The Changing World of Metallurgical Education

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Do we need metallurgists?

Changing Profile of Metallurgy (Flemings, MIT, 1999)

School of Mines

Mineral Processing

Iron and Steel production

Non-Ferrous metal production

Alloy Development

Ceramic Materials

Electronic/Magnetic Materials

Biomaterials

Optical/Photonic Materials

Composite Materials

Next?

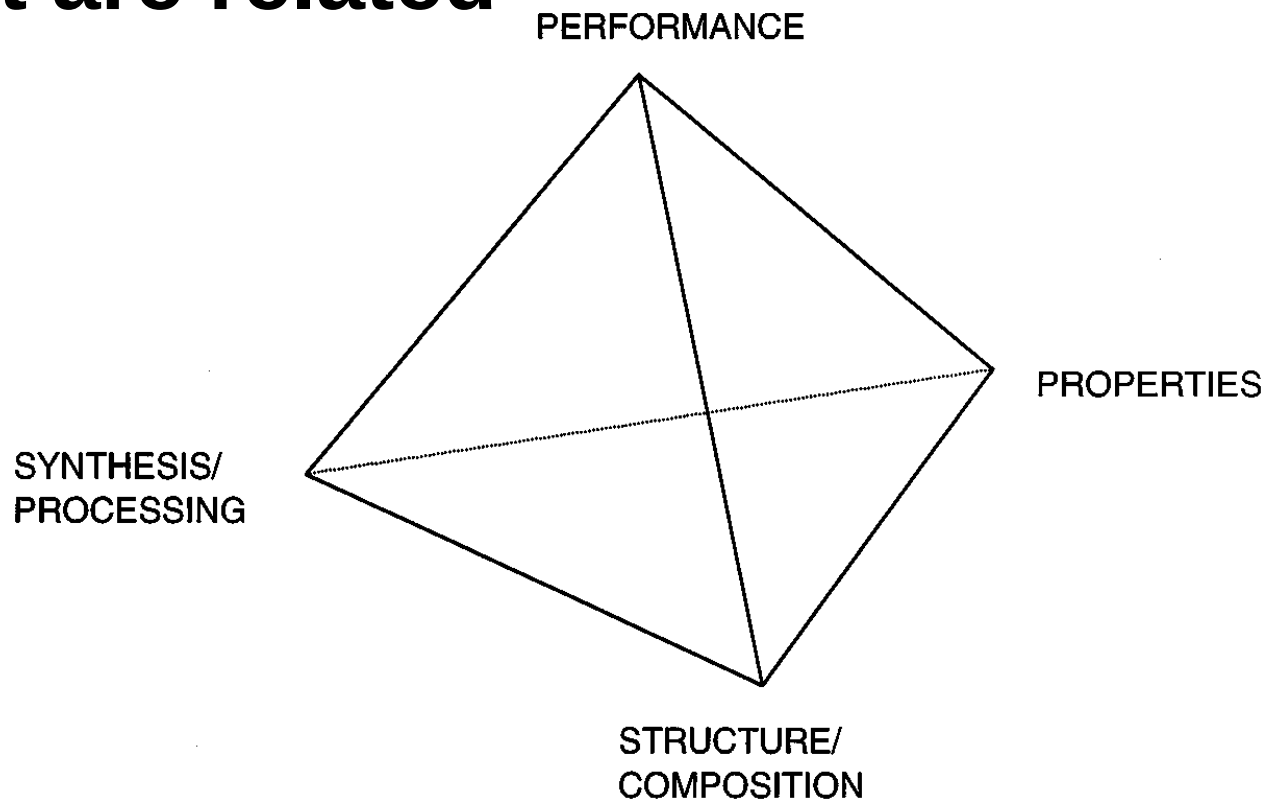
Year 1900 1950 2000 2050

Majority of Tertiary Metallurgical Engineering Programs have morphed into *Materials Science & Engineering (MS&E) Programs*

- a matrix of disciplines that are related through common elements

- **Structure/composition**
- **Properties/**
- **Performance**
- **Synthesis**

(Flemings)



The growth of metallurgical engineering

There has been a major expansion in research in Material Science and Engineering

However, the industry faces major challenges to the future of primary metal production and recycling.

These challenges include

- **declining ore grades,**
- **increased feed complexity,**
- **rapid changes in technologies, and**
- **environmental and social concerns,**

- **We are in a period of rapid change - a critical time in the development of our societies.**

Climate emergency, renewable energy, electric vehicles, electronic devices - the need for advanced materials.

Our technologically-based society cannot be sustained without the supply of metals.

So YES, we do need metallurgists.

Developing efficient and environmentally sustainable processing will be the key to economic survival of our industries.

We need to invest in our future, in technology and in people, if we are to continue to provide these critical resources.

What do we need for our future workforce?

Metallurgical Process Engineering (MPE)

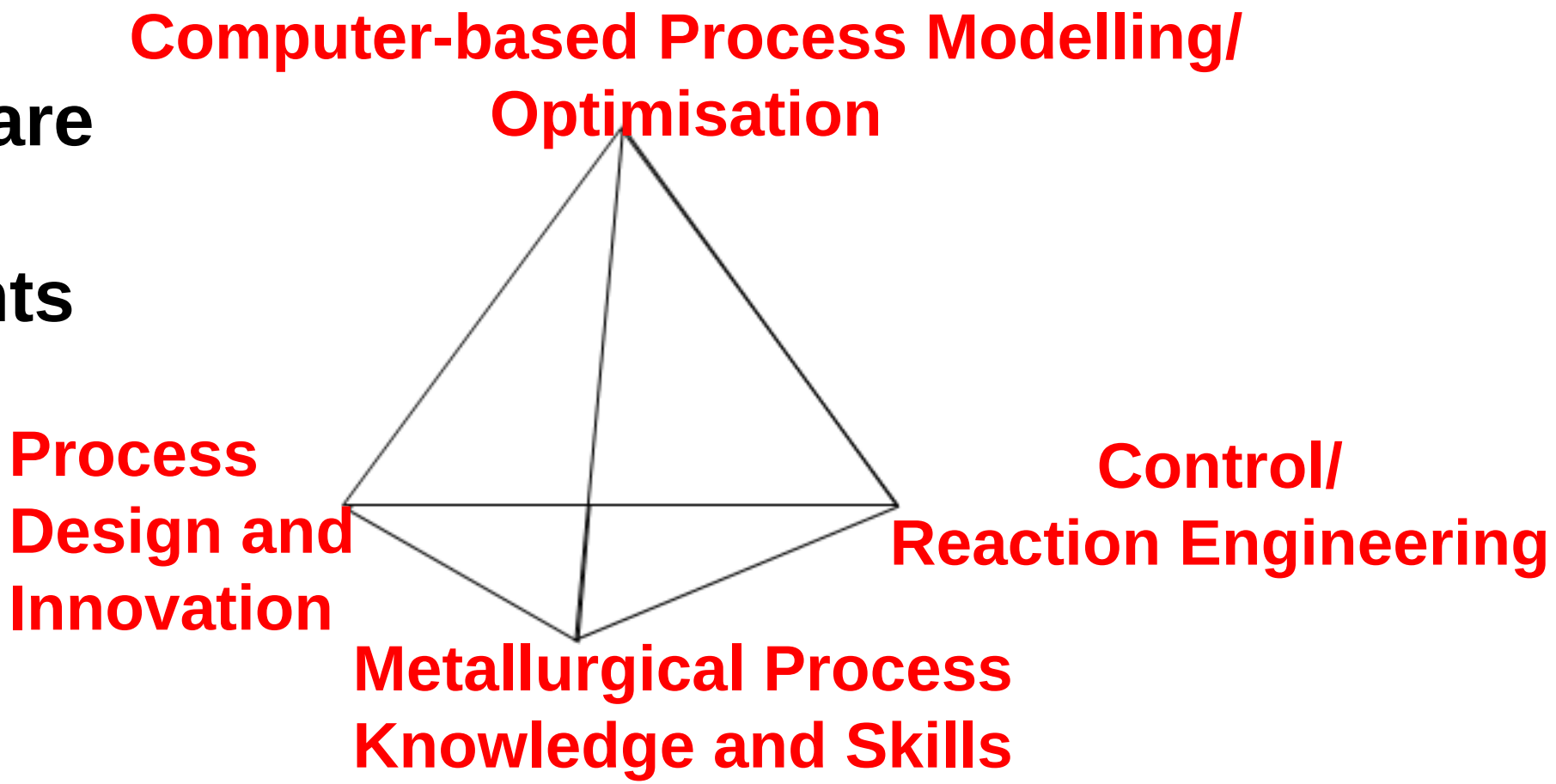
A discipline characterised by application the common elements **of**

- **Metallurgical Process Knowledge and Skills (Mass and energy balances, thermodynamics, heat and mass transport, kinetics, microstructure, reaction mechanisms…)**
- **Control/Reaction Engineering**
- **Process Design and Innovative Thinking**
- **Computer-based Process Modelling/Optimisation**

to sustain primary metal, recycling and advanced materials production.

What do we need for our future *Metallurgical Process Engineering (MPE)* workforce?

A matrix of disciplines that are related through common elements of



What do we need from our future workforce?

(ABET Criteria for graduate engineers)

Generic Skills **– the ability to**

- **apply knowledge of mathematics, science, and engineering,**
- **analyse and interpret data,**
- **design a system, component, or process to meet ….economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability criteria,**
- **identify, formulate, and solve engineering problems,**
- **use the techniques, skills, and modern engineering tools necessary for engineering practice.”**

What do we need from our future workforce?

(ABET/Institute of Engineers Criteria for graduate engineers)

Professional Attributes

- **an ability to communicate effectively,**
- **an ability to function on multidisciplinary teams,**
- **an understanding of professional and ethical responsibility,**
- **the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context,**
- **a recognition of the need for, and an ability to engage in life-long learning,**
- **a knowledge of contemporary issues**

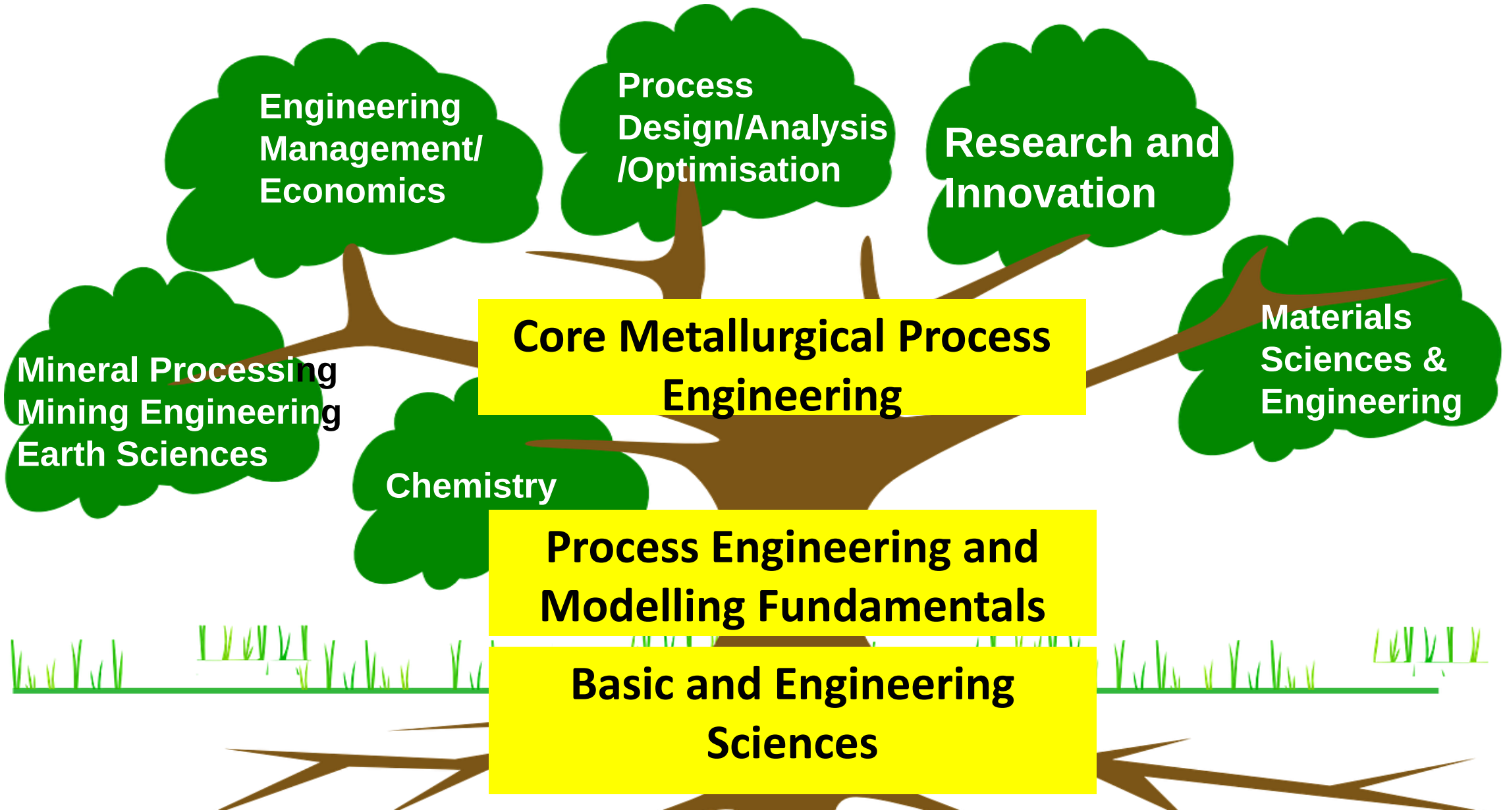
What do we need for our future workforce?

Key features of a Metallurgical Process Engineering education program –

Core Process Knowledge and Skills in

- **Process Engineering - thermodynamics, transport properties, reaction kinetics, control, systems engineering analysis.**
- **Specialist Metallurgical Engineering fields of: mineral(physical) processing, hydro/electrometallurgy, pyrometallurgy**
- **Process Design, Synthesis and Professional Engineering**
- **Basic sciences, material and other engineering sciences**
- **Generic graduate skills and professional attributes**

The Metallurgical Process Engineering Tree

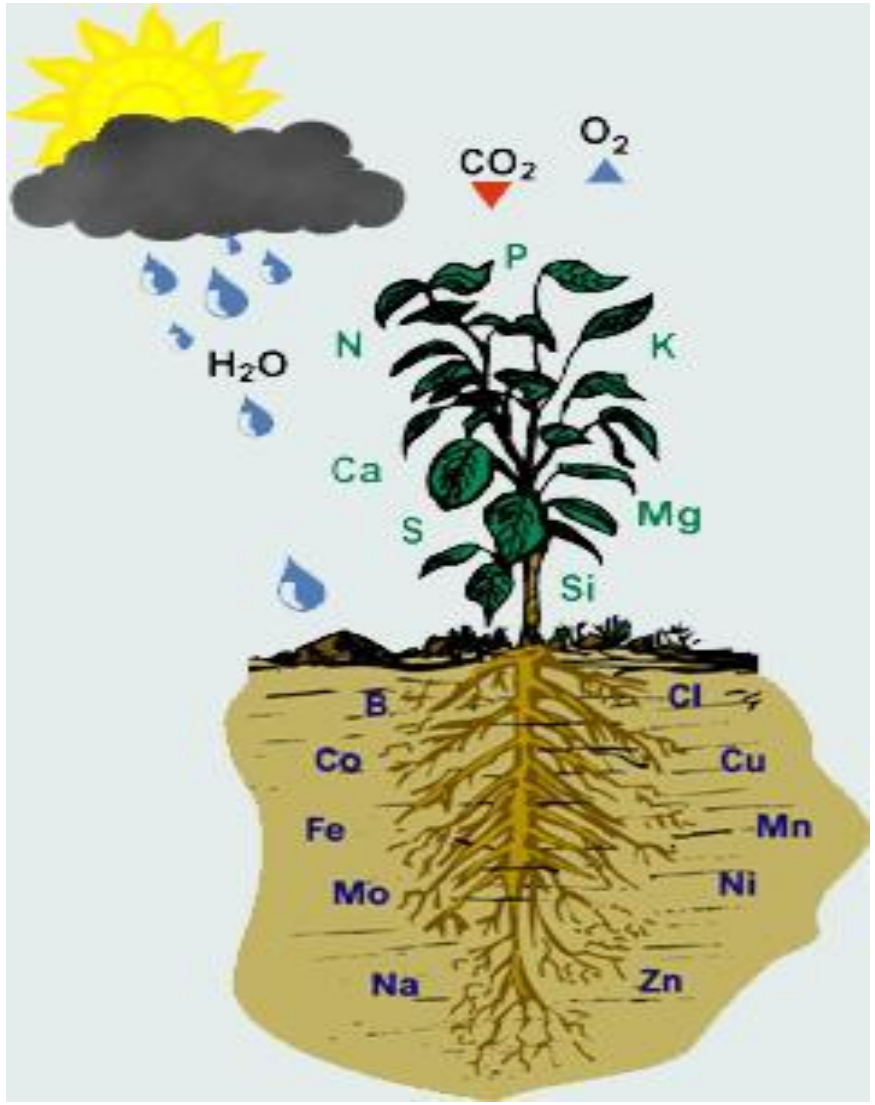


How can we develop our future *Metallurgical Process Engineering (MPE)* workforce?

Essentials elements for organic growth

Atmosphere
- Sunlight
- Carbon dioxide
- Oxygen

Fertile Environment
- Essential elements
- Organic matter
- Nutrients
- Microbiological Activity



Outputs
- Carbohydrates
- Proteins
- Vitamins
- Oils

We can use this analogy to develop a way forward

Essential elements for sustainability and growth of Metallurgical Process Engineering

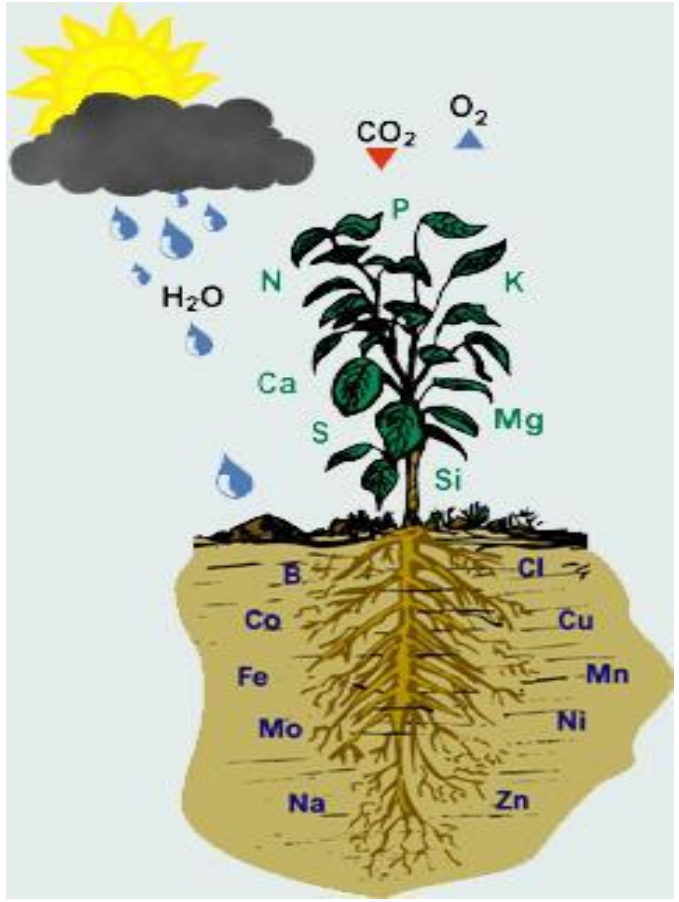
Atmosphere

- Industry support at senior leadership level
- Positive and exciting vision of the future
- Exposure/publicity/promotion

of opportunity

Fertile Environment

- Engagement with minerals, primary and recycled metals, advanced materials industries
- Supportive environment and academic disciplines
- Active support from industry professionals
- Funding



Outputs/Benefits

- Improved process plant performance and productivity
- Innovation
- Sustainability

Strategies to develop our future workforces?

A concerted effort is needed by Industry, Professional Societies and Academia to develop a Strategic Plan

Aim: To develop, promote and sustain the education and research capacities in Metallurgical Process Engineering at our tertiary institutions

Strategies to develop our future workforce?

Potential Actions by Universities

- **Re-establish attractive undergraduate majors in Metallurgical Process Engineering programs with focus on core metallurgical and process engineering skills**
- **Develop flexible entry and pathways into MPE programs**
- **Articulate clear exciting career pathways and opportunities**
- **Ensure active industry engagement in promoting work experiences for *early year (1 and 2) undergraduate students***
- **Promote a positive view of the future of the metallurgical industry**

Strategies to develop our future workforces?

Potential Actions by industry

- **Actively support engagement with academic and research staff through funding industry focussed research**
- **Seek co-funded industry/government research with University teams**
- **Develop long term partnerships in support research and development strengths in selected core fields of expertise**
- **Incorporate continuing professional development in workforce planning**

Summary

The world needs METALLURGICAL PROCESS ENGINEERS to ensure continued metal resource supply and sustainability of our technologically-based society.

We need to provide the next generation with the knowledge and skills necessary to will enable them to address the rapid changes faced by the modern metallurgical industry.

Thank you for listening and I look forward to your suggestions on how we can move forward to ensure the future of metallurgical process engineering education.

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