THE FUTURE OF DIAMOND LIBERATION AND RECOVERY
A LITTLE HISTORY

LIBERATION
- Flooring
- Stamp mills
- Scrubbing and screening
- Jaw/cone crushers
- High pressure grinding rolls

CONCENTRATION
- Rotary pans
- Dense medium separation static cones
- Dense medium separation cyclones

RECOVERY
- Hand sorting
- Grease belts
- X-ray machines
“THE THREE HALVES”

PPM has developed the philosophy of the three halves.

This revolves around the opportunity to bring diamond mines into production for half the capex, ensure that they run at half the opex and are into nameplate production in half the time.

OPTIMISTIC?
UNIT PROCESSES

- Autogenous milling
- Large diamond recovery (XRT)
- Waste sorting (NIR)
- Dense medium separation (DMS)
- X-ray Diamond recovery
- Laser Raman diamond concentration
- Size frequency distribution analyses
- Secure diamond storage
THERE ARE MANY BENEFITS TO AUTOGENOUS MILLING

- Combines many unit processes into one
  - Scrubbing
  - Secondary crushing
  - HPGR/recrush crushing
  - HPGR Disagglomeration
  - Recovery plant feed preparation
- Improved diamond liberation
- Reduces diamond breakage
- Removes circulating loads within the plant
- Generates a high percentage of fine, discard material
- Reduces downstream unit processes required capacities
- Effectively undertakes preliminary waste sorting
- Treats weathered kimberlite: easier downstream materials handling
Autogenous milling can have a significant impact on the upstream mining processes.

- It can handle less “well shaped” material than conventional crushing. Therefore allows for the use of primary jaw crushers rather than the more expensive gyratory crushers or mineral sizers.
- Handles fine, sticky material well. Mining can blast finer. Blasting is cheaper than crushing and milling.
- Finer blasting. Reduces overall mine operating costs. Can increase diamond liberation. Can decrease diamond breakage.
XRT COMBINES DIAMOND CONCENTRATION AND RECOVERY
- High capacity sorting made possible by increases in computer processing power
- Now also economically viable
- Can sort from 150mm to ~12mm
- Capacities up to 150tph
- Low yield: concentrate reports directly to the Sorthouse

REPLACES DMS IN THE TREATMENT OF THE +12mm MATERIAL
- Lower opex
- Lower power consumption
- Lower water consumption
- No coarse X-ray machines
- Improved security
- Less logistics: FeSi and spares
WASTE SORTING, COMBINED WITH AUTOGENOUS MILLING, HAS MANY ADVANTAGES

Autogenous milling of kimberlite effectively concentrates waste in the mill recycle load. Historically this has been crushed, often using expensive HPGRs prior to returning to the mill feed. Waste sorting can remove a very high percentage of the basalt and granite in this stream: potentially up to 80% of the mill recycle load.

Advantages
- Lower power consumption
- Less diamond breakage
- Lower opex
- Lower downstream unit processes capacity requirements
- Less wear and maintenance
DMS

XRT TECHNOLOGY IS DEVELOPING FAST AND WILL EVENTUALLY BE ABLE TO TREAT ALL THE REQUIRED SIZE FRACTIONS DOWN TO 2mm. HOWEVER DMS STILL HAS A PART TO PLAY IN THE MEDIUM TERM

PPM has developed a new DMS design that can operate with minimum number of drives: 4 vs 8 for the same functionality.

Advantages
- Lower power consumption
- Lower water consumption
- Less manpower required to operate and maintain
- Lower opex
**RECOVERY PLANT**

- XRT technology will eventually remove the need for X-ray machines to recovery diamonds from the coarse DMS concentrates.
- In the medium term, XRT will be applied to the Recovery Plant X-ray machines in order to improve selectivity and reduce yields.
- Laser Raman machines will become more common in order to generate a process stream containing up to 90% diamond.
- Size frequency distribution (SFD) analysis machines will be installed to provide on line information for metallurgical accounting and process management.
- Secure packaging systems will also become more prevalent to reduce risk.
Diamond security must be fully integrated into the metallurgical processes

- **XRT technology**
  Concentrate reports directly to the Sorthouse and removes other high risk unit processes

- **Laser Raman**
  “Hands-off” sorting

- **SFD**
  Again a “hands-off” process

- **Canning**
  Secure export
WHERE DOES THIS ALL LEAD US?

SIMPLICITY IN DIAMOND PLANT FLOWSHEET DESIGN
MEDIUM TERM FLOWSHEET

PRIMARY CRUSHING
AG MILL
SCREENING
XRT
COARSE SFD
DMS
DRYING
MIDS X-RAY
MIDS RECONC
MIDS RAMAN
MIDS SFD
CANNING
FINES X-RAYS
FINES RECONC
FINES RAMAN
FINES SFD
WASTE SORTING
PEB CRUSH
MEDIUM TERM FLOWSHEET
SECURITY

THE SIMPLE FLOWSHEET HAS SIGNIFICANT IMPACTS ON DIAMOND SECURITY: A MUCH NEGLECTED CONSIDERATION IN DIAMOND PROCESS ENGINEERING DESIGN

- Less equipment
- Less maintenance
- Easier process control
- Less spillage
- Less manpower
- Smaller footprint to secure

ALL OF THE ABOVE MEANS LESS OPERATIONAL ACCESS TO DIAMONDS AND HENCE LESS THEFT
“IF YOU CAN'T EXPLAIN IT TO A SIX YEAR OLD, YOU DON'T UNDERSTAND IT YOURSELF”: Albert Einstein

“LIKE ALL MAGNIFICENT THINGS, IT'S VERY SIMPLE”: Natalie Babbitt

“LIFE IS REALLY SIMPLE, BUT WE INSIST ON MAKING IT COMPLICATED”: Confucius

“SIMPLICITY IS THE ULTIMATE SOPHISTICATION”: Clare Boothe Luce

“SIMPLICITY IS GENIUS”: Ron Greenwood
WHAT DOES SIMPLICITY GIVE US?

- Lower capex
- Lower opex
- Less manpower
- Less working capital
- Lower logistics requirements
- Quicker commissioning and ramp-up
- “Automatic” plants rather than “automated” plants
- Less unit process complexity = less circuit vulnerability
- Higher overall plant utilisation
- Easier process control
- Easier operational training
- Improved safety
HISTORICALLY DIAMOND PLANTS WERE DESIGNED ON THE BASIS OF PROCESS ENGINEERING EXCELLENCE. THIS FOCUSED TOO MUCH ON MAXIMUM DIAMOND LIBERATION AND RECOVERY RATHER THAN THE DEFINING THE OPTIMAL MIX OF TECHNICAL AND FINANCIAL SOLUTIONS.

DIAMOND MINES AND PLANTS MUST NOW BE DESIGNED FOR BUSINESS EXCELLENCE.
PPM COMPLETED THE FEASIBILITY STUDY FOR THE KAROWE MINE IN BOTSWANA: WHAT WAS ACHIEVED?

- Capex reduction of 60% compared to conventional plant design for the same functionality
- Opex reduction of 40%
- Project construction and commissioning: 21 months to nameplate production levels compared to an estimated 30 months

THE THREE HALVES IS NOT OPTIMISTIC

IT HAS BEEN DONE
THE THREE HALVES: WHAT HAS BEEN ACHIEVED?

THE 1,111ct DIAMOND RECOVERED FROM KAROWE
THE SECOND LARGEST DIAMOND EVERY FOUND
PPM BELIEVES THAT THE PRINCIPLES OF SIMPLICITY, WHICH HAVE PROVEN TO BE SUCCESSFUL IN THE DIAMOND INDUSTRY, CAN BE APPLIED TO OTHER MINES AND COMMODITIES.

THIS IS CONSIDERED TO BE AN ESSENTIAL PART OF THE NECESSARY MOVE TOWARDS A MORE PROFITABLE GLOBAL MINING INDUSTRY, AS WELL AS A MORE ENVIRONMENTALLY FRIENDLY ONE.