A Proposed TQM Approach to Powered Support Specification, Design, 
Commissioning and Utilisation

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Abstract: The use of the powered support system at maximum efficiency is the key to a 
safe and successful longwall. Modern, complex powered supports isolate the operator from 
the surrounding rock, and the manner in which the support controls the roof, and what is 
demanded of the support, may not always be obvious. A Total Quality Management (TQM) 
approach is proposed, facilitating the co-ordination of the many skills which must come 
together to enable the powered supports to be properly specified and used.

Key words: Powered supports, longwall, TQM

Introduction
The success of a longwall operation depends largely on the performance of the powered 
support system. The matching of the powered support system to the operational conditions 
and the subsequent application of the system involves a multi-disciplinary team in the 
following steps:-

Step 1:- Specification, involving the Manufacturer’s Mining Engineer and Rock 
Mechanics Specialist

The life of the powered support installation begins with a geotechnicians’ 
appraisal of the seam to be worked. Using a combination of fundamental 
knowledge, conceptual models and local experience - if available as the 
longwall continues to invade green field sites - the support density and 
configuration is optimised in a site-specific manner.

Step 2:- Design and Manufacture, involving Mechanical and Electronics/Software 
Engineers

Having determined the optimum specification for the support system, the 
mechanical design team turns the specification into reality. Steps 1 and 2 
are not undertaken in isolation, as the specialists involved interact to achieve 
an affordable solution to the clients needs.
Step 3:- Commissioning, involving Mechanical, Mining and Electronics/Software Engineers.

Following manufacture, the support system is commissioned. It is during this phase that the mine’s engineers begin to get involved in earnest.

Step 4:- Utilisation, involving Mine personnel - Mining, Mechanical and Electrical Engineers - supported where appropriate by the Manufacturer’s staff.

Here the mine personnel frequently need to acquire longwall mining skills for the first time, or indeed learn to use the updated support technology that he has bought.

The principles of rock mechanics, support design and the operation and maintenance of a complex electro-hydraulic system are involved in each of these steps to varying degrees as shown in Table 1. Sharing of these principles forms the basis of a TQM network as described below.

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<th>Roof Control Concepts</th>
<th>Support Design Principles</th>
<th>Hydraulic and Electronic Operational Principles</th>
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<td>1. Specification</td>
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Table 1. Relative Importance of Principles Involved in the Specification, Design and Utilisation of Powered Supports (XXXXXX very important)

2. Proposals
All involved in the use of the powered support system will understand the functions of the support system, the manner in which these functions influence safety and productivity, and
the effect that their actions have on the manner in which the support system performs its function - hence a TQM network will be created.

The people involved in the TQM network are:

- Operators of the Supports and the Shearer
- Maintenance staff
- Mine Management
- Mine Geotechnical Engineer
- Manufacturer's personnel

The network will share a site-specific appreciation of the strata control function of the powered support, that strata control function will be explained with diagrams and where appropriate, numerical data – thus a conceptual model will be created, with different types of description appropriate to the responsibilities of the network member. Furthermore, network members will be encouraged to improve the conceptual model as operational experience is developed. The conceptual model will allow for the range in operating conditions anticipated at the site.

A multi-media package and hands-on training should be used to convey the strata control principles involved, producing the networking/controls required between the various engineers involved at appropriate levels of complexity. Thus, while there will be common threads running through the package, the information presented will be pitched at a 'fit for purpose' level. For example, conceptual models of strata deformation around the longwall - the deformation that the support must control - will be explained in detail for the mining engineers, and backed up with fundamental rock mechanics, while the same conceptual model will be presented in diagrammatic from only for the longwall operators.

Network members will also understand how the performance monitoring system installed on the support system will be used to provide diagnostics for support utilisation, including optimisation of performance and maintenance. To this end, it is suggested that the Predict - Detect - Control approach can be routinely applied to maximise the efficiency of the supports in controlling roof strata.

Predict-Detect-Control
This approach is presented using the occurrence of periodic weightings as an example of a roof control problem which must be managed. As is frequently the case with rock mechanical phenomena, further data may be required to confirm the cause of the weightings at a new longwall site, enabling the measures which must be taken to eliminate, or minimise their effect on production to be developed. While that work is on-going, the mine must continue to be as productive as possible with the existing equipment. Accordingly the following action plan is proposed, based on a PREDICT-DETECT-CONTROL approach which can be applied immediately, followed by a list of proposals which will help to develop a fuller understanding of the occurrence and control of the problem.
STEP 1 - PREDICTION of approaching weighting

- Produce a working explanation for the weightings - they may for example be caused by widely-spaced and substantial joints sub parallel to the face, or the caving characteristics of a thick sandstone stratum in the roof.

- Using this working explanation, predict the frequency and therefore the timing of events

STEP 2 - DETECTION of approaching weighting

- Fit leg closure instrumentation to the supports, with two transducers per instrumented support, monitoring front and back leg closure so that roof convergence and rotation can be detected.

- Analysis of these measurements along with leg pressure transducers should lead to the establishment of guidelines as to when a weighting is developing - this can be achieved with the assistance of appropriate software which substantially automates this process.

STEP 3 - CONTROL of approaching weighting

As a weighting approaches:

- Ensure that the support installation is working at full specification as the weighting develops.

- Ensure that the face-to-canopy tip distance is minimised during the weighting.

- Keep cutting until the weighting and the damaged roof associated with it has been left behind.

The network will encourage communication between all members, creating a data base of support performance information and observations, augmenting the data collected routinely by the support monitoring system, and leading to the natural development of "best practice" for the site. While the Predict-Detect-Control approach has been explained with reference to the control of weightings, a similar approach can be taken to support health management, horizon control etc. Importantly, the support users and owners are being provided with the information necessary to use the support system to maximum efficiency, akin to the visual
signs of the roof deterioration and the sounds of yielding supports available on faces supported with props and bars.

**Action Required to Develop and Implement the TQM System**

The following action is required:-

- The mine’s co-operation in setting up the network must be obtained
- The principles involved need to be brought together and the inter-relationships between network members defined, creating a TQM manual for support system operation
- A site-specific strata control conceptual model must be created, and appropriate explanations developed, along with the assessment of likely threats and explanations of the importance of network members individual inputs
- Having established the basis for the network, the TQM network must be created through an induction/training session for all members, covering:-
  - The site-specific conceptual strata control model of roof deformation
  - the roof control function of the powered supports, and their operation
  - other powered support functions
  - the mechanics and electrics of supports, and their influence on support functions
  - powered support monitoring
  - the feedback/communication mechanisms within the TQM network for the mine

**Conclusions**

It is suggested that the benefits to the mine accruing from the TQM approach will be:-

- continually improving understanding of the roof control challenges and their solutions
- a mode of operation which is highly responsive to changes in conditions
- the encouragement of teamwork
- consistently high standards of safety and productivity
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