Improving Processes. Instilling Expertise.

QUARRY
ACADEMY

Crushing & Screening Workshop
Design & Operation Do’s & Don’ts

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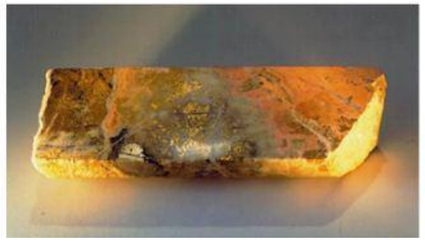
Crushing & Screening Workshop
Do's & Don'ts Introduction



Feed

Machines & Processes

Products

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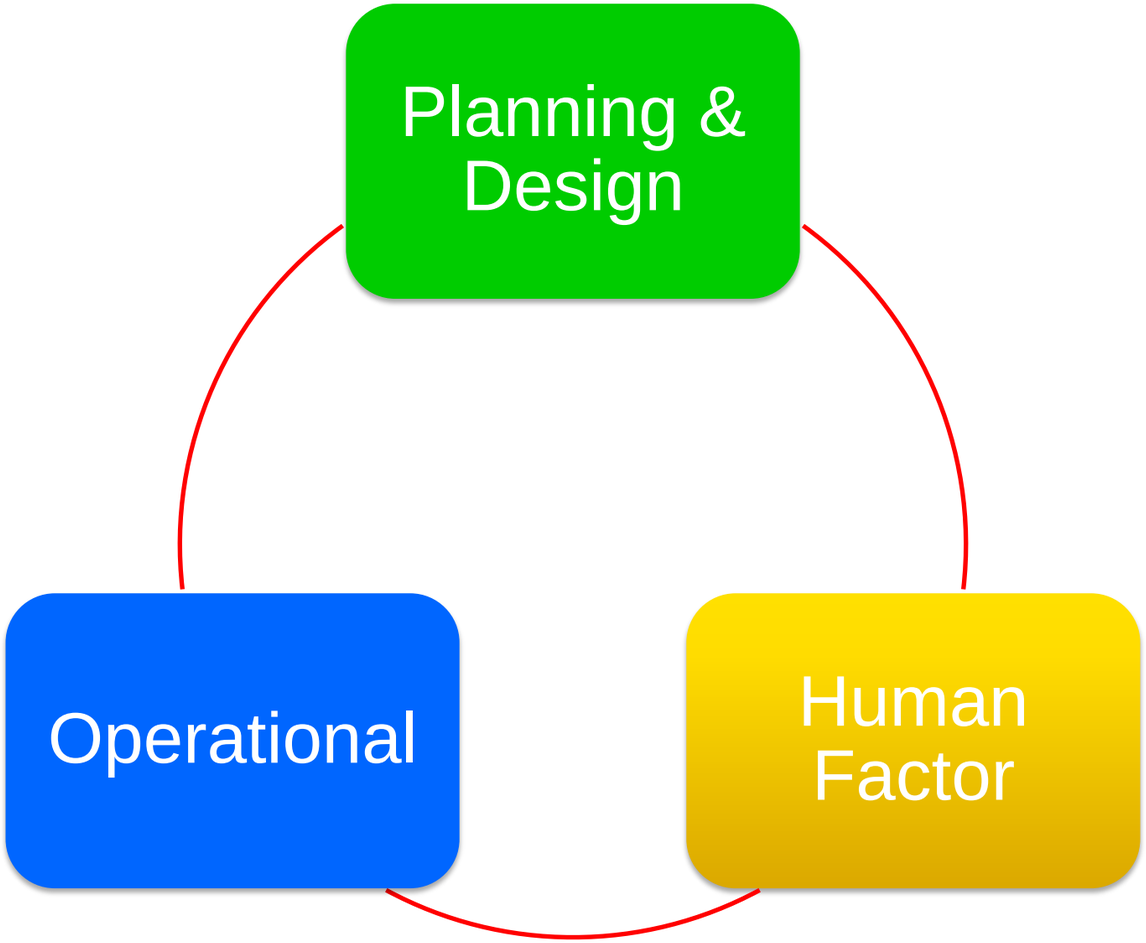
Crushing & Screening Workshop
Do’s & Don’ts Introduction



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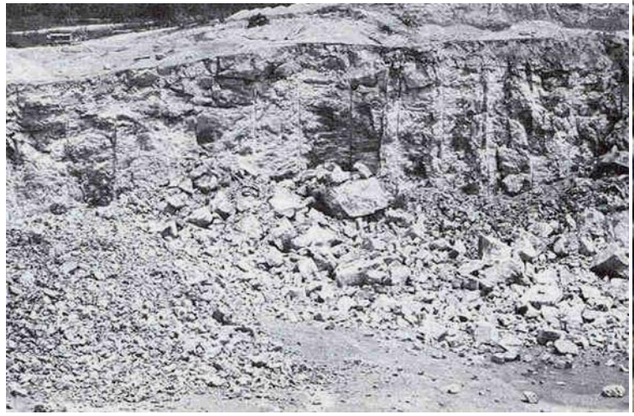
Crushing & Screening Workshop
Material Appreciation

Planning & Design



- **Have the material tested:**
  - ✓ **Work index / hardness / toughness**
  - ✓ **Abrasion index**
  - ✓ **Shape quality**
  - ✓ **Density**
- **Set clear product needs (what, how much, etc.)**
- **These will:**
  - ✓ **Determine equipment selection**
  - ✓ **Allow evaluation of economic costing & feasibility**

Assumption is the mother of all screw-ups, Wethern's Law

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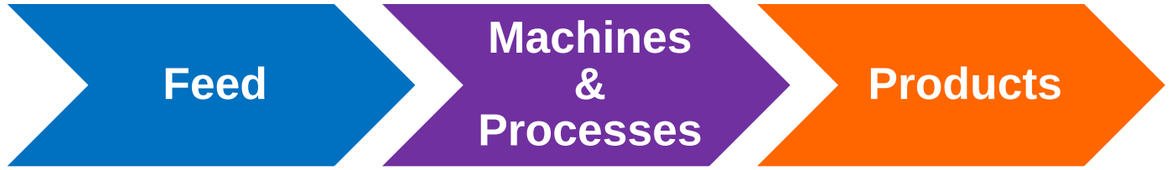
Crushing & Screening Workshop
Equipment Selection

Planning & Design

- **Select equipment to suit the material and process requirements.**
- **Select equipment to optimize cost/ton rather than investment cost.**
  - ✓ **Example:**
    - Capital Investment 5M$ vs 4.5M$.
    - Operating cost of 3.50$/ton vs 3.00$/ton, 500K tons/year = 250K savings per year = 2 year pay back over 15-20 year investment.
- **Avoid cutting corners :**
  - ✓ **Wear parts (type and thickness)**
  - ✓ **Surge & stockpile capacity**
  - ✓ **Screen size**
  - ✓ **Conveyor width**
  - ✓ **Instrumentation process data or automation**



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Design & Layout

Planning & Design

- Consider topography for advantages & disadvantages.
- Plan to have plant in line wherever possible.
- Avoid change in material flow direction ahead of a process.
- Consider maintenance requirements, health & safety, etc.
- Keep in mind trucking &/or loading requirements.

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Design & Layout – Intermediate Storage

Planning & Design

- **DO plan on intermediate storage if possible:**
  - ✓ **Stabilize crushing process to maximize efficiency & product quality.**
  - ✓ **Flexibility to integrate tramp safety interlocks.**
  - ✓ **Provides safety net in the event of unforeseen failure.**

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Design & Layout – Material Flow

Planning & Design

- **DON'T feed equipment at an angle or change feed direction ahead of equipment.**
- **DO try to feed in line. Change direction <u>after</u> process.**
  - ✓ **Segregation compounded by change in direction.**
  - ✓ **Reduces process efficiency.**
  - ✓ **Increases operating costs when trying to "correct" design flaw.**

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Design & Layout - Conveyors

Planning & Design

- **Try to design conveyors as wide as possible and as slow as possible.**
  - ✓ **Improves component life cycle – reduces operating cost.**
  - ✓ **Reduces transfer point segregation.**
  - ✓ **Reduces need for deflectors, rock boxes, etc.**

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Design & Layout – General Installation

Planning & Design

- **What <u>NOT</u> do to:**
  - ✓ **No access to crushers for servicing.**
  - ✓ **Expensive chute work for no reason.**
  - ✓ **Added steel costs to get height.**
  - ✓ **Difficult access for screen maintenance.**
  - ✓ **High impact on belting.**
  - ✓ **Etc….**

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Crushing & Screening Workshop
Design & Layout – General Installation

Planning & Design

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Design & Layout – General Installation

Planning & Design

- **Better concepts…:**
  - ✓ **Readily accessible for maintenance & inspections.**
  - ✓ **Controlled flow to crushers.**
  - ✓ **Optimal feed distribution to crusher.**

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Design & Layout – General Installation

Planning & Design

- **Speed = Wear**
  - ✓ **Reduce material velocity as much as possible.**

- **Design equipment so that operator can ‘drive’ the process**
  - ✓ **Surge capacity**
  - ✓ **Level sensors**
  - ✓ **Belt scales**
  - ✓ **The more you can measure, the better you can control, the more you can improve!**

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Operation – Mass Flow Control

Operational

- **Problem:** High flow fluctuations. All equipment prefers steady choke conditions.
- **Effect:** While cycling, performance is not optimized, reduced product quality and production consistency.
- **Possible improvements:**
  - ✓ Is the feeder speed correct?
  - ✓ Is the feeder surging due to poor chute/throat design?
  - ✓ Check preceding screen/feeder separation size.
  - ✓ Is the crusher properly configured set up (chamber and throw)?
  - ✓ Check setting on preceding crusher.

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Operation – Bridging

Operational

- **Problem:** Bridging at crusher opening
- **Effect:** Flow restriction, loss of production.

- **Possible improvements:**
  - ✓ If problem with primary crusher, check drill & blast design.
  - ✓ If problem with primary crusher, check S&G feed size, do you need to pre-scalp?
  - ✓ If jaw is producing slabs, check setting of jaw, check feed control of VGF.
  - ✓ Check setting of preceding crusher.
  - ✓ For cone crushers, check chamber configuration.
  - ✓ Check separation of preceding screen.

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Operation – Crusher Setting

Operational

- **Problem:** Control of the crusher's setting.
- **Effect:** Excessive coarse or fine material.

- **Possible improvements:**
  - ✓ Calibrate your crusher, record in operation log book or automation system.
  - ✓ Check for uneven wear by measuring in 3 locations.
  - ✓ Eliminate segregation that causes uneven chamber wear.
  - ✓ Sometimes a red herring. You want ¾'' opening but can't hold it. Are you exceeding mechanical capabilities of crusher?
  - ✓ Check chamber configuration, do you have right chamber for feed size and CSS targeted? Adjust chamber (EC, C, MC, etc.) or adjust mantle (A, B, FF, OptiAgg, etc.)

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Operation – Crusher Setting

Operational

Feed to FINE

Feed to COARSE

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Operation – Segregation

Operational

- **Problem:** Segregation is the single most important factor affecting crushing & screening performance.
- **Effect:** Power & pressure fluctuations, ring bounce/bowl float, even wear, premature replacement of spare & wear parts, negative impact on product quality. Reduced throughput. Higher cost per tonne.

- **Possible improvements:**
  - ✓ Terminal disease for crushing & screening. Seek it out and eliminate it.
  - ✓ Starts from the design phase.
  - ✓ Use deflectors, redirectors, splitters, etc.

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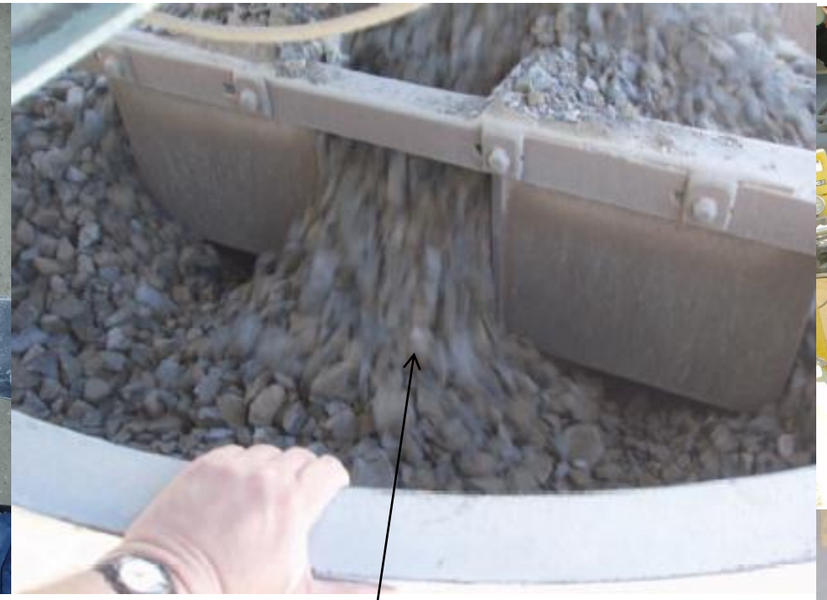
Crushing & Screening Workshop
Operation – Segregation At Crusher

Operational



Uneven wear

Even flow around chamber.

Easily removed.

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Operation – Horizontal Segregation

Operational

- **Occurs at all conveyor transfer points. Natural separation of fines/coarse vertically on the belt are transferred horizontally onto the next conveyor belt.**

Coarse **Fine**

Coarse **Fine**

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Operation – Segregation on Screens

Operational

- **Screening efficiency & cost negatively affected by segregation.**
  - ✓ **As much as possible, feed in line, counter current with screen flow.**
  - ✓ **Otherwise feed in line with screen flow.**
  - ✓ **Avoid feeding at an angle or from the side.**

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Operation – Maintenance Do's & Don'ts

Operational

- Do you keep detailed records of equipment maintenance interventions?
- Do you keep detailed records of periodic maintenance measurements?
- Do you trend your periodic measurements?

  - Spider bushing play
  - Dust seal play
  - Axial play
  - Return oil screen deposits (weight)
  - Eccentric assembly component plays
  - Bearing temperatures
  - Etc…..

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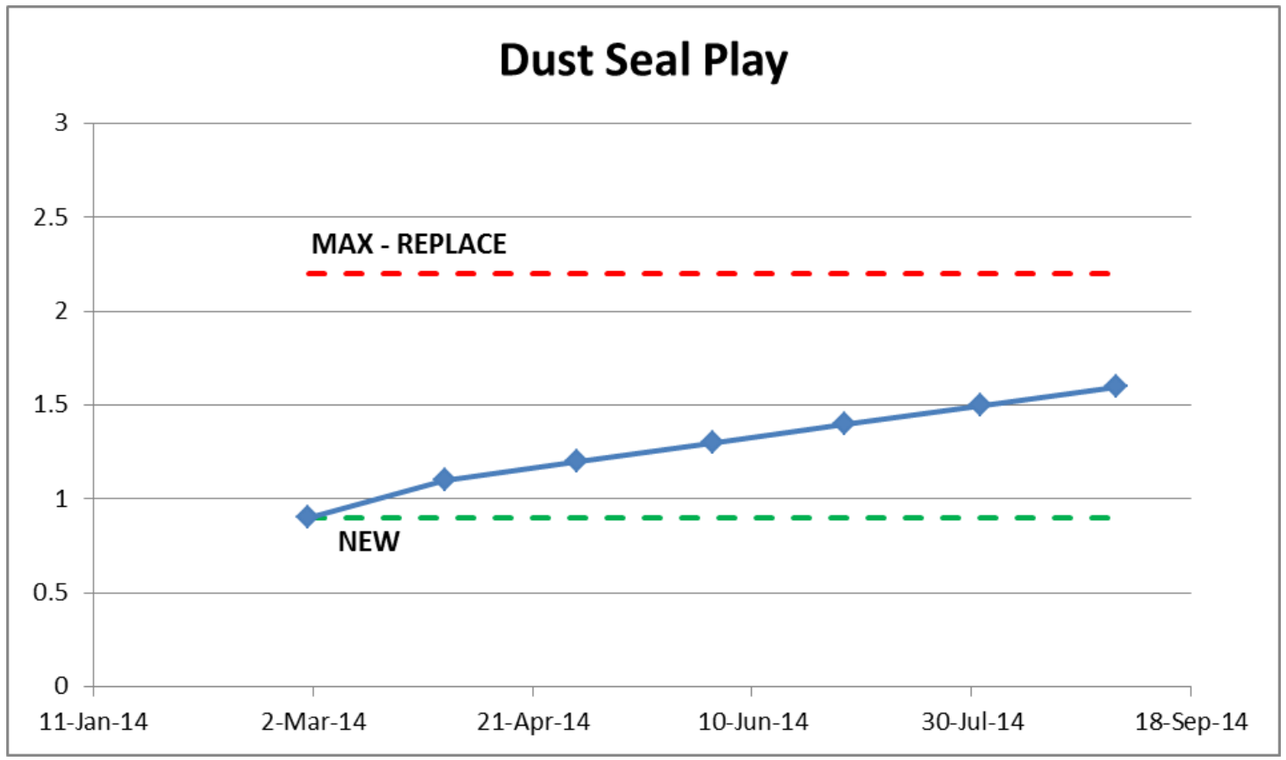
Crushing & Screening Workshop
Operation – Maintenance Do's & Don'ts

Operational



Example…dust seal play on Sandvi cone crusher. Impacts oil quality → gears, pinion, eccentric components, filters, etc.)

- **DO trend equipment measurements.**
- **Provides feedback on operating practices.**
- **Allows for predictive PM.**
- **Fewer budgeting surprises.**
- **Provides information to see if changes in operating practices affect equipment life cycle. Measurable cost savings.**

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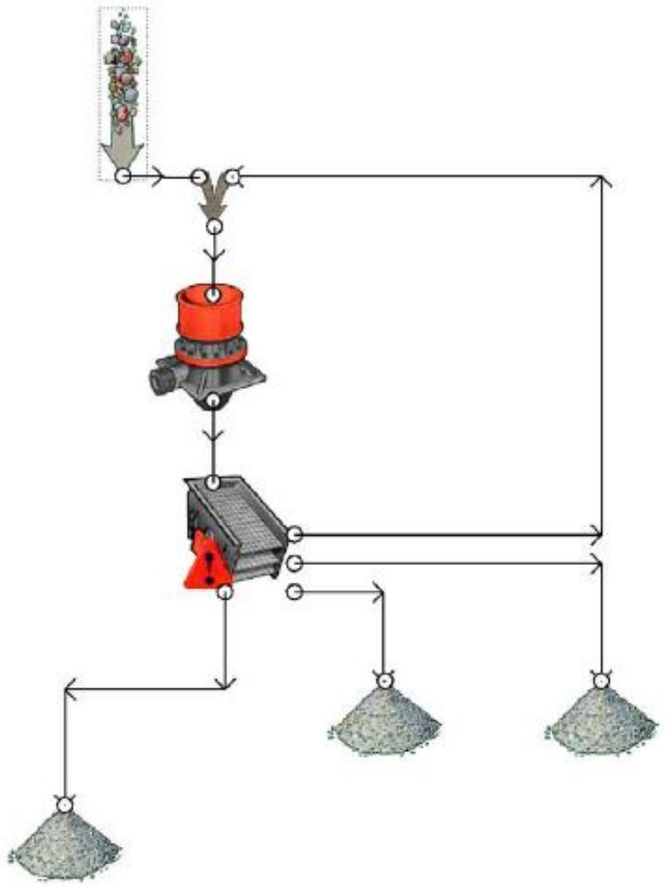
Crushing & Screening Workshop
Operation – Screen & Common Problems

Operational

- **Pegging & blinding.**
- **Fines in the overs.**
- **Overs in the fines.**
- **Excessive wear.**
- **Carrying capacity.**



What are the efficiencies of each of your screens?

When was your last screen survey done? Did it result in positive changes to your operation?

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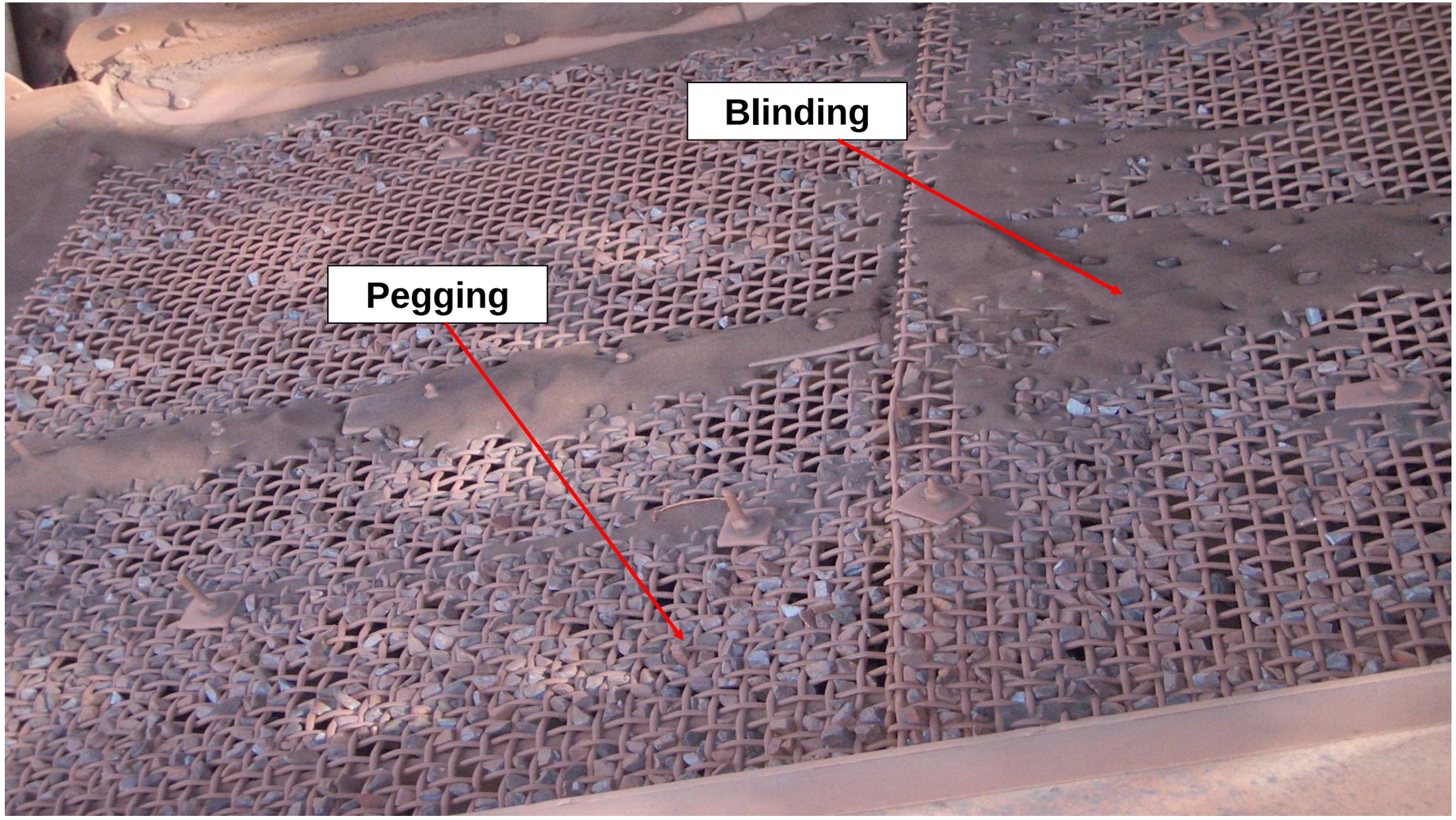
Operation – Screen Pegging & Blinding

Operational



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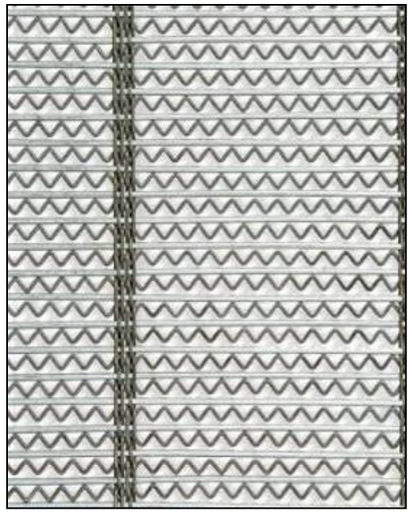
Crushing & Screening Workshop
Operation – Screen Pegging & Blinding

Operational

- **CAUSES:**
  - ✓ **Stroke is too low**
  - ✓ **Media type**
  - ✓ **High moisture**
  - ✓ **Clay**
- **Solutions:**
  - ✓ **Increase screen stroke. Do not exceed G-force limitations, always check with manufacturer.**
  - ✓ **Innovative medias: flexible rubber, flexible urethane, piano wire, special wire media, stainless steel etc.**
  - ✓ **Wet screening vs dry screening.**
  - ✓ **Change screen technology.**



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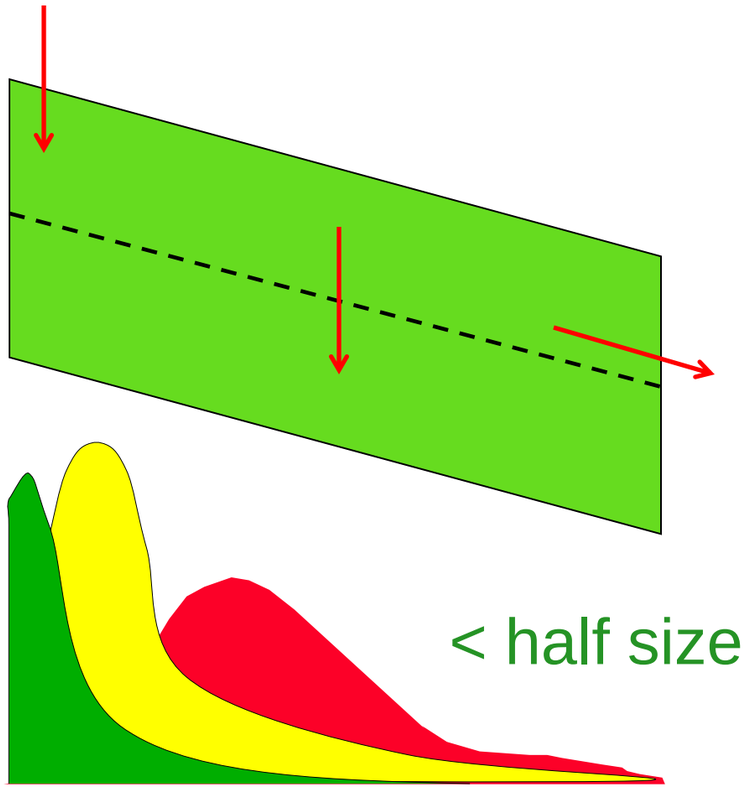
Crushing & Screening Workshop
Operation – Screen Fines in the Overs

Operational

- **CAUSES:**
  - ✓ **Pegging & blinding.**
  - ✓ **Material tracking – especially in crown valleys.**
  - ✓ **High bed depth.**

- **Solutions:**
  - ✓ **Create deflectors to move material laterally on screen.**
  - ✓ **Increase the rate of travel by increasing the stroke and/or speed. More drastically, increase slope.**
  - ✓ **Increase media opening size at the FEED END. Majority of fines (< ½ size of hole) are removed at the start.**



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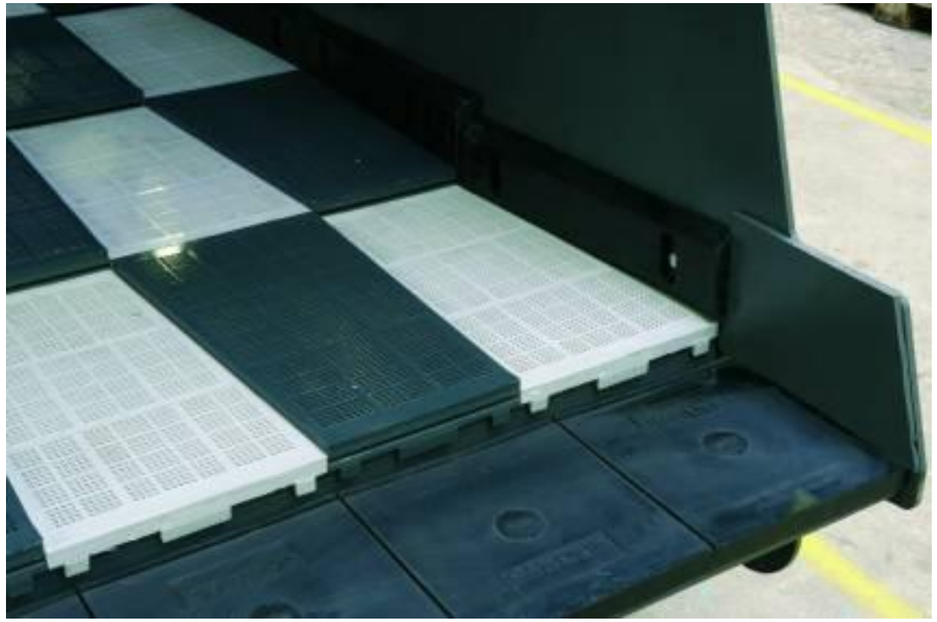
Crushing & Screening Workshop
Operation – Screen Overs in the Fines

Operational

- **CAUSES:**
  - ✓ **Media opening too big**
  - ✓ **Damaged media**
  - ✓ **Incorrect placement of oversized media in screen to resolve fines in overs.**

- **Solutions:**
  - ✓ **Preventative inspections & replace as needed.**
  - ✓ **For high wear applications, start media with slightly smaller opening to account for wear.**
  - ✓ **Use flat deck modular panels – best option to fine tune opening across screen surface.**
  - ✓ **Relocate fines removal over dimensioned medai to the FEED END of the screen.**



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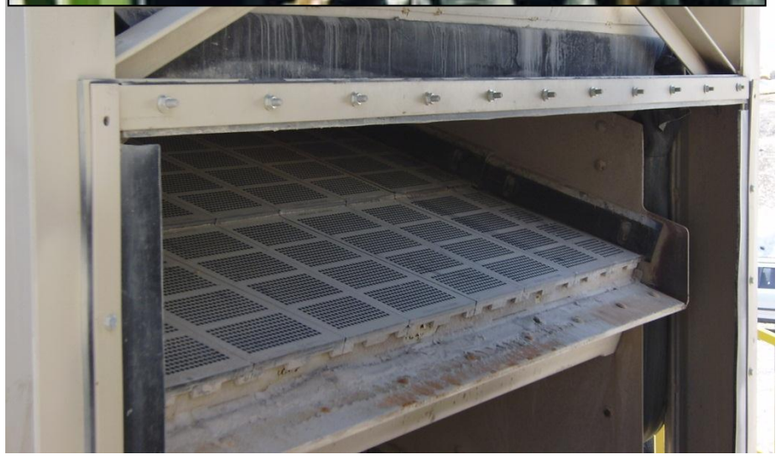
Crushing & Screening Workshop
Operation – Screen Media Excessive Wear

Operational

- **CAUSES:**
  - ✓ **Impact at loading point**
  - ✓ **Abrasion**
- **Solutions:**
  - ✓ **If using steel wire, replace with rubber panels best suited to application (flat deck, modular, side tensioned, etc.)**
  - ✓ **Check to make sure drop point is on feed box and not media.**
  - ✓ **For abrasion, use innovative wear products to meet needs (rubber or urethane).**
  - ✓ **Don’t use rubber media when wet screening.c**



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Crushing & Screening Workshop
Operation – Screen Carrying Capacity

Operational

- **Carrying Capacity: Amount of material a screen can handle before momentum of screen is overcome.**

$$\text{CARRYING CAPACITY} = \frac{M \times V \times S^2 \times N^2}{C_1 \times L}$$

- **M = eccentric weight (inclined) or live weight (horizontal).**
- **V = material travel rate**
- **S = stroke**
- **N = rotational speed.**
- **L = length of deck**
- **C = performance constatn**

Consequences:

- ✓ **Springs bottom out and fail.**
- ✓ **Uneven movement of material on the deck.**
- ✓ **Screen body twist and fatigues.**

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Operation – Screen Carrying Capacity

Operational

- **How to increase Carrying Capacity?**

- **INCREASE MOMENTUM OF SCREEN:**
  - ✓ **Larger throw**
  - ✓ **Increase speed RPM**
  - ✓ **Heavier screen**

- **INCREASE MATERIAL TRAVEL RATE:**
  - ✓ **Steeper incline**
  - ✓ **Straight line motion vs circular motion screen**
  - ✓ **Increase throw &/or speed**
  - ✓ **Use flat deck vs camberred surface**

BUT BE CAREFUL:

- ✓ **Throw & speed affect bearing life.**
- ✓ **Throw & speed combination affect G-Force.**

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Crushing & Screening Workshop
Operation – Screen Do's & Don'ts

Operational

Screen Do's & Don'ts

- **Most screen problems are related to the PLANNING phase → Underestimating screening needs.**
- **Incorrect screen selection can results in:**
  - ✓ **Limited ability to play around with media to optimise cost/tonne.**
  - ✓ **Limited ability to play around with media to handle pegging/blinding issues.**
  - ✓ **Limited ability to handle production increases.**
  - ✓ **Limited ability to change product sizes.**
  - ✓ **Lower overall plant production.**

- **With sufficient screening area, you are able to try various medias, resolve more problems, make more tonnes.**

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Crushing & Screening Workshop
Human Factor

Human Factor

- Do involve all stake holders.
- Don’t be afraid to try new technology or products.
- “This is how we have always done it”.
- Empower operations & maintenance to make the right decisions.
  - ✓ Need measurable data & feedback.

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