



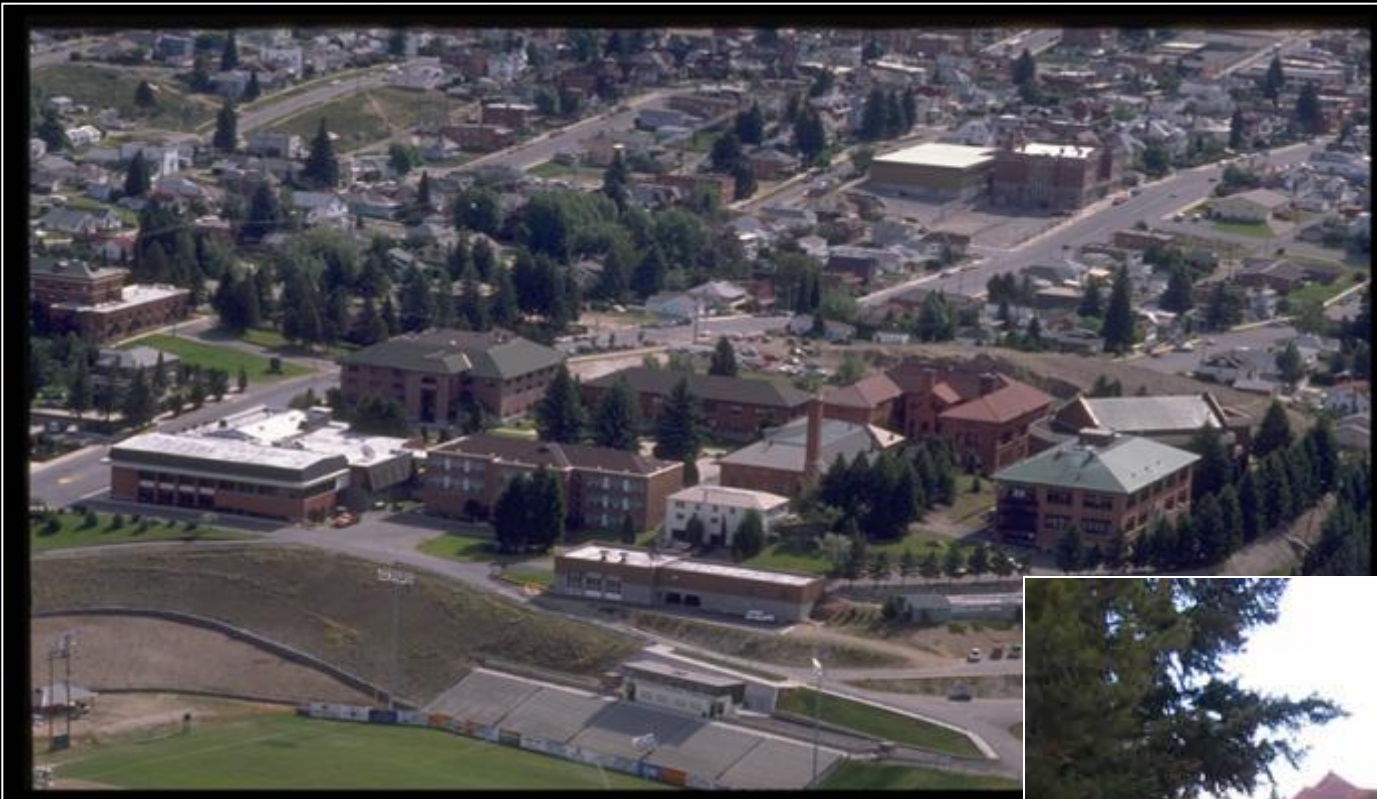
# MONTANA TECH



**Metallurgical and Materials Engineering**



# MONTANA TECH



**Twenty-one buildings are situated on the picturesque campus, which overlooks the city of Butte (pop. 34,000).**



# MONTANA TECH



Montana Tech is comprised of three colleges:

❖ **College of Letters, Sciences & Professional Studies**

Biological Sciences – Business and Information Technology – Chemistry and Geochemistry – Computer Science – General Science – General Studies  
Health Care Informatics – Liberal Studies – Mathematical Sciences  
Nursing – Professional and Technical Communication – Software Engineering – Statistics

❖ **School of Mines & Engineering**

Electrical Engineering – Environmental Engineering – Geological Engineering – Geophysical Engineering – General Engineering – Metallurgical and Materials Engineering – Mining Engineering – Petroleum Engineering  
Safety, Health and Industrial Hygiene

❖ **Highlands College of Montana Tech**

Business and Accounting Technology – Health Programs – Network Technology – Trades and Technical



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# SCHOOL OF MINES & ENGINEERING



## Bachelor of Science Degree Programs:

- ❖ Electrical Engineering
- ❖ Environmental Engineering
- ❖ General Engineering
  - ❖ Civil, Mechanical, Robotics, and Welding Options
- ❖ Geological Engineering
- ❖ Metallurgical and Materials Engineering
- ❖ Mining Engineering
- ❖ Occupational Safety and Health
- ❖ Petroleum Engineering



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- ❖ Geological Engineering
- ❖ **Metallurgical and Materials Engineering**
- ❖ Mining Engineering
- ❖ Occupational Safety and Health
- ❖ Petroleum Engineering



# GRADUATE SCHOOL

## Master of Science Degree Programs:

- ❖ Environmental Engineering
- ❖ Electrical Engineering
- ❖ General Engineering
- ❖ Geoscience
- ❖ Industrial Hygiene
- ❖ **Metallurgical/Mineral Processing Engineering**
- ❖ Mining Engineering
- ❖ Petroleum Engineering
- ❖ Project Engineering and Management
- ❖ Technical Communication





# GRADUATE SCHOOL

## Master of Science Degree Programs:

- ❖ Environmental Engineering
- ❖ Electrical Engineering
- ❖ General Engineering
- ❖ Geoscience
- ❖ Industrial Hygiene
- ❖ **Metallurgical/Mineral Processing Engineering**
- ❖ Mining Engineering
- ❖ Petroleum Engineering
- ❖ Project Engineering and Management
- ❖ Technical Communication





# METALLURGICAL & MATERIALS ENGINEERING



*Molten iron being charged to a Basic Oxygen Steelmaking Furnace*



*Conceptual drawing of nanobots on a cancer cell search-and-destroy mission*

# METALLURGICAL AND MATERIALS ENGINEERING

## UNIQUE FEATURES

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- ❖ **Combination of Theoretical and Practical Experiences**
  - ❖ M&ME course every semester including freshman year
  - ❖ 15 Labs/8 M&ME Labs/at least 1 lab every semester
- ❖ **Broad Materials Processing Coverage**
  - ❖ Physical processing
  - ❖ Chemical processing
  - ❖ Development, application, and maintenance of fabricated materials
- ❖ **Small Classes** with a strong emphasis on practical, industrial examples.
- ❖ **Strong Industry Support** from advanced materials, mining, chemical, engineering & construction, environmental, and recycling companies

# METALLURGICAL AND MATERIALS ENGINEERING

## FAQS

---

- ❖ What is metallurgical and materials engineering?
- ❖ What can I expect in the metallurgical and materials engineering program at Montana Tech?
- ❖ What types of employment opportunities are available for metallurgical and materials engineering graduates?
- ❖ What is the employment outlook for metallurgical and materials engineers?

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# THE MATERIALS LIFE CYCLE

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# THE MATERIALS LIFE CYCLE

Mine, Drill,  
Harvest



RAW MATERIALS:  
Ore, coal, sand, oil,  
wood, plants



# THE MATERIALS LIFE CYCLE

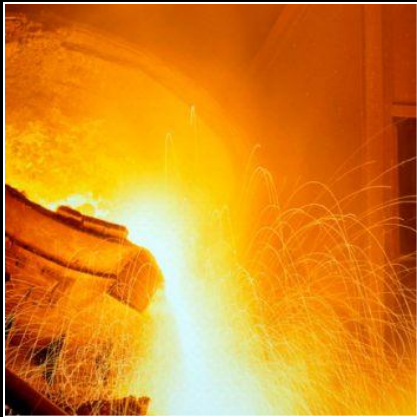


Mine, Drill,  
Harvest



RAW MATERIALS:

Ore, coal, sand, oil,  
wood, plants



Extract, Refine,  
Process



BULK MATERIALS:

Chemicals, lumber,  
metals, cement,  
paper, fibers



# THE MATERIALS LIFE CYCLE



**BULK MATERIALS:**  
Chemicals, metals,  
cement, paper, fibers

Process



**ENGINEERING MATERIALS:**  
Alloys, crystals, ceramics,  
plastics, composites, textiles





# THE MATERIALS LIFE CYCLE



**PRODUCT MATERIALS:**  
Machines, structures,  
roads, consumer goods

Design, Manufacture,  
Assemble



**ENGINEERING MATERIALS:**  
Alloys, crystals, ceramics,  
plastics, composites, textiles

# THE MATERIALS LIFE CYCLE



WASTE & SCRAP  
MATERIALS

Use, Service,  
Performance

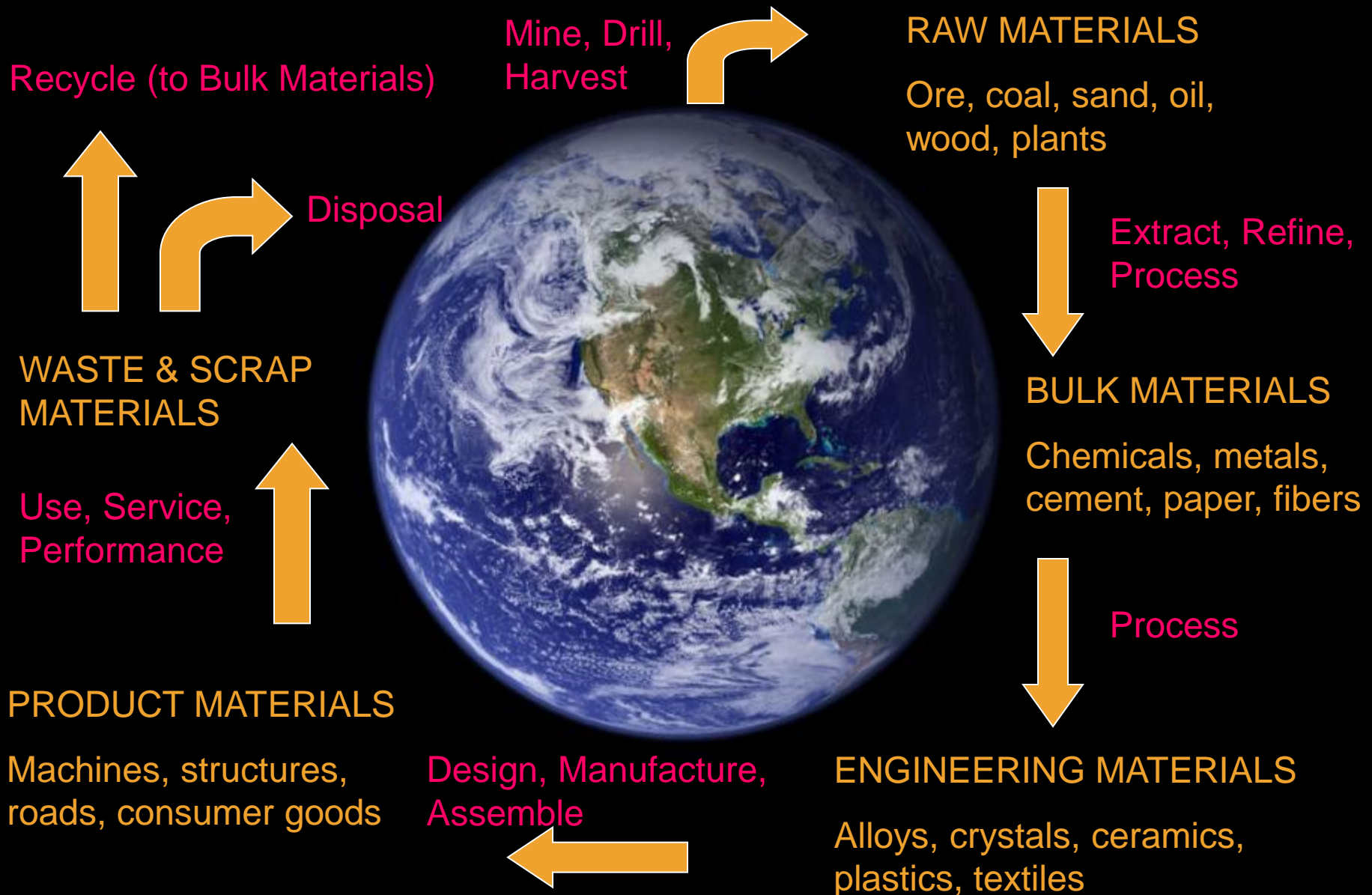


PRODUCT MATERIALS:

Machines, structures,  
roads, consumer goods



# METALLURGICAL AND MATERIALS ENGINEERS ARE INVOLVED IN EVERY STAGE OF THE MATERIALS LIFE CYCLE!



# THE MATERIALS LIFE CYCLE

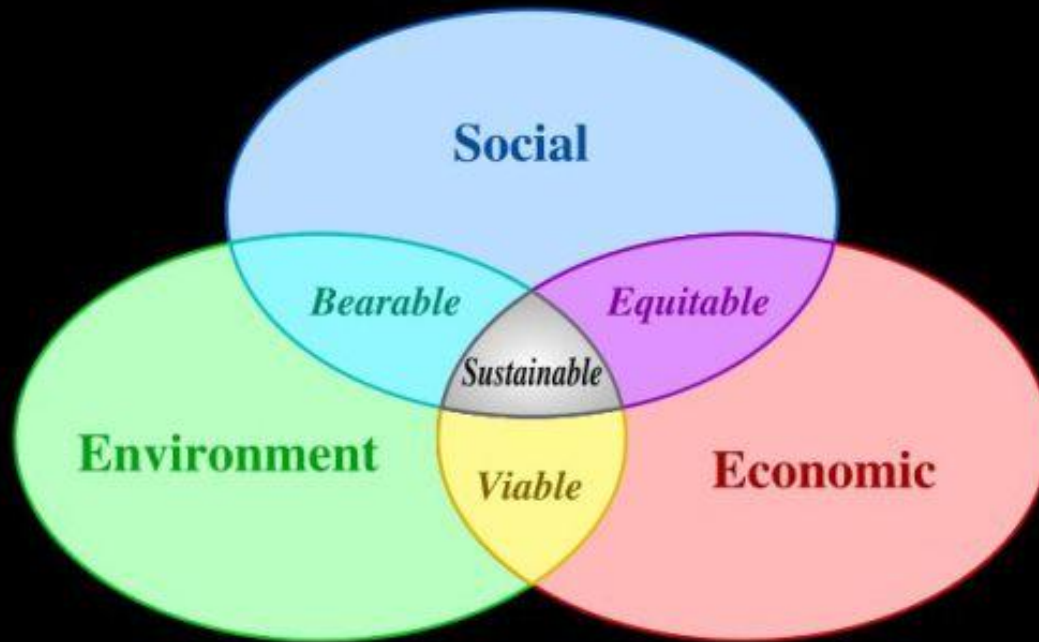
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Materials and processes are interdependent arenas:

- ❖ **Materials** are involved in **every stage** of the cycle. Without materials, there would be nothing to process.
- ❖ The stages are connected by a series of **processes**.
- ❖ Every process adds value to the materials.
  - ❖ Every process requires energy and/or resources.
  - ❖ Every processes generates by-products or waste.

# MATERIALS SUSTAINABILITY

Students learn to develop processes and materials in environmentally responsible ways that maximize efficiency and minimize energy consumption.



*Sustainable Development “meets the needs of the present without compromising the ability of future generations to meet their own needs.”*

# METALLURGICAL AND MATERIALS ENGINEERING

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# METALLURGICAL AND MATERIALS ENGINEERING

# DEPARTMENT PHILOSOPHY & OBJECTIVE

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The Metallurgical and Materials Engineering Department faculty are dedicated to the purpose of providing our students with **a challenging and rewarding academic experience.**

Our core philosophy is to **promote intellectual and professional growth** by emphasizing and reinforcing the importance of responsibility, self-reliance, diligence, and perseverance.

Our objective is to graduate engineers with the technical competence and professional maturity to perform productively on behalf of their employers.

**Our graduates are ready to go to work!**

# METALLURGICAL AND MATERIALS ENGINEERING

## FACULTY AND STAFF

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The Department is staffed by six full-time faculty and one full-time administrative assistant.

- ❖ All faculty members have Ph.D.'s and three earned their undergraduate and/or graduate degrees at Montana Tech.
- ❖ The faculty have **extensive industrial experience**, a network of contacts, and perform research programs with industry.
- ❖ The **student-to-faculty ratio** in upper division department classes is typically about 10:1.



# METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM

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Metallurgical and Materials Engineering is a **multidisciplinary field** – a metallurgist must be a jack of all trades and a master of many...

- ❖ The program includes courses in mathematics, chemistry, physics, humanities and the social sciences.
- ❖ Students gain **hands-on experience** in laboratories; our program features **15 laboratories** – more than any other program!
- ❖ Students earn credit for working on **summer internships**.

# METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM

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To earn a bachelor of science degree in Metallurgical & Materials Engineering, the student is required to complete **136 credit-hours**:

Metallurgical & Materials Engr.	57 credit hours
General Engineering	14
Physical Sciences	38
Humanities & Social Sciences	18
Science & Technical Electives	9

# METALLURGICAL AND MATERIALS ENGINEERING UNPARALLELED CLASSROOM EXPERIENCE



***Small class sizes give students opportunities that simply do not exist in larger departments. For example, students become proficient at delivering technical presentations.***

# METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM

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## Unique M&ME Materials Engineering Core:

### ❖ Year 1:

- ❖ M&ME Seminar – Plant Tours and Speakers
- ❖ M&ME Safety and Health
- ❖ Mineral Processing I

### ❖ Year 2:

- ❖ Metallurgical Thermodynamics – Basics
- ❖ Materials Science I – Basics of Structure, Processing and Properties
- ❖ Minerals Processing II

# METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM



***Freshman Class Field Trip to the  
Montana Resources Operations in 2011***

# METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM

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## Unique M&ME Materials Engineering Core:

### ❖ Year 3:

- ❖ Mass Transfer and Kinetics/Advanced Transport
- ❖ Materials Science II
- ❖ Ceramic Materials

### ❖ Year 4:

- ❖ Polymeric Materials
- ❖ Process Instrumentation and Control
- ❖ Processing of Aqueous Systems/Elevated Temp. Systems
- ❖ Environmental Degradation of Materials (Corrosion)
- ❖ Composites or Flowsheet Design
- ❖ Technical Electives –Additional Specialized Courses

# METALLURGICAL AND MATERIALS ENGINEERING HANDS-ON LABORATORY EXPERIENCE



***Preparing to execute a well conceived demonstration under the scrutiny of Department Head Courtney Young.***

The Department has over \$3.5 million of analytical instruments and process equipment.

Undergraduate students are encouraged to use equipment that is typically available only to graduate students at other schools.

The department does not believe in demonstration laboratories; ours feature “hands-on” learning experiences.

# METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM

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## The Unique M&ME Lab Experience:

### ❖ Year 1:

#### ❖ Particulate Processing I Lab

- ❖ Sieve Analysis, Wilfley Table, Magnetic Separator, Spiral Separator, Flotation Cell, Knelson Concentrator

### ❖ Year 2:

#### ❖ Particulate Processing II Lab

- ❖ Electrostatic Separation, Coulter Counter, Thickeners, Jaw Crusher, Roll Crusher, Rod & Ball Mills, Bond Work Index



# METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM

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## The Unique M&ME Lab Experience:

### ❖ Year 3:

#### ❖ Microstructural Interpretation Lab

- ❖ Grain Size Determination, Steel Metallurgy, Heat Treatment, Identification of Phases

#### ❖ Physical Metallurgy and Materials Lab

- ❖ Annealing, Casting, Precipitation Hardening, Heat Treating, Non-metals

### ❖ Year 4:

#### ❖ Materials Characterization Lab

- ❖ SEM/MLA, XRD, ICP

#### ❖ Aqueous and Elevated Temperature Lab

#### ❖ Senior Design I and II

# METALLURGICAL AND MATERIALS ENGINEERING HANDS-ON LABORATORY EXPERIENCE



***Contemplating the intricacies of froth flotation.***



***Scrutinizing the results of a spark test***

# METALLURGICAL AND MATERIALS ENGINEERING RESEARCH



***Laboratory facilities are similar to those seen on CSI and NCIS – but without the gore!***

# METALLURGICAL AND MATERIALS ENGINEERING RESEARCH

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Department faculty have developed active research programs:

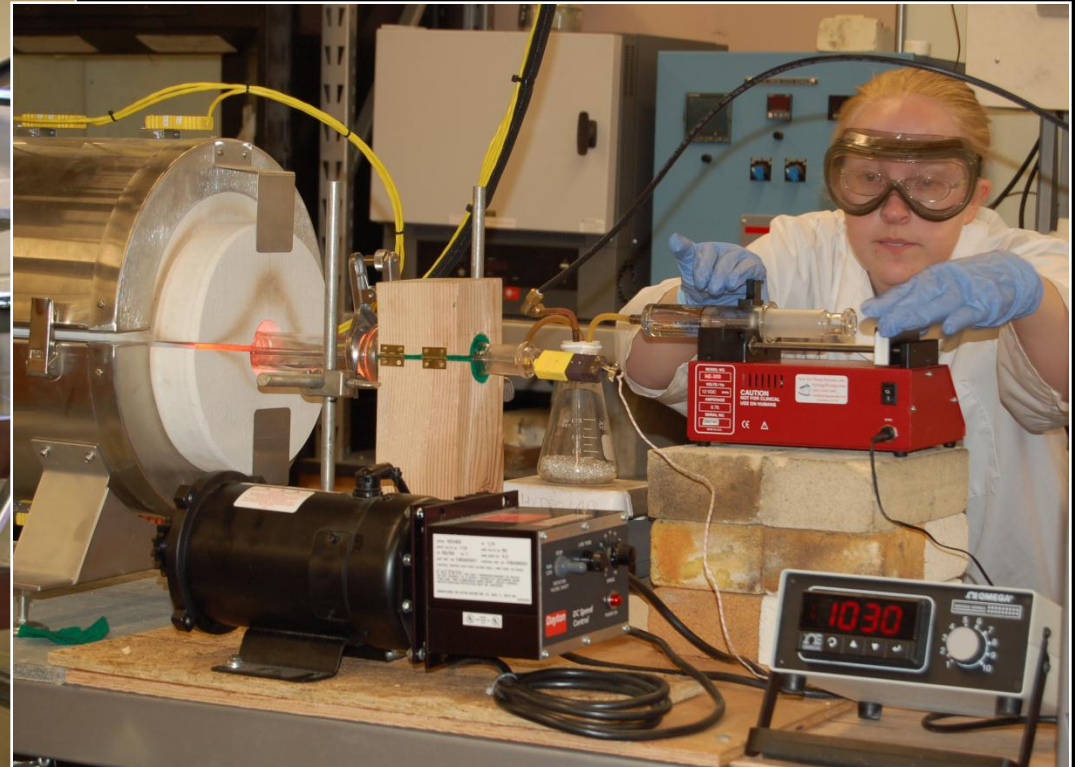
Undergraduate research projects (URPs)

Graduate research projects funded by government and industry.  
Recent examples include:

- ❖ **Minerals** – coal , precious metals, copper, rare earth elements, silicon
- ❖ **Energy** – development of fuel cell materials, purification of silicon for solar energy, nuclear fuel recycling
- ❖ **Environment** – wastewater treatment, clean coal technologies

*Our goal is to produce maximum value to the sponsor in every project that we accept.*

# METALLURGICAL AND MATERIALS ENGINEERING RESEARCH



***Friendly and helpful graduate students.***

# METALLURGICAL AND MATERIALS ENGINEERING FINANCIAL ADVANTAGES



Financial advantages for M&ME students include:

**Affordable Tuition & Fees** – resident fees range from \$3200 to \$3500 per semester, and nonresident fees range from \$9,000 to \$10,000 per semester. Out-of-state fees are substantially reduced for students that qualify for Western Undergraduate Exchange (WUE) scholarships.

**Scholarships** – awarded on a competitive basis to industrious students by the department, school, industry, and professional societies and organizations.

**Internships** – most M&ME majors opt for lucrative summer employment with industrial concerns throughout the U.S.

**CAMP** – the Center for Advanced Mineral and Metallurgical Processing provides students with the opportunity to earn while they learn.

***ADVANTAGE: motivated students have the opportunity to graduate and start their careers essentially debt-free.***

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# METALLURGICAL AND MATERIALS ENGINEERING A HYBRID DEGREE PROGRAM

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M&ME is one of the most **diverse and flexible** engineering degree programs. Tailor your career to fit your interests.

**Process engineers** invent, develop, and operate technologies to recover and refine metals and other materials, produce energy, and improve the environment.

**Materials engineers** create new materials from metals, ceramics, polymers (plastics), semiconductors, and composites.

The two disciplines overlap – knowledge of one discipline enhances the probability of success in the other. **M&ME graduates are proficient in both disciplines.**



# ARENA OF PROCESS ENGINEERING

**Process engineers** use materials and energy resources to produce value-added materials and, in some cases, energy.

*Mineral processing separates valuable materials from waste rock based on differences in physical characteristics.*



Grinding ore in ball mills

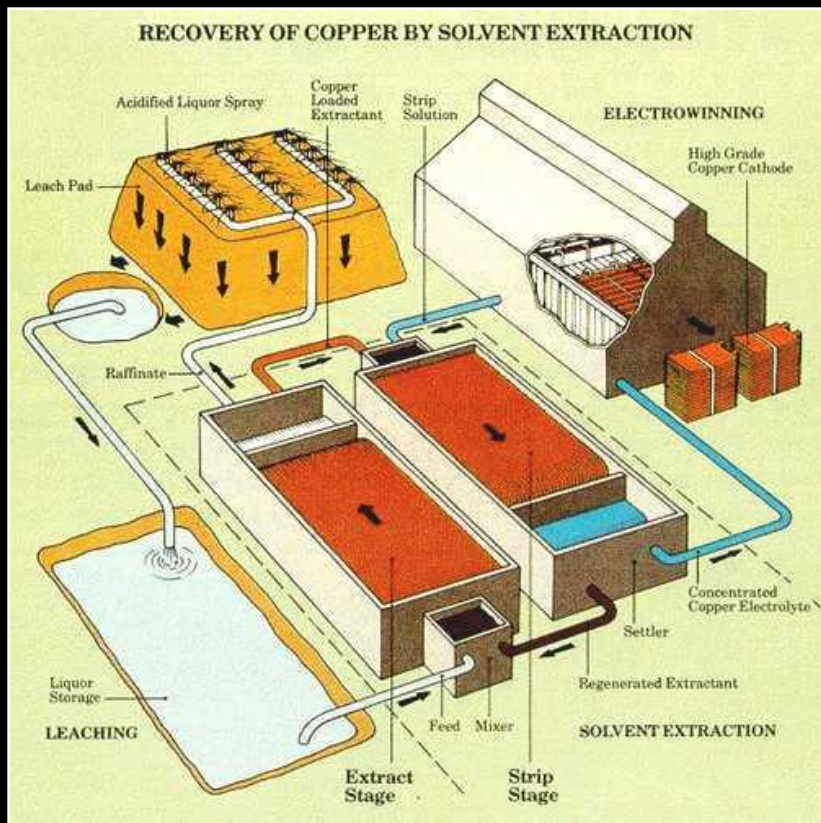
Pouring liquid steel



*Thermal processing uses heat to drive the desired chemical reactions.*

# ARENA OF PROCESS ENGINEERING

*Aqueous processing technologies separate valuable metals in a liquid medium.*



Drawing of a hydrometallurgy plant

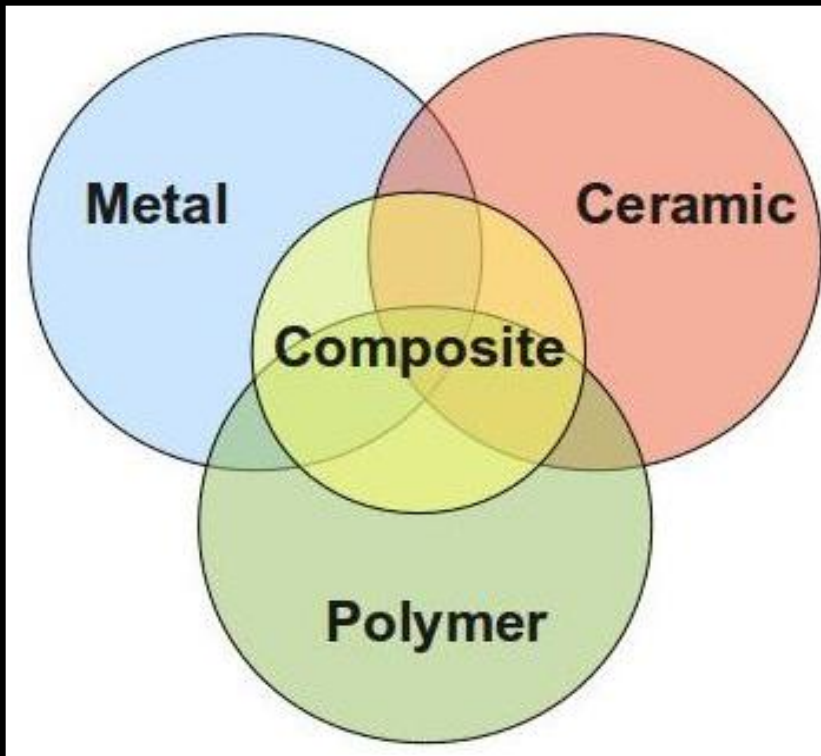
Aluminum Electrolysis



*Other process use electric current to drive chemical reactions.*

# ARENA OF MATERIALS SCIENCE & ENGINEERING

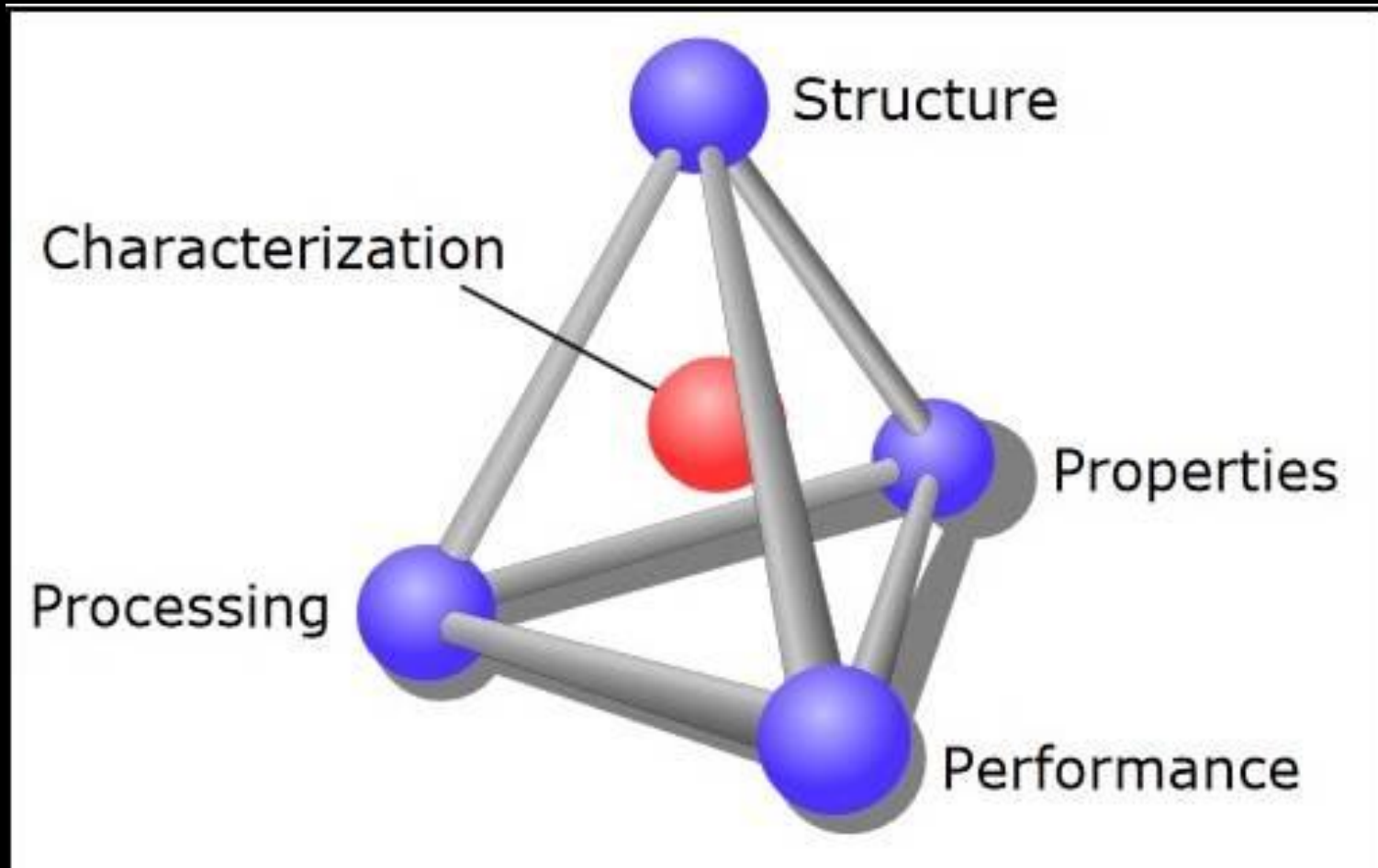
**Materials Scientists and Engineers** are concerned with the structure and properties of the four major materials categories.



Materials engineers can choose to **specialize** in many areas:

- ❖ Material development
- ❖ Corrosion
- ❖ Failure analysis
- ❖ Welding and joining

# ARENA OF MATERIALS SCIENCE & ENGINEERING



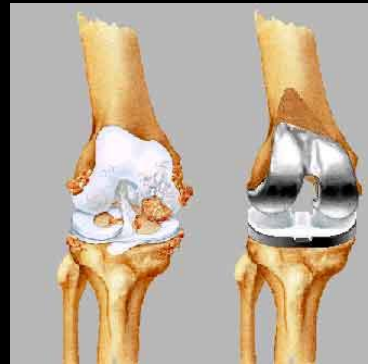
***The Materials Pyramid***

# ARENA OF MATERIALS SCIENCE & ENGINEERING

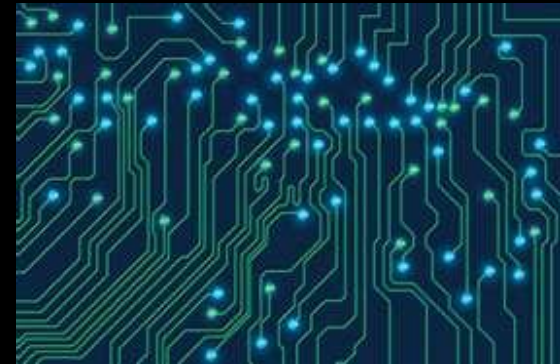
Materials engineers create new materials for specific applications:



*Body Armor [Ceradyne, Inc.]*



*Biomaterials (knee replacement)*



*Semiconductors*



*Synthetic Diamond*



*PEM Fuel Cells*



*Steel Billets*

# METALLURGICAL AND MATERIALS ENGINEERING

# RECENT M&ME GRADUATE PLACEMENT

## IN INDUSTRY

**Adam Hammes**  
Materials Engineer  
Puget Sound Naval Shipyard  
BS 2008

**Merle Kahlstrom**  
Shift Supervisor  
Hecla Mining Co.  
BS 2010

**Katie Schumacher**  
Metallurgical Engineer  
Stillwater Mining Company  
BS 2007, MS 2009

**Sean Dudley**  
Environmental Consultant  
CDM Smith  
MS 2011

**Jerek Depuydt**  
Mill Metallurgist  
Stillwater Mining Company  
BS 2012

**Megan Black**  
Metallurgical Engineer  
Kennecott Utah Copper  
BS 2012

**Keri Caldwell**  
Research Engineer I  
F.L. Smidth  
BS 2010, MS 2012

**Diane Bell**  
Research Engineer  
F.L. Smidth  
MS 2012

**Zach Johnson**  
Metallurgist  
Newmont Mining Corp  
BS 2010

**Nicole Loehr**  
Metallurgical Engineer  
Newmont Mining Corp.  
BS 2011 (NV)

**Matt Wilson**  
Metallurgical Engineer  
Newmont Mining Corp.  
BS 2012

**Josef Bilant**  
Plant Metallurgist  
Yukon-Nevada Gold  
BS 2008

**Theo Winkelman**  
Junior Metallurgist  
Mineral Park, Inc  
BS 2010

**Tyler Salisbury**  
Project Engineer  
Hazen Research, Inc  
BS 2010, MS 2011

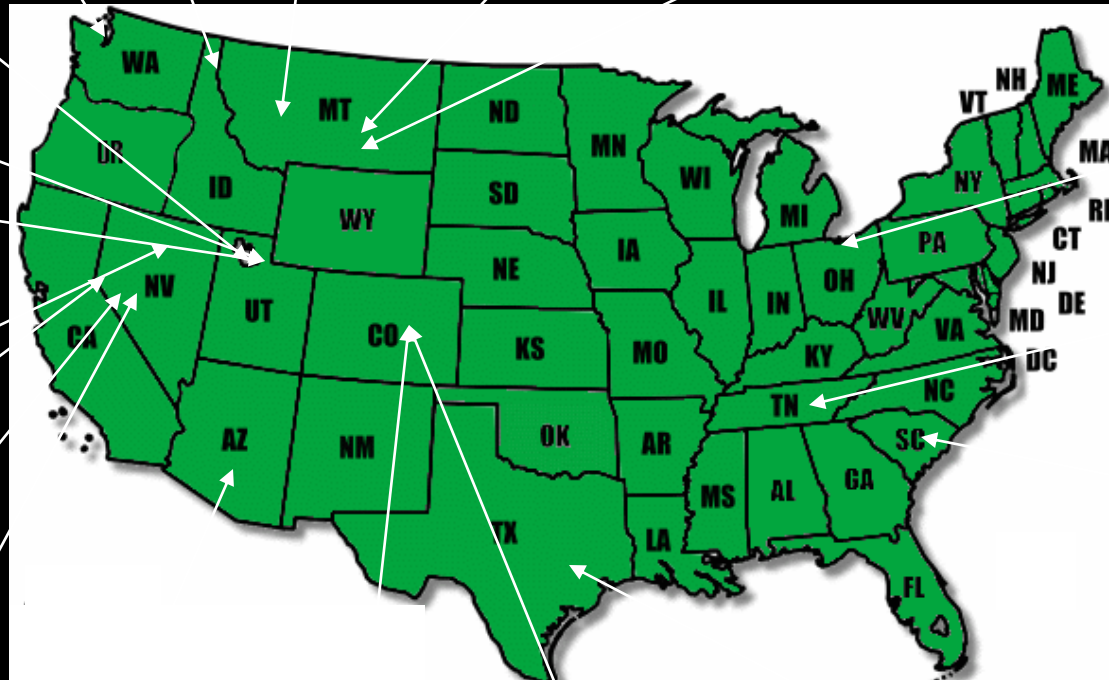
**Matt Hercun**  
Metallurgical Engineer  
Newmont Mining Corp  
BS 2011

**Nisanthan Myelswamy**  
Assoc. Technical  
Professional  
KBR, Inc.  
MS 2008

**Stacy Davis**  
Metallurgical Engineer  
Alcoa Forgings &  
Extrusions  
BS 2010, MS 2011

**Pankaj Sharma**  
Project Specialist  
Buckman, Inc.  
(TN)  
MS 2009

**Mike Spicher**  
Metallurgical Engineer  
Hailey Gold Mine  
BS 2011



# METALLURGICAL AND MATERIALS ENGINEERING

# RECENT M&ME GRADUATE PLACEMENT

## IN GRADUATE SCHOOL

### Ph.D. Students

Nick Gow*	Montana Tech & University of Montana (IIP program)
Jeff Kline*	Norwegian University of Science and Technology, NTNU (Trondheim, Norway)
Teresa Hayward-McGrath	Curtin University (Perth, Western Australia)
Caleb Ellefson	Washington State University (Pullman, WA)
Caelen Anderson	Colorado School of Mines (Golden, CO)

### M.S. Students

Matt Esquibel	Colorado School of Mines
Ariane Erickson	University of Washington (Seattle, WA)
Tyler Broden	Montana Tech
Jesse Bowden	Montana Tech
Ashley Carter	Montana Tech
Ryan Foy	Montana Tech
Brandon Steinborn	Montana Tech

\* Expected to fulfill doctoral program requirements by Fall 2012.

# METALLURGICAL AND MATERIALS ENGINEERING CAREERS

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## Why consider a career in M&ME?

- ❖ The work is interesting, challenging, and intellectually stimulating.
- ❖ You may choose to work almost anywhere in the U.S. International employment opportunities are also available.
- ❖ Your work will benefit mankind.

*But most of all because ...*



**It could lead to  
FINANCIAL  
SECURITY!**



# METALLURGICAL AND MATERIALS ENGINEERING FINANCIAL ADVANTAGES



Financial advantages for M&ME graduates include:

- ❖ **Placement** – despite a shaky national economy, M&ME graduates have enjoyed 100% placement throughout the past decade. Most are able to secure permanent employment early in their senior year.
- ❖ **Salaries and benefits** – starting salaries begin at about \$65,000/year. Graduates with prior work experience and/or internships typically command higher starting salaries.
- ❖ **Opportunities** – students generally choose among multiple employment offers. This advantage ensures competitive salaries and provides the student flexibility in establishing their preferred career path and choice of location.

# METALLURGICAL AND MATERIALS ENGINEERING FINANCIAL ADVANTAGES



Financial advantages for M&ME graduates include:

- ❖ **Placement** – despite a shaky national economy, M&ME graduates have enjoyed **100% placement** throughout the past decade. Most are able to secure permanent employment early in their senior year.
- ❖ **Salaries and benefits** – starting salaries **exceed \$65,000/year**. Graduates with prior work experience and/or internships generally get higher starting salaries.
- ❖ **Opportunities** – students generally choose among **multiple employment offers**.

# METALLURGICAL AND MATERIALS ENGINEERING SALARIES



- ❖ In 2010, the mean annual salary of those working in the metallurgical and materials engineering field was \$86,860.
- ❖ Lowest paid engineers earned just less than \$51,680, *which is still more than the average household income in any of the 7 largest cities in Montana.*
- ❖ The middle 50% of salaries ranged from \$64,930 to \$105,090. *M&ME graduates begin near the middle, not at the bottom!*
- ❖ The top 25% earned more than \$105,000.
- ❖ The top 10% earned more than \$126,800.

*Source: U.S. Bureau of Labor (2010)*

# METALLURGICAL AND MATERIALS ENGINEERING

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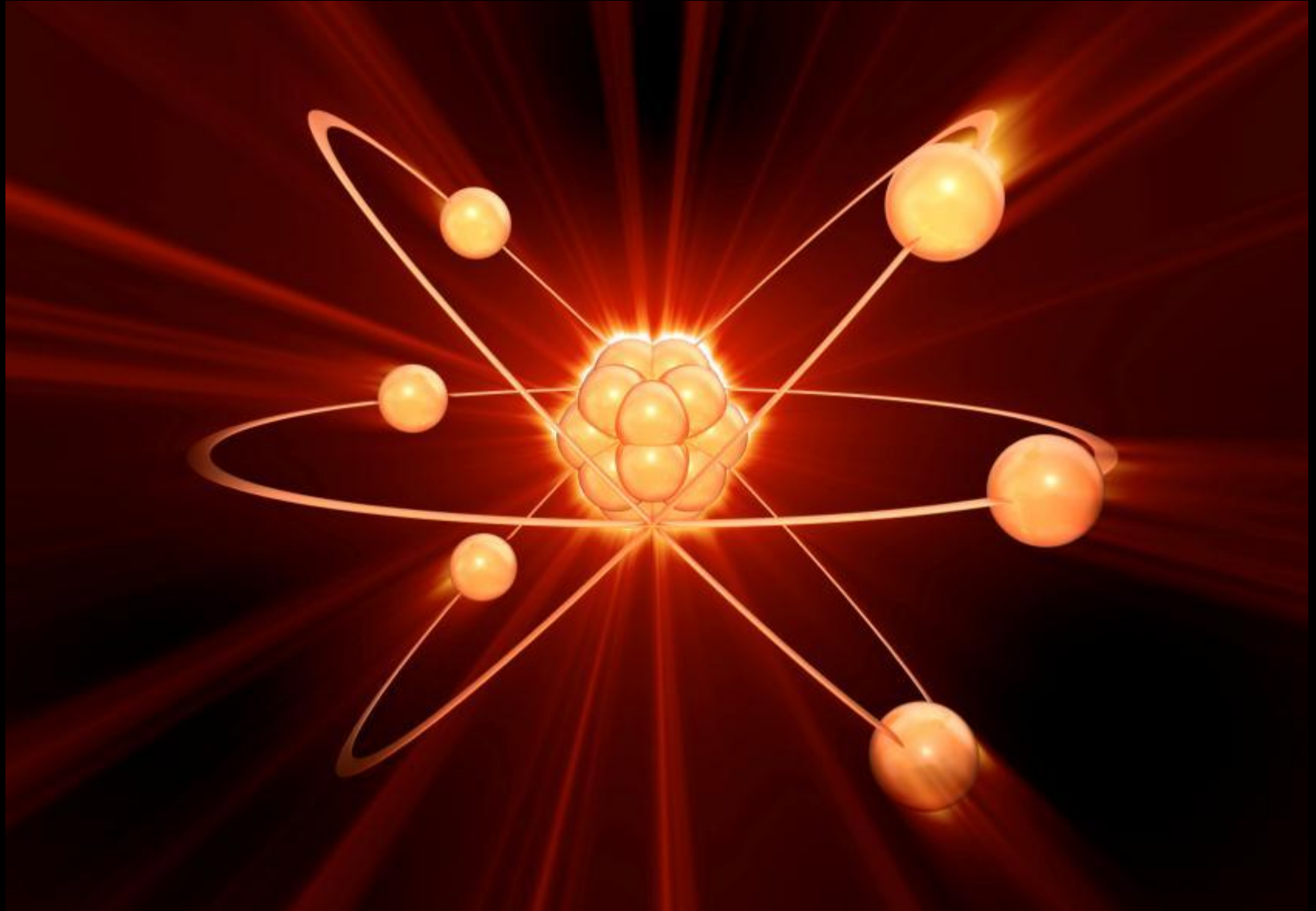
# METALLURGICAL AND MATERIALS ENGINEERING EMPLOYMENT OUTLOOK

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- ❖ Materials engineers are employed in almost every industry – there are an estimated **300,000 types of materials** and thousands more are under development!
- ❖ Between 2008 and 2018, the market for metallurgical and materials engineering is expected to increase by 9%; this level of demand equates to **thousands of new job opportunities**.
- ❖ Many engineers are near retirement – their positions must be filled by new engineers, creating even more jobs and **opportunities for rapid advancement**.
- ❖ Due to the healthy materials and metals markets, **opportunities are rapidly expanding**.

*Source: U.S. Bureau of Labor (2010)*

# METALLURGICAL AND MATERIALS ENGINEERING QUESTIONS



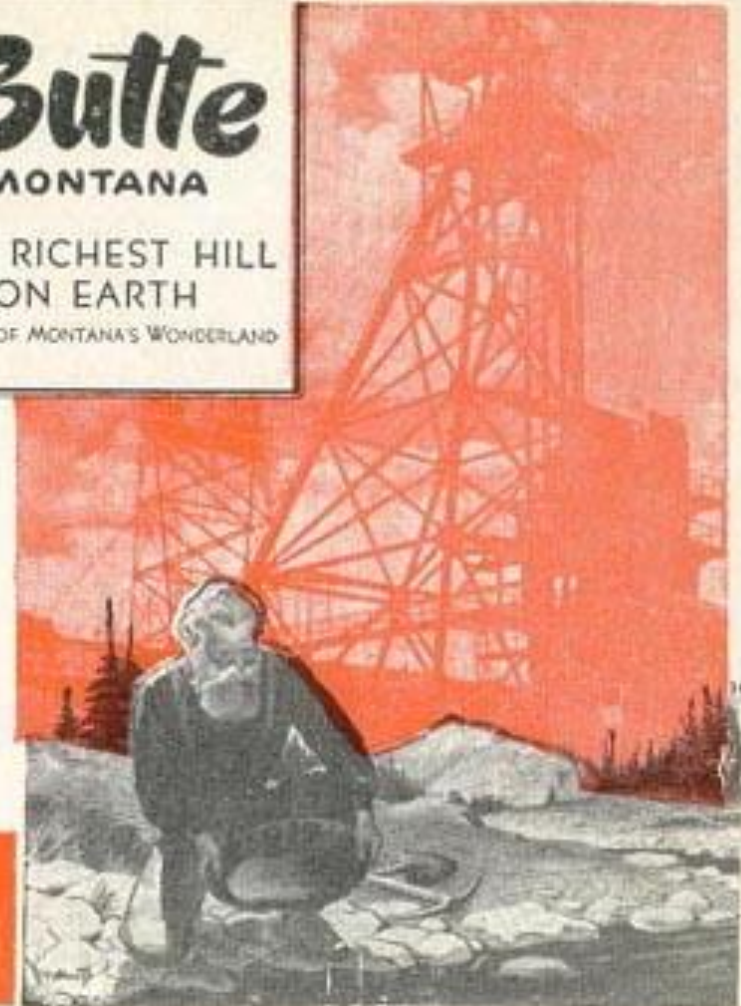
# METALLURGICAL AND MATERIALS ENGINEERING THANK YOU!

*Ride in and look us  
over.... until then,  
"TAP 'ER LIGHT!"*

*Yours truly,  
**Butte***

## **Butte** MONTANA

THE RICHEST HILL  
ON EARTH  
CENTER OF MONTANA'S WONDERLAND



● ● ● ●  
LAST OF THE WESTERN FRONTIER TOWNS  
METROPOLIS OF THE TREASURE STATE ● ●  
WORLD'S GREATEST MINING CAMP ● ● ● ●  
LAND OF THE SHINING MOUNTAINS ● ● ● ●