Design for maintainability

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In order to discuss plant design for maintainability, it is necessary to understand what is meant by both design and maintainability. For the context of this abstract, 'design' is defined as 'the transformation of an idea into a process that meets both the designer's requirements and end user's needs'. 'Maintainability', in turn, is defined as 'the degree (or ease) to which the design can be maintained (or repaired), both economically and efficiently'. Maintainability is therefore a characteristic of the final design, whereas maintenance is the result of the design. Design for maintainability is therefore designing the plant to find the optimum balance between capital cost and ongoing maintenance cost, as illustrated in Figure 1.

For any design team, the end user is both the operational and maintenance teams of the plant. A survey was therefore conducted with 5 concentrator engineers within Lonmin Platinum. The survey consisted of a single, open-ended question: 'What would be your requirements in terms of plant maintainability when designing a new concentrator?' The results of this survey are given in Figure 2. Interestingly, the top 4 requirements, namely ease of access, standardization of equipment both internally and between concentrators, skill levels to maintain equipment and redundancy of running equipment, all have a 'time to repair' component associated with them. For instance, the easier it is to access equipment, the shorter the time would be required to maintain it. Also, if equipment is standardized, specialized maintenance skills would not be required, thereby reducing the time to repair.

The reason behind this focus on 'time to repair' (or mean down time), becomes clear from Figure 3, a plot of 'mean down time' vs. 'mean time between maintenance' for various operational availability levels. At a target of 90% availability, the plant engineer will have 80 hours to complete all corrective and preventative actions (not only failures) on the plant. In addition, this down time includes all the delays, not only the pure repair time of the equipment. At a 95% target, the available time reduces to 38 hours, while at 99% target, only 7 hours will be available.

The design team should therefore always aim to reduce the mean down time when a piece of equipment fails, or requires preventative maintenance. Some practical examples include:

- Provide lifting equipment access to all high maintenance equipment, such as pumps and pulleys
- Install permanent trolleys on all crawl beams to increase time to repair
- Install standby pumps and dedicated pipelines (with automatic changeover), thereby not affecting on the available maintenance hours per month
- Make pumps accessible, even under flooded plant conditions, through walkways and access platforms
- Provide dedicated pipe routes with access
- Install split guards and split bearings on main conveyor pulleys
- Provide easy and clean access to all instrumentation
- Take cognisance of environmental implications of oil spills as well as time to clean up.

In conclusion, maintainability is a design parameter and it is not expensive if considered early in the design process. However, failure to take the needs of the maintenance team into consideration can be very expensive in the form of safety risks to personnel, retrofits to equipment, operation disruptions and 'cutting torch' maintenance. The design engineer should therefore review project goals and strategies with the operational team prior to design sign-off. Specifically, the design engineer should invest time to compile design and installation specifications and obtain sign-off from both the operational teams, as well as the contractor responsible for the design and construction of the concentrator. During the design process, utilize 3D design packages where possible, and specifically review maintenance access with key members of the maintenance team. Finally, notwithstanding the best efforts of design teams and construction personnel, potential design improvements will become apparent during only construction. Therefore, remain flexible during construction and get the maintenance team on site early. It will always be cheaper to improve a design during the construction process, than disrupting the value chain of a running concentrator. ◆

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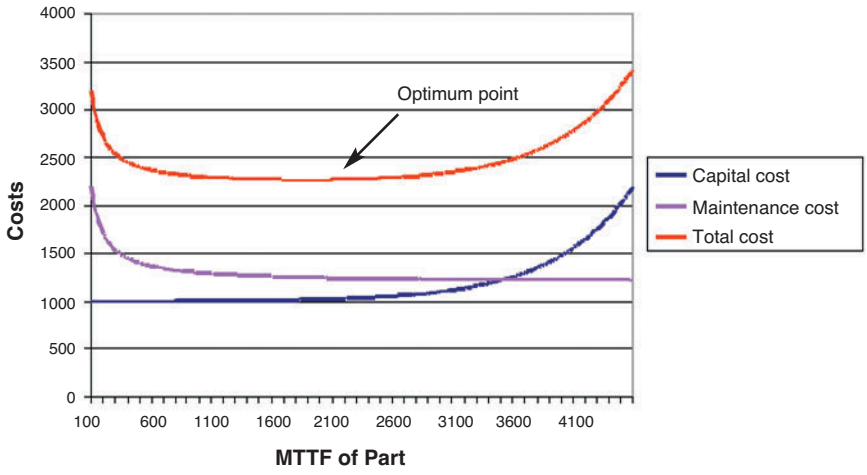

Figure 1—Interaction of capital cost anad maintenance cose

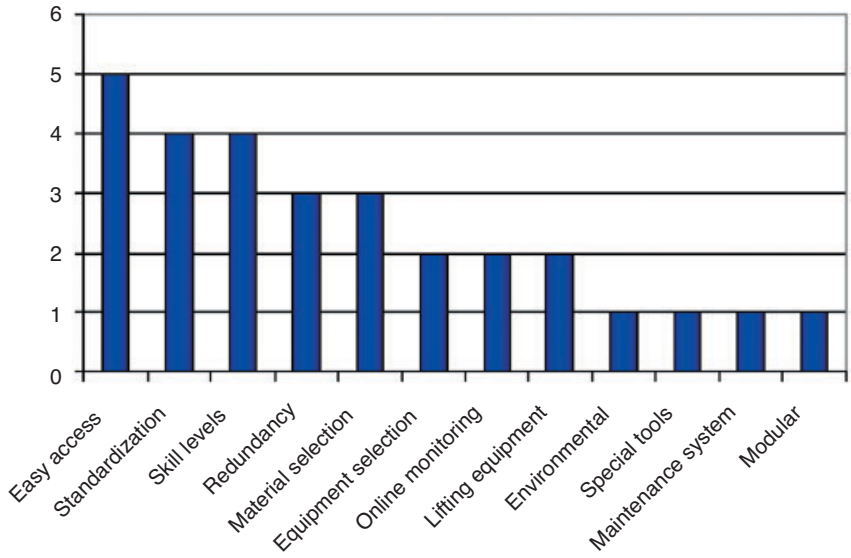

Figure 2—Outcome of engineering survey on maintainability requirements

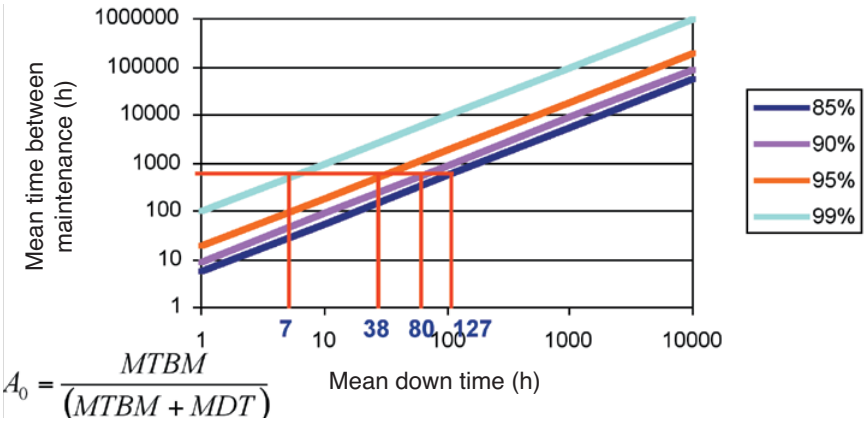

Figure 3—Available time to repair for various availability targets