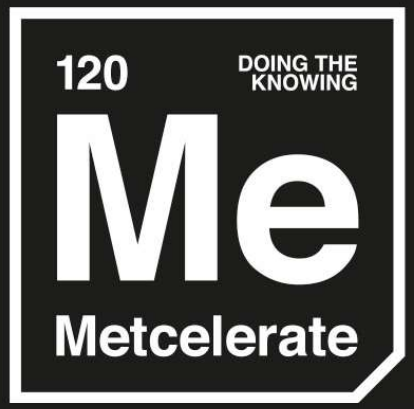


The Metcelerate Program

Diana Drinkwater

Jan Cilliers

Bob Seitz

Brian Flintoff

10 May 2020

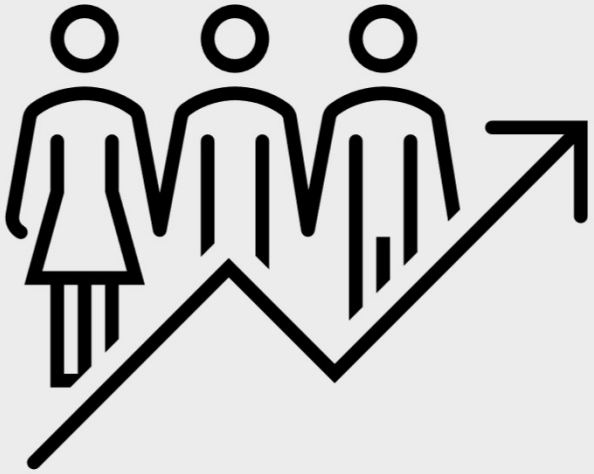
The Metcelerate program is designed by industry, for industry

An on-line training curriculum for mineral processing engineers

To transform their value to the organization

..by translating academic knowledge and skills to practice

DOING THE KNOWING



01 What is Metcelerate?

Designed with employers, to meet 21st century workplace requirements

The Metcelerate Method

Created for modern learners using advanced instructional design and delivery tools

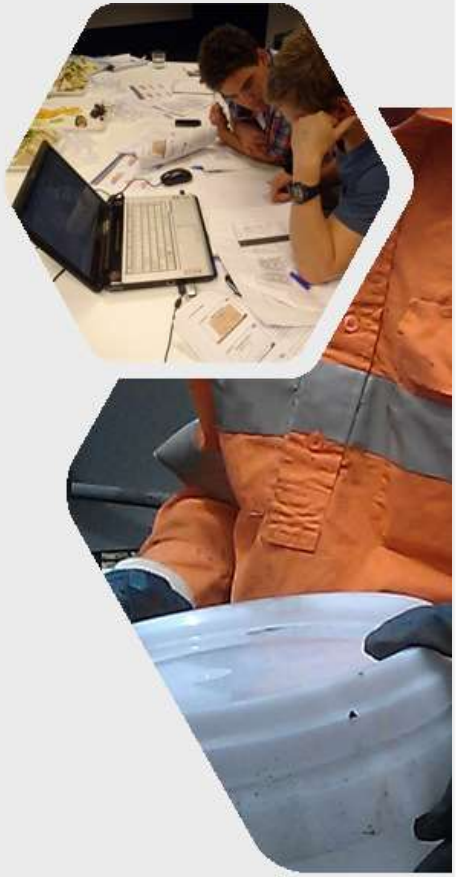
Covers fundamentals, applied problem solving, and hands-on experience

Includes learning activities and projects, facilitated by experienced mineral processing practitioners

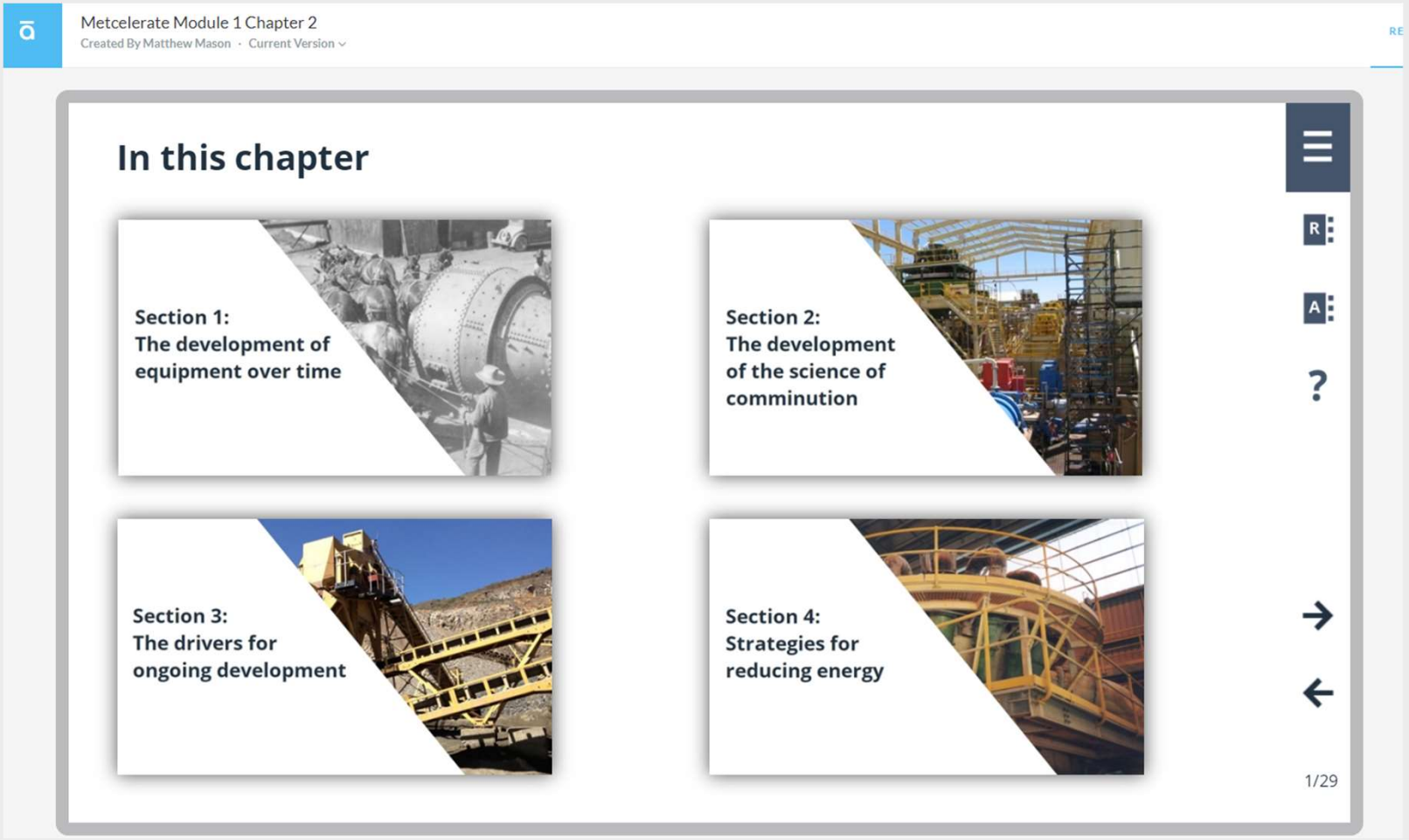
Relevant, up to date and high quality training material from world-renowned experts

Content includes video, audio, animations, diagrams, text, interactive quizzes, and practical exercises

In-plant activities to reinforce essential metallurgical functions are built into the program



Online content designed for self-paced study



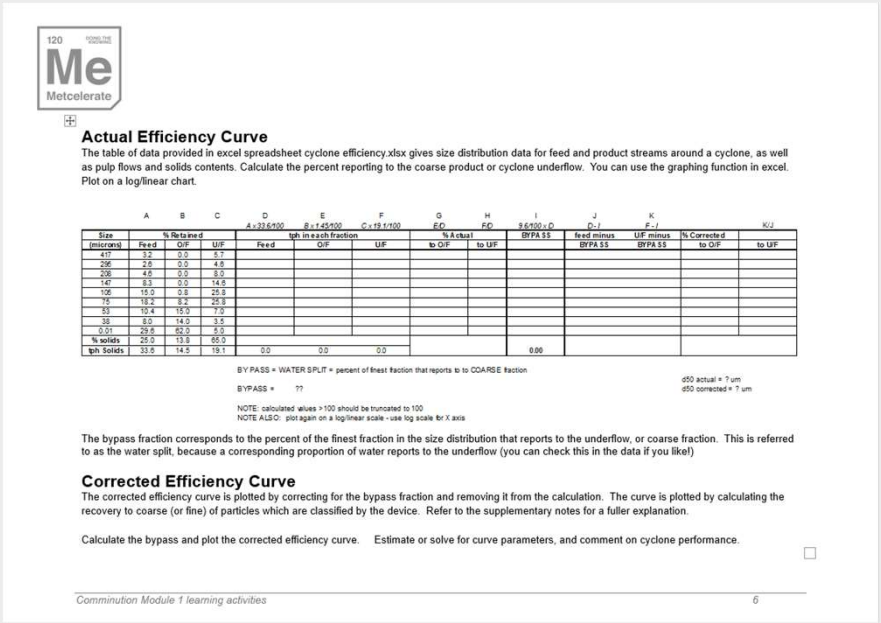
Learning activities focused on developing capability

Activities that relate directly to mineral processing tasks and responsibilities are embedded into the formal online content, to ensure that new knowledge is translated to practice

Learning activities focused on developing capability

Activities are supported by clear instructions

Weekly online tutorials allow learners to discuss outcomes with their peers and course leaders



Actual Efficiency Curve

The table of data provided in excel spreadsheet cyclone efficiency.xlsx gives size distribution data for feed and product streams around a cyclone, as well as pulp flows and solids contents. Calculate the percent reporting to the coarse product or cyclone underflow. You can use the graphing function in excel. Plot on a log/linear chart.

	A	B	C	D	E	F	G	H	I	J	K		
				A x 33.6/100	B x 145/100	C x 19.1/100	E/D	F/D	9.6/100 x D	D-J	F-J		K/J
Size	% Retained			tph in each fraction			% Actual		BYPASS	feed minus	U/F minus	% Corrected	
(microns)	Feed	O/F	U/F	Feed	O/F	U/F	to O/F	to U/F		BYPASS	BYPASS	to O/F	to U/F
417	3.2	0.0	5.7										
295	2.6	0.0	4.8										
208	4.6	0.0	8.0										
147	8.3	0.0	14.6										
105	15.0	0.8	25.8										
75	18.2	8.2	25.8										
53	10.4	15.0	7.0										
38	8.0	14.0	3.5										
0.01	29.6	62.0	5.0										
% solids	25.0	13.8	65.0										
tph Solids	33.6	14.5	19.1	0.0	0.0	0.0			0.00				

BY PASS = WATER SPLIT = percent of finest fraction that reports to to COARSE fraction

BYPASS = ??

d50 actual = ? um
d50 corrected = ? um

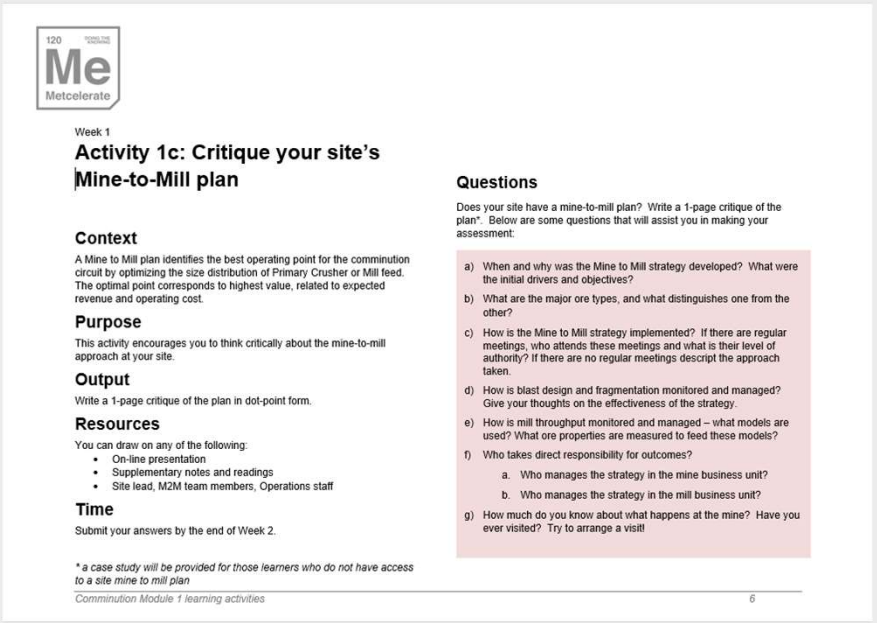
NOTE: calculated values >100 should be truncated to 100
NOTE ALSO: plot again on a log/linear scale - use log scale for X axis

The bypass fraction corresponds to the percent of the finest fraction in the size distribution that reports to the underflow, or coarse fraction. This is referred to as the water split, because a corresponding proportion of water reports to the underflow (you can check this in the data if you like!)

Corrected Efficiency Curve

The corrected efficiency curve is plotted by correcting for the bypass fraction and removing it from the calculation. The curve is plotted by calculating the recovery to coarse (or fine) of particles which are classified by the device. Refer to the supplementary notes for a fuller explanation.

Calculate the bypass and plot the corrected efficiency curve. Estimate or solve for curve parameters, and comment on cyclone performance.



Week 1

Activity 1c: Critique your site's Mine-to-Mill plan

Context

A Mine to Mill plan identifies the best operating point for the comminution circuit by optimizing the size distribution of Primary Crusher or Mill feed. The optimal point corresponds to highest value, related to expected revenue and operating cost.

Purpose

This activity encourages you to think critically about the mine-to-mill approach at your site.

Output

Write a 1-page critique of the plan in dot-point form.

Resources

You can draw on any of the following:

- On-line presentation
- Supplementary notes and readings
- Site lead, M2M team members, Operations staff

Time

Submit your answers by the end of Week 2.

** a case study will be provided for those learners who do not have access to a site mine to mill plan*

Questions

Does your site have a mine-to-mill plan? Write a 1-page critique of the plan*. Below are some questions that will assist you in making your assessment:

a) When and why was the Mine to Mill strategy developed? What were the initial drivers and objectives?

b) What are the major ore types, and what distinguishes one from the other?

c) How is the Mine to Mill strategy implemented? If there are regular meetings, who attends these meetings and what is their level of authority? If there are no regular meetings descript the approach taken.

d) How is blast design and fragmentation monitored and managed? Give your thoughts on the effectiveness of the strategy.

e) How is mill throughput monitored and managed – what models are used? What ore properties are measured to feed these models?

f) Who takes direct responsibility for outcomes?

   a. Who manages the strategy in the mine business unit?

   b. Who manages the strategy in the mill business unit?

g) How much do you know about what happens at the mine? Have you ever visited? Try to arrange a visit!

Essential Functions

Each course is designed around essential functions for metallurgists. For example, the essential functions of a metallurgist working in Comminution are defined as:

Managing process inputs

- Ore Body Knowledge - Mine to Mill and Geometallurgy
- Material Properties
- Fragmentation
- Geometallurgical Process Throughput Models

Managing equipment and data

- Equipment inspection and condition reporting - circuit equipment including ancillary equipment; consumables (liners) and operating conditions (eg: loads)
- Managing measurement quality, inspection of sensors and samplers , calibration - (Maintenance strategies and Preventative maintenance)
- Management of consumables eg: equipment relining, media consumption, inventory management
- Laboratory and metallurgical test QA/QC

Managing the process

- Process management - automation, manual, SOPs, fragmentation (stockpile management)
- Routine use of comminution circuit diagnostic tools for performance management

Comminution course

LEARNING OBJECTIVES

1. *Develop a sound knowledge of basic theory and current best practice in comminution, classification and other related processes.*
2. *Develop competency in the use of available tools and analytical methods for operation, monitoring and evaluation of circuits.*
3. *Be aware of the relevant areas of technical research and development.*

Example

MODULE 1 – BASICS 1

An introduction to the science of comminution and a closer look at crushing and screening circuits

- Defining comminution: Terminology, fundamental concepts (liberation, basic breakage mechanics, crushing vs grinding), approach to characterisation, role in processing, types of models
- Some history of comminution and future technology trends; Industrial applications
- Unit operations and equipment: Crushing
- Unit operations and equipment: Classification using screens
- Ancillary equipment: Feeders and operation of stockpiles and bins
- Basic monitoring and evaluation of crushing circuit performance, using simple crushing and screening circuit examples

MODULE 2 – BASICS 2

Grinding in tumbling and other mills, rolls crushers, operating comminution circuits

- Unit operations and equipment: Tumbling Mills
- Unit operations and equipment: Stirred Mills
- Cyclones in grinding circuits, cyclone partition curves, impact of classification efficiency on comminution
- Ancillary equipment in crushing and grinding circuits
- Grinding circuit flowsheet examples
- Monitoring energy use

MODULE 3 – APPLICATIONS 1

Testwork and laboratory characterization

- Laboratory ore characterization tests for crushing and grinding; other tests that can be useful (rock strength tests), applicability.
- Comminution circuit performance analysis: mass balancing for comminution, performance indices, approaches to modelling
- Collecting data in comminution circuits: sampling and comminution surveys (including mill load and related measurements), application of mineralogical data
- Practical calculation of breakage indices from laboratory test results
- Assignment - operating work indices around selected section of plant

MODULE 4 – APPLICATIONS 2

Evaluating circuit performance

- Cyclone efficiency curves, cyclone operating strategies
- Comminution process management: operating strategies, benchmarking, energy efficiency, managing consumables (liners, media), practices and standards for crushers and mills
- Feed management strategies including stockpile blending strategies
- Grind curves, energy benchmarking
- Operability and maintainability of comminution equipment
- Comminution circuit problem solving
- Practical plant assignment: benchmarking of selected section of circuit, group discussion activity based on outcomes.

It all adds up to high quality learning

- Online, flexible, self-paced technical content
- Learning supported by practical activities
- Problem-based approach develops higher-level skills
- Expert facilitation and feedback
- Assessed as pass/fail based on submission of activities
- Online group interaction (social constructivism)

02

Metcelerate
Topics and Timetable

Metcelerate

A Structured Program of Applied On-Line Training

INTRODUCTION

Mineral Processing in the Mining Value Chain

› An introductory course to put mineral processing into context

TECHNICAL FOUNDATIONS

Mineralogy

Experimental Design

Comminution

Flotation

Physical Separation

Hydrometallurgy

› A combination of courses broken into stand-alone modules to provide a solid technical foundation.

› Modules include classical theory and practical applications

APPLICATION

Process Optimization Project

› Applying new knowledge and skills to real plant interventions

Q1a → Q1b → Q2 → Q3 → Q4 → Q5 → Q6a → Q6b

18-month to 2-year timeline

03 The Metcelerate Team

The Metcelerate Governance Team

Diana Drinkwater CEO Australia

Metallurgical engineer with 30+ years experience and a passion for helping young professionals achieve full potential through career development. Expert in building and delivering on the job training programs, face-to-face, online and blended

Robert Seitz CTO USA

40-year career developing, designing and optimizing mineral processing plants. Nearly as many years supporting professional development via training, use of competency models, mentoring and managing corporate and site-based education programs.

Brian Flintoff Consultant Canada

Operator, academic, technical developer and consultant. Helped create CBT for mill operator training. Well known specialist in analysis, optimization and control of mineral processing systems. 30 years in training and professional development activities.

Jan Cilliers CFO United Kingdom

Professor of Mineral Processing in the Royal School of Mines at **Imperial College London**. More than 100 technical publications in journals, and 20+ years managing Industry/Academic partnerships for education and research.

World-leading Subject Matter Experts

Hydrometallurgy

Kathryn Sole

Physical Separations

Jan Cilliers & Dolf McHunter

Process Mineralogy

Elaine Wightman & Cathy Evans

Value Chain

Glen Corder & Artem Golev

Flotation

Jim Finch & Kathryn Hadler

Comminution

Diana Drinkwater & Bob Seitz

Experimental Design

Tim Napier-Munn

Mentors

Katie Barns

Joe Pease

Rodolfo Espinosa Gomez

Duncan Bennett

Peter Munro

Benefits for Sponsors

Close critical skills gaps

Improve on-the-job performance

Reduce hiring costs and turnover

Direct

- Guaranteed places for employees at substantially discounted rates
- Subsidized learning activities focused on sponsor company needs, customised and facilitated by SMEs
- Customised program modules using sponsor company case studies

Indirect

- Development opportunities will make the company an employer of choice for graduates
- Enhanced technical knowledge and skills within the mineral processing cohort will lift operational performance and ability to adapt to change

Thank you