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Designing for Efficient Installation and Relocation of Trunk and Panel Conveyors at Donaldson Coal, Tasman Mine

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DESIGNING FOR EFFICIENT INSTALLATION AND RELOCATION OF TRUNK AND PANEL CONVEYORS AT DONALDSON COAL, TASMAN MINE

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Abstract: Mining operations at Donaldson Coal's Tasman Mine were planned around maximizing the efficiencies in road way development and panel extraction within a mine to be established on traditional bord and pillar mining methods. Of particular relevance in early mine development, was that the installation of trunk conveyors stopped all coal production. Further, the mine plan required repeated relocation of production panel systems in relatively short cycles over the life of the mine.

A key element of the requirements identified by mine management was to minimize the non productive time that occurred during installation of trunk conveyors and the installation and relocation of panel conveyors. Aggressive targets were established for the time to be taken from hand over of a completed heading by the Mining team to Engineering team until hand back with an installed and operational conveyor. These targets, amongst others, necessitated a specific approach to the design of equipment with particular emphasis on simplicity of transport, minimized underground assembly and electrical termination, standardisation of parts and the ability to efficiently add to the installation following initial operation. A collaborative approach between mine engineering staff and the equipment supplier was established to share operational and design experience and develop practical design solutions to meet management's targets.

This paper presents the criteria that were established for design constraints and required operational outcomes, the review of existing methods and the ultimate designs deployed at the mine. Several innovations were incorporated in the final designs to achieve the desired outcomes and these are presented.

Whilst the design criteria were specific to the Tasman operation, the results of the process and equipment features have likely applications in other mine operations seeking to improve development efficiencies and minimize conveyor installation times.

INTRODUCTION

Donaldson Coal's Tasman Mine is located in the Lower Hunter area off George Booth Drive, West of the F3 Freeway and much of the lease lies beneath the Mount Sugarloaf Reserve. Mine life is expected to be 12 – 15 years with a total reserve of around 10 Million tones.

The target seam is the Fassifern seam. Due to the geometry and relatively small size of the deposit along with surface considerations, longwall mining methods were not considered economical or practical. Therefore the mine has been planned around bord and pillar mining methods with possible future production being supplemented by augering techniques.

Based on the bord and pillar mining method the mining layout comprises "main trunk" roadways developed throughout the lease and herringbone layout "panel" areas that side load onto the trunk system from numerous of areas. Roadways are nominally 3000 mm high x 5000 mm wide.

Economic production of this relatively small deposit at relatively low tonnages relies on cost effective infrastructure and efficient mining techniques. Further, the evolving mine design, based on issues of geology and production requirements meant that maximum flexibility was required in the configuration and re-use of the conveyor hardware.

Part of that planned efficiency has been identified in the safe transport, installation and commissioning times for the "trunk" conveyors and the similar recovery, relocation and installation of the "panel" conveyor units. The key parameter was the turn around time between access to a completed roadway and the hand over of an operating conveyor. Whilst rapid installation and commissioning was required on all conveyors, Trunk conveyors were expected to remain in position for life of mine where-as Panel conveyors would be recovered and relocated numerous times in the mine plan.

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This and other operating criteria for the equipment required a rethink on the traditional designs and existing equipment used in similar mine development applications.

DESIGN CRITERIA

The operational criteria for the conveyors was developed over a period of time by mine management and mine engineering staff along with input from the OEM supplier.

The anticipated mine layout, production levels and mining methods required conveyors using 1200 mm wide belt and either 75 KW or 150 kW installed power.

Belt speeds were assessed and predetermined at no more than 2.7 m/s. This conservative belt speed was adopted to minimize anticipated issues with low height transfers, general wear and tear on idlers and belt as well as providing reasonable scope to increase speed if needed due to unexpected or unspecified requirements in the mine.

The power and belt selections were supported by an assessment of likely life-of-mine requirements for trunk and panel conveyors in terms of lengths and lifts across the resource. Trunk systems would require up to 150 kW installed and panel systems only 75 kW to meet the expected conveyor geometries.

These ratings are typical of many "temporary development" systems used throughout the industry and are not in themselves significant other than to establish the base case for design. Of importance however is the realization that most of the equipment traditionally applied to such modest ratings was developed and used in the 1960's or 70's and would have typically involved the traditional style drives sold at the time by companies such as Huwood or Fox Manufacturing coupled with a separate loop take up and perhaps an integrated jib.

More recently, wheel mounted designs with loop take ups and drives have been developed with similar ratings and improved portability however they were considered unsuitable for the specific duty at Tasman. Tasman staff determined that design specific or "fit for purpose" equipment would be required to meet their application.

For example, whilst the Trunk conveyors would be left in position for the life of mine, they would be installed and extended in sequences and cycle times typical of development headings in other mines. Therefore the equipment design had to meet this dual functionality.

Beyond the normal criteria of design compliance, safety and operating parameters, the operational and other criteria established by the mine and relevant to this paper included:

- 48 hours Target time for installation, powering up and commissioning of a Trunk conveyor.
- 48 hours Target time for recovery, re-installation and commissioning of a Panel conveyor
- Typical set up for a new installation to be the starter, mechanical terminal set, structure, boot end and belting for a 100 metre initial length at hand over to the mining team.
- Panel conveyors to be able to load at any point on a Trunk conveyor.
- Trunk conveyors to be transom mounted trough idler design, optionally roof hung or floor mounted, panel conveyors to be suspended trough, floor mounted design but to have maximum commonality of components.
- Trunk structure design to provide simple "bolt free" construction to suit the development sequence.
- Minimised types of pulleys in the system.
- Maximum interchangeability and commonality of mechanical hardware in all conveyors.
- To suit future anticipated roadway limits the Panel conveyors had to be installed and able to transfer to a Trunk conveyor in no more than 2200 mm head height.

These criteria in combination required a "ground up" approach to the design of the conveyors and associated power and control systems.

DESIGN ASSESSMENT

Installation Time

In order to address the key criteria of limited installation or "hand over" construction times a review was undertaken of each element in a typical conveyor installation program to consider potential gains in the critical path.

The review necessarily involved OEM staff from the Mine Services division along with OEM design staff and mine operating personnel. The review identified major areas of concern or potential for improvement in traditional equipment designs or methods that could have a favourable impact on construction critical path.

The review identified the following:

- Preassembly
    - Piecemeal transport and assembly increases the "underground" time for installation therefore as much as possible should be pre-fitted before transport.
    - It is common for discharge assemblies to be installed separately and in particular chute work to be erected separately so an integrated, preassembled design has significant opportunity to reduce times.
    - Small parts add disproportionate times to installation. All incidental parts such as transition idlers, belt cleaners, brackets, electrical mountings should be pre-fitted.
- Electrical
    - Electrical fit up and testing can be a significant portion of the critical path.
    - Cabling and termination of electrical parts can not be easily accelerated underground due to limited access.
- Minimised Scope for Critical Period
    - In order to get away, the initial installation required only limited take up storage capacity. The design, if possible, should allow for the loop and winch to be installed in minimum length initially and extended at a later date without major interruption.

Panel Transfer

A similar review was undertaken on the requirement to be able to establish a transfer from panel conveyor to any section of the trunk conveyors and be able to relocate it efficiently with the panel move. The primary issue was the ability to construct an impact station at any (unknown) location on the trunk system. Traditional designs would not suit the objectives.

The issues identified in that review included:

- Minimised Scope
    - Breaking the belt or conveyor structure to affect the install is not attractive as it inevitably adds to the construction or recovery time.
- Portability
    - Accessibility to all points and both sides of the trunk system may be problematic so components should be ideally suited to allow safe man handling.
- Space
    - The specified clearance envelope for the panel transfer meant that the design must use minimum clearances

DESIGN RESULTS

The review process and subsequent detailed engineering phase led to several innovations in design for the various elements of the equipment. A summary of those features are:

Pre-assembly

The entire drive (Figure 1), jib module for the Trunk system is preassembled prior to underground installation. The chute work and belt cleaner sets are also pre-fitted. The jib assembly has a pinned and hinged design that allows the completed unit to fold into a low height, collapsed position for transport.

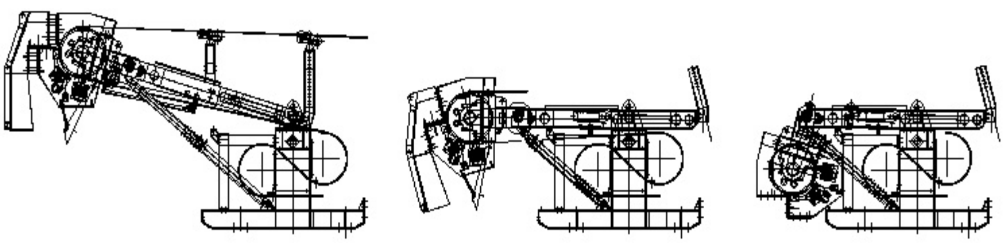

Figure 1 - The drive assembly incorporates fork tyne pockets in the base frame so that the unit can be easily carried into position underground before the unit is deployed.

Electrical

All electrical field devices are pre-fitted, cabled up and terminated to a common junction box. Prior to delivery or installation underground the entire assembly is wired and tested then broken down for transport. Wiring up underground requires only for the signal cable to be run and terminated to the J box.

Minimised Scope

If space or time limits require, the Trunk conveyor loop take up can be installed with a reduced number of modules. The winch is mounted at the inbye end of the assembly but on a carriage that can be detached and travel along the modules. Once further storage modules are required, they can be fitted to the inbye end of the loop and the winch slid back to the new inbye end. This feature allows the loop to be extended at any time without breaking the belt or re-roping the winch.

Panel System

The Panel conveyor system uses completely interchangeable mechanical and electrical components to the trunk system including drive module, pulleys, winch parts etc (Figure 2). The head pulley of the Panel is one of the loop pulleys of the Trunk system, where-as the head pulley on the Trunk is interchangeable with the larger drive pulley. There are only two pulleys designs used in entire system :

1. High tension bend / drive pulley (Live shaft)
2. Low tension bend / loop / tail / panel head pulley (dead shaft)

For compactness and portability the shaft mounted drive assembly of the trunk system including standard base plate, coupling and motor is mounted inboard in the Panel drive. A low speed chain drive is used to couple the gearbox to the drive pulley.

The Drive module incorporates a sliding, retractable jib frame and hinged impact plate / chute. The jib geometry is designed specifically to meet the very low head height specified in the design criteria.

The entire assembly is divided into separate, self contained modules that spigot together during installation.

Each section is mounted on wheels with integrated tow eyes at the inbye end of each section. Typically a panel installation will comprise a drive / discharge module and two loop modules. The winch incorporates the relocate able feature of the Trunk system so the loop can be extended at any time.

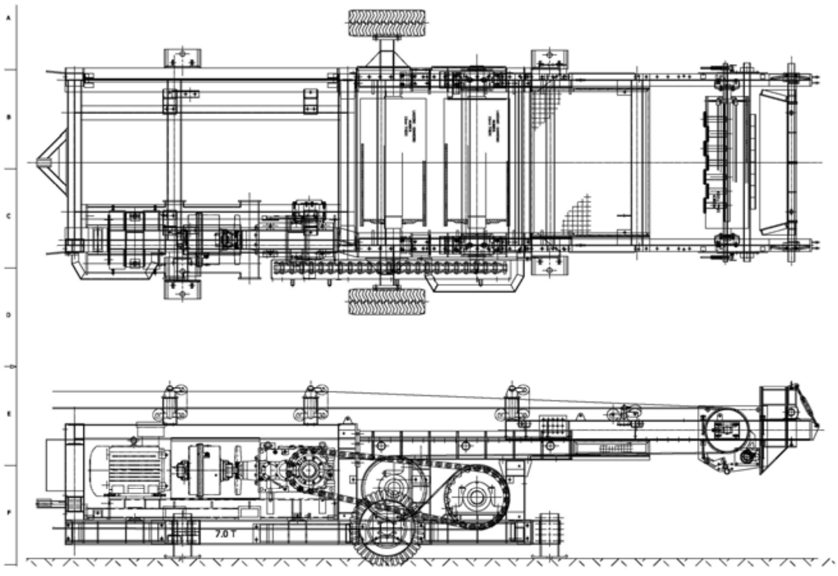

Figure 2 - The conveyor drive panel assembly

Panel Load Station

The load station developed so that a panel conveyor can load to any point on the trunk system is based on adding elements to the standard floor mounted conveyor structure to provide sufficient strength, the required impact idler spacing and the skirt and guarding requirements. The parts are all generally less than 25 kg each so can be managed by hand.

RESULTS IN THE FIELD

The results in practice have justified the effort put into specifying the stringent criteria and undertaking the reviews.

Installation times have bettered the targets and operating performance has been excellent.

To date three Trunk systems have been installed and two Panel systems.

Key achievements to date include:

- The most recent Trunk 3 was installed and running in a total of three shifts including boot end and 120 metres of structure
- The most recent Panel 2 was installed and running in two shifts including boot, structure and belt.
- Idler life has exceeded expectations with zero bearing failures in the rollers since start of operations in September 2006. This result considered partly due to the modest belt speeds that were specified along with good seal design and accurate roller manufacturing tolerances.

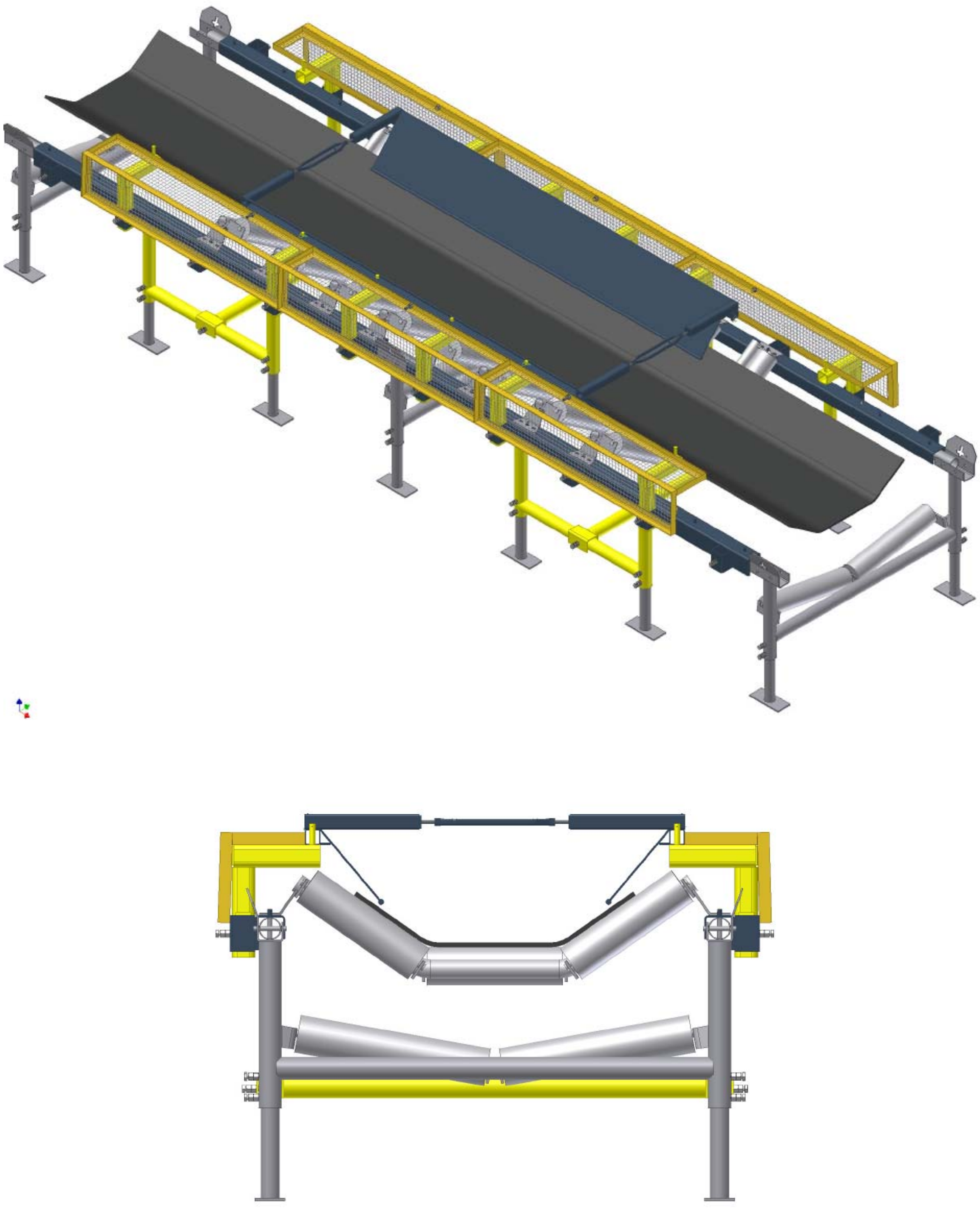

Figure 3 - Conveyor loadstation system

Field experience has lead to some refinements in original designs:

- A "spoon " half has been introduced in the trunk to trunk transfers to improve material delivery and control
- The impact half of the trunk transfer chute has been modified to incorporate additional curvature and improve flow.
- Ground clearance on the Panel conveyor assembly has been improved after the experience with Panel 1.

CONCLUSIONS

The specification and design process adopted for the Tasman Mine conveyors has highlighted the often under rated opportunity to improve mine efficiency by reductions in installation and relocation times of development conveyor systems.

The process relies on a "ground up" review of both installation process and equipment design in order to tailor the results to the stated objectives. No element can be considered a fore gone conclusion as it is too easy to adopt the usual in the false expectation that longevity of practice is equivalent to ideal.

A collaborative approach to equipment design has significant benefits by allowing shared technical and operations knowledge to be applied to assessment and design evolution.