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# Application of Artificial Intelligence in the Powertrain of Off-Highway Mining Automobiles

**Mr A. Ghosh[1] and Mr. S. Dey[2]**

*[1]Workshop Manager, Normet India (P) Ltd., Rampura Agucha Mines, Rajasthan.*
*[2]Engineer, Normet India (P) Ltd., Vishakhapatnam, A.P.*
*E-mail: [1]abhijit_8338@yahoo.com, [2]shamikdey23@gmail.com*

**Abstract—***The mining sector offers a distinct uncouth challenge to the things associated by virtue of its nature. Due to cragged and complex acute angular slope gradient, both in open cast and underground mines in India, the mining equipment face various criticalities in regular basis. The powertrain system of the equipment has been observed being affected the most, especially the affecting the driveline retarder unit along with the overall braking efficiency of the equipment. To increase the equipment part life in order to achieve maximum work efficiency, an artificial intelligence approach has been developed in the powertrain system of the off-highway mining trucks, in this work.*

## 1. INTRODUCTION

Consider the problem of the frequent failure issues of an off-highway mining truck, whose prime mover consists of an Engine transferring power to the final drives (driving wheels or continuous tracks) through transmission, driveshaft & differential. Considering the present scenario of the mining equipment, we are also considering that an electromagnetic retarder unit, which actually acts as an auxiliary braking unit by generating a comparatively powerful electric current that acts as a retarding force, is fitted to the rear drive line and activated through a manual control lever mounted in the dashboard of the operator' cabin. Considering two separate cases of equipment movement, either in horizontal ground or in a down gradient of ≥10° for more than two consecutive wheel rotation, the proposed model will either automatically activate or deactivate the retarder unit, through a series of sensors, control relays and programmed control module, thereby avoiding or engaging necessary braking, increasing part life of the powertrain unit and increased safety & reliability of the equipment. The ladder logic approach is considered in the cases of relay circuit design & electrical networking of the automobile system.

## 2. GOVERNING LOGIC

The equipment while being operated at a down gradient of -13° in a mining situation for more than two consecutive rear wheel rotation and the operator if ignores to turn on the retarder unit, the direct load will be plonked into the braking system of the equipment initially (the service brakes in this case) thereby generating a desynchronized load into powertrain system. The same condition must be observed in the cases where the equipment is travelling on a horizontal ground or up gradient of +13° and the operator of the equipment ignores to turn off the retarder unit. The proposed model will automatically enable or disable the retarder unit of the equipment through a series connected circuit of sensors & control relays with the main electric control circuit.

The circuit diagram should be designed with the help of tilt sensor/s (in the form of an inclinometer), hall effect sensor/s (in the form of magnetic field magnitude measurement sensor) and a control module (in the form of an microcontroller) programmed logically and looped electrically as such that when the equipment is being operated at a down gradient of -13° in a mining situation for more than two consecutive rear wheel rotation and the operator if ignores to turn on the retarder unit, the tilt sensor will be activated which will, in loop, turn on the hall effect sensor and jointly these two sensors will activate the retarder guided by the sensor module to the main activation switch of retarder looped along with. Similarly, in the cases where the equipment is travelling on a horizontal ground or up gradient of +13° and the operator of the equipment ignores to turn off the retarder unit, the tilt sensor will be deactivated which will, in loop, turn off the hall effect sensor and jointly these two sensors will deactivate the retarder guided by the sensor module to the main activation switch of retarder looped along with.

## 3. EFFECTS ON PROCESS PARAMETERS

The speculative effects of various parameters such as acceleration, braking efficiency, Engine in the powertrain of the automobile mining equipment are described below. The effect of distinguished parameters such as heat, power loss etc. are considered by fixing some parameters constants.

## 4. ENGINE

Unsynchronized Engine RPM and wheel movement, guided by unnecessary braking application, induces high undesired load on the Engine and reduces product life, in any

automobile. With the present approach Engine RPM and wheel movement can be concurred with perfect balance of load, thereby contributing to extended system life, reliability and safety.

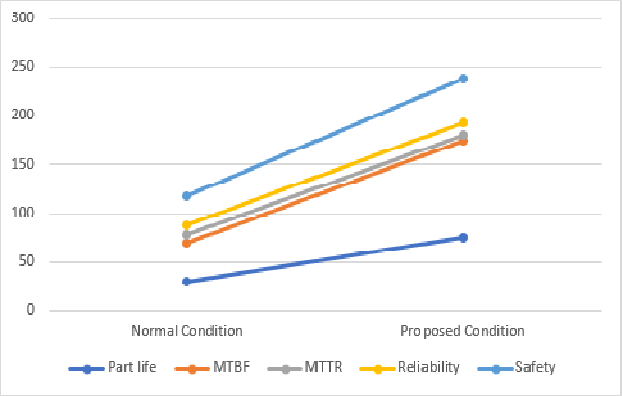
## 5. ACCELERATION

The acceleration and de-acceleration processes and their synchronization in between can be governed and operated with utmost efficiency in this regard which will in turn reduce unsynchronized loads to the powertrain.

## 6. BRAKING EFFICIENCY

The braking efficiency will increase comparatively in this regard thereby increasing individual part life, increased safety and reliability of the equipment.

The graph below depicts the speculative changes in MTBF, MTTR, Equipment reliability, Equipment safety and consolidated part life.

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