyar Mosavat
  MS Civil Eng
  Seattle Tunnel Partners
  Seattle, WA
  SR99
- Kevin Hart
  BS Civil Eng
  Kiewit
  Portland, OR
- Simon Prasetyo
  PhD Civil Eng
  Golder Associates
  Lake Oswego, OR
- Mark Sundstrom
  BS Civil Eng
  J.F. Shea Construction
  Los Angeles, CA
  Crenshaw/LAX Corridor
- Justin Downs
  BS Civil Eng
  Atkinson Construction
  Golden, CO

Mechanical Engineering
- Jessica Buckley
  MS Mech Eng
  Jay Dee
  Seattle, WA
  Northgate Link

Urban & Transportation (UC&T)
- Brock Rysdahl
  MS UC&T
  Traylor Bros.
  Washington, D.C.
  Blue Plains Tunnel
- John Kuyt
  MS UC&T
  Arup
  San Francisco, CA
  Central Subway

Mining Engineering
- Lisa Mori
  PhD Mining Eng
  Jay Dee
  Seattle, WA
  Northgate Link
- Christian Karns
  BS Mining Eng
  USGS
  Lakewood, CO
- Laura Porras
  MS Mining Eng
  Moretrench
  Rockaway, NJ

Geological Engineering
- Stephen Semmens
  MS Geological Eng
  J.F. Shea Construction
  Los Angeles, CA
  Crenshaw/LAX Corridor
- James Halverson
  BS Geological Eng
  CTL Thompson
  Lakewood, CO
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

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
  - 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: http://uca.smenet.org/