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High Risk Management in Two Long Wall Operations

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HIGH RISK MANAGEMENT IN TWO LONG WALL OPERATIONS

Roger Kahler [1] and Mark Slater [1]

ABSTRACT: Within the mining industry, there is recorded data which describes damage to people. The damage can be classified in a hierarchy ranging from incidents which produce multiple fatalities, single fatalities, non-fatal permanent disabilities, temporary damage and inconvenience. There is also a body of unreported collective knowledge in the workforce associated with the tasks which do not produce damage, which are not perceived as high risk; are seldom, if ever, reported and are consistent with that which produce non-fatal permanent damage. The key to successful high risk management is the collection of this unreported knowledge.

The vast majority of personal damage (measured in dollars, suffering, and impairment) is associated with non-fatal permanent disability. It is multiple fatalities and single fatalities which bring about the greatest level of change through the attention which is drawn to such events but these are not the categories which produce the majority of damage. Organisations must predict the potential for permanent non-fatal damage within their operation.

The mining industry's pattern of non-fatal permanent disability has been accurately described. This generalised pattern provides the basis of implementing systematic high risk identification using appropriate focusing questions and focused groups comprised of underground miners. The process is known as Focused Recall. It is a systematic collection of the experience and knowledge of the workforce against the pattern of non-fatal permanent disability. It couples appropriate experience with external expertise. The process has been applied to Oaky Creek Coal and Oaky Creek North and, in particular, their longwall operations, the development crews and support groups. The pattern of collected data parallels the known industry pattern of non-fatal permanent disabilities. The process harvests the collective experience and knowledge which has seldom, if ever, been reported into the organisation's data base. The information correlates strongly with the phenomena of non-fatal permanent disability.

The results of the use of this powerful productive process at Oaky Creek Coal and Oaky Creek North are presented

INTRODUCTION

Work related non-fatal permanent damage is by far the greatest cost to the community, the family and the individual. Regardless of whether the cost is measured in terms of dollars, pain, impairment (a medical judgement of the percentage loss of function) or emotional hardship, non-fatal permanent disability is the most significant category of personal damage. The future prediction and management of this level of personal damage should be of the highest priority. Very seldom is there a lack of physical and financial resources to achieve change once the issues have been identified.

The critical issues appear to be:-

1. A recognition of the size and nature of the personal damage problem;
2. Collating the future potential exposure for the particular mining operation into a manageable document.

An appropriate focus (the elimination of permanent personal damage) with an appropriate predictive strategy is the key to progress.

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THE SIZE AND NATURE OF THE PROBLEM

Personal damage can becaused by those aspects of work which produce:

- Multiple fatalities;
- Single fatalities;
- Non-fatal permanent damage;
- Temporary damage;
- Minor damage;
- Reported near-misses.

The majority of experience at sites is with the latter three categories. It is necessary to establish what is the relative size (numbers of people) and cost of the different categories. Probably the most definitive work is that documented by the Commonwealth Department of Training's Industry Commission Report into Workplace Health and Safety (1995). They categorised damage as:

- Less than five days off work;
- Five days and more off work and return on to work full duty;
- Five days and more off work and return to work on reduced duties for a temporary period;
- Invalided out and return to work after a long period of absence on a permanently reduced income (permanent damage)
- Permanently incapacitated and does not return to work
- Fatality

Table 1 shows the number of cases and cost of damage for Australia 1992-1993.

Table 1 Number of Cases & Cost of Damage

NUMBER OF CASES & COST OF DAMAGE
(Australia 1992 – 93)

	<5 days	>5 days, full duties	>5 days, reduced duties	>5 days, lower duties	Permanently Incapacitated	Fatal
No. of occurrences	144,053	123,395	78,333	30,728	19,290	693
% of occurrences	36.33	31.12	19.75	7.74	4.86	0.17
	87.23%			12.77%		
Cost of occurrences ($Billions) total 20	0.136	1.063	2.415	4.555	11.684	0.299
% of cost	0.67	5.28	11.99	22.62	57.93	1.48

Basically the table can be summarised as follows:

(a) From a total of 396 492 occurrences:

- 50 711 occurrences are permanent, and
- 345 800 occurrences are temporary damage.

(b) Of the 50 711 permanent damage incidents:

- 693 were fatal
- 19 290 were non-fatal – no return to work and
- 30 728 were non-fatal – reduced income work.

(c) The total cost derived from direct and indirect costs is $20 billion and is allocated to:

- permanent – fatal $0.3 billion
- permanent – non-fatal $16.4 billion, and
- temporary - $3.6 billion.

This data is based upon 1992-1993 figures. There is no equivalent dataset produced by any authority in Australia since that time which gives such a clear distinction between the different categories of personal damage. Essentially the Pareto Principle applies: 80% of the damage is associated with 12% of the incidents.

To determine whether there has been any significant change in the size and nature of the problem, reference is made to WorkCover New South Wales Statistical Bulletin 1999-2000 (2001). This organization usefully categorises damage as fatal, permanent disability, temporary disability - greater than six months and temporary disability - less than six months. It is useful to understand that a person who has been off work for more than six months has a one in four chance of returning to work, and a person who has been off work for more than twelve months would have a one in two chance of returning to work. These ratios are now applied to published incident data to gain insight into the current size of the permanent damage problem.

New South Wales datasets define non-workplace injuries as being caused by accidents "*occurring away from the workplace but where the worker is considered to be on duty eg road traffic accidents"*. Workplace injury refers to an accident "*which occurs at the workplace either during work or during a work break*". The results for the year 1999-2000 can be summarised as follows in Table 2:

Table 2 Number of Permanent Disability & Six Months and Over Cases for NSW 1999-2000

	Permanent Disability	**Six Months & Over**
Workplace injuries/permanent disability	8 818	3 951
Non-workplace injuries	995	550
Total Numbers	9 813	3 951

With respect to Table 2, assuming a one in four people for return to work for the "six months and over cases", then 10 800 would be categorised as permanent damage cases within New South Wales in one year. If we assume New South Wales represents one quarter to one fifth of the Australian injury problem (a reasonable proposition) then the number of Australian work related permanent damage cases (excluding disease) would still be at least in the order of 50 000 cases. The previous discussion did not include the approximate 5 500 people categorised as permanently damaged from occupational disease. The majority of these cases are associated with noise (80%). The key learning is that there can still be no successful argument to say the size of the permanent damage problem has decreased. There is, in part, an argument to the contrary i.e. the size of the permanent damage problem has increased.

The previous information applied to all industries. It remains to answer "what is the coal industry situation?" The Queensland Mines and Quarries Safety Performance and Health report 1st July 2000- 30th June 2001 produced by the Department of Natural Resources and Mines (2002) gives a total of eleven cases of permanent damage between 1999 – 2001 for Queensland open cut and underground coal mining operations. There were no reported permanent damage cases for Queensland open cut coal in the year 2000-2001. It is suggested that any honest assessment of the situation would indicate that the data collection systems are not capturing the information.

Examination of the National Occupational Health and Safety Commission's database (1997) for the years 1996-2000 reveals that there were 1 170 cases in the Australian coal mining industry where people experienced more than sixty days off work. Again it can only be a judgement, but assume that one third of those cases are non-fatal permanent damage. This would indicate that the coal mining industry for Australia has experienced approximately 100 people permanently damaged per annum as a consequence of work. Part of the problem, and part of the tragedy, is that non-fatal permanent disability cannot be accurately described.

In the coal mining industry of New South Wales in the period 1998-2000, there were recorded 28 cases of permanent disability and 117 cases of people experiencing six months or more off work. Again applying the 1:4 ratio to the people with more than six months off work there are 57 cases of permanent disability recorded in New

South Wales compared with the recording of 11 cases in Queensland for a similar two year period. It would be nonsense to suggest that Queensland is five times "safer". The open cut and underground mining populations are similar with Queensland having 8 500 employees and New South Wales 9 606 (Minerals Council of Australia: 2002). New South Wales has a higher percentage of underground employees.

Why does this situation of such low recorded numbers occur? It is that people filter out of the system because non-fatal permanent damage is, in the main, not a traumatic injury; that is, does not involve amputation or disfigurement? If one were to examine 1 000 people who were classified as non-fatal permanent damage the Pareto Principle would apply, i.e. more than 80% of those people would have soft tissue damage to their body structures such as ligament, vertebral disc and tendons. Those people would appear "normal" until the body was asked to do work.

THE LIKELIHOOD OF PERMANENT DAMAGE

Risk can be defined as the product of a particular consequence against the likelihood of that particular consequence. One way of expressing likelihood is in terms of the number of employee years required to produce one case of the particular consequence, essentially an "incident rate". Based on an Australian working population of approximately 8 million, and 50 0000 cases of non-fatal permanent damage, the Industry Commission Report would suggest that the likelihood of non-fatal permanent damage is one per 160 employee years.

For the coal industry, the Minerals Council Safety and Health Performance Report (2002) indicates that the total number of people employed in the Australian coal industry is 20 230. If one accepts the previous statement that there are 100 cases of permanent damage generated per annum then the likelihood of non-fatal permanent damage is one per 200 person years worked the likelihood of fatality within the coal industry 1998-2001 was approximately one per 4600 employee years worked.

How does the likelihood of non-fatal permanent damage for the coal industry compare with New South Wales industry generally? Table 3 shows the likelihood of non-fatal permanent damage, assuming that one in four of those people who are off work for more than six months become classified as permanently damaged.

Table 3 Likelihood of Non-Fatal Permanent Disability – NSW – All Industries

1991-1992	1:578
1992-1993	1:510
1993-1994	1:361
1994-1995	1:273
1995-1996	1:288
1996-1997	1:262
1997-1998	1:262
1998-1999	1:262
1999-2000	1:255

The interesting observation from this table is that the likelihood is increasing over time with respect to non-fatal permanent damage. The coal industry would not appear to perform any better than industry as a whole. It is suggested that the previous likelihood of non-fatal permanent disability for the coal industry is significantly under-stated. It is possible for a coal mining operation to gather experienced and long-standing employees and make a list of the number of employees (who either still work with the organization or are separated from the organization) carry work-related permanent impairment and complete the calculation set out in Figure 1:

FOR YOUR SITE

Average number of Employees over last 5 years =
Number of permanent disability injuries over last 5 years =
Likelihood of permanent disability in any one year = $\frac{\text{Number of Cases}}{\text{Number of employee years}}$

FIG. 1 - Likelihood of Permanent Damage

The previous discussion is intended to create sensitivity to the need to identify and predict the future potential non-fatal permanent damage within an organization. Industry has an appropriate but excessive emphasis on catastrophic failure to the detriment of people who are permanently damaged.

WHAT DO WE KNOW ABOUT THE PATTERN OF NON-FATAL PERMANENT DAMAGE?

Damage to people can be considered to be a consequence of an energy exchange. Energy is simply the capacity to do the work. Damage to people occurs when the energy exposures exceed the tolerable limits of the person. Energy can be loosely, but usefully, classified as shown in Table 4:

Table 4 Damaging Energy Classification

Human Energy	Physical muscular exertion of varying intensity and duration
Gravitational Energy	People and objects falling
Vehicular Energy	Single and multi-vehicle collisions Pedestrian strikes Vibration, jolting and jarring
Machine Energy	Fixed or portable machinery in operation
Object Energy	Person contacted by moving objects either constrained or unconstrained in their movement path e.g. projectiles
Electrical Energy	Contact with electricity
Thermal Energy	Extremes of temperature
Chemical Energy	Chemicals damage to the body through absorption, inhalation, ingestion or contact with skin/muscle tissue
Noise Energy	Exposure to a noise source of varying intensity and duration
Other Energy sources	E.g. animal, biological, radiation

An energy exchange can be considered to have a time/intensity relationship (dose) and has been grouped by McDonald & Associates into one of three classifications as listed below in Figure 2.

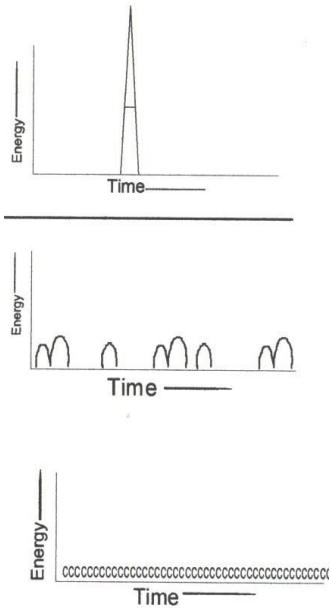


FIG. 2 - TimeVs Energy Graphs

Type A Damage
Single traumatic energy exchange.
Examples:

- *Electric Shock;*
- *Hit by fast moving object;*
- *Burnt by flames;*
- *Jolt/jar*

Type B Damage
A series of discreet energy exchanges, each not affecting the function or generating pain, but each exchange reducing the damage limit. The cumulative effect is damage.
Examples:

- *Lifting, pushing or pulling tasks leading to back damage.*

Type C Damage
Continuous exposure to small energy exchanges which produce cumulative damage.
Examples:
Continuous exposure to:

- *Repetitive movements leading to repetitive strain injuries (occupational overuse syndrome);*
- *Noise;*
- *Prolonged postural displacement;*
- *Chemicals, or*
- *Ride vibration leading to back damage.*

Analysis of datasets within Australia reveals very consistent patterns with respect to non-fatal permanent damage. Human, gravitational and vehicular energy are those few energy sources that contribute 80% of permanent disability.

Table 5 Classification of Accidents in the Coal Mining Industry – New South Wales & Queensland

DAMAGING ENERGY	NUMBER OF PEOPLE
Human Energy	491
Gravitational Energy	398
Machine Energy	254
Object Energy	36
Thermal Energy	16
Chemical Energy	12
Susceptible Part	7
Anxiety/Stress Disorder	7
Oxygen Deprivation	1
Heart Attack	1
Biological Energy	1
Specialised Shape	2
Insufficient Information	5
TOTAL	1231

Table 5 is a summary classification of 1 231 cases of permanent non-fatal damage for the New South Wales and Queensland coal mining industries between 1990 and 1995 (892 underground cases; 339 open cut cases). The sponsors for this work were the New South Wales Minerals Council and the Queensland Mining Council. It remains one of the most definitive works with respect to non-fatal permanent disability for the coal mining industry. Table 6 shows the very high involvement of "human", "gravitational" and "vehicular" energy for the underground coal mines of Queensland and New South Wales. For the period 1990-1995, there were 892 cases of permanent damage. The underground classifications are summarised in Tables 7 to 9:

Table 6 Underground Classification – Permanent Cases 1990-1995

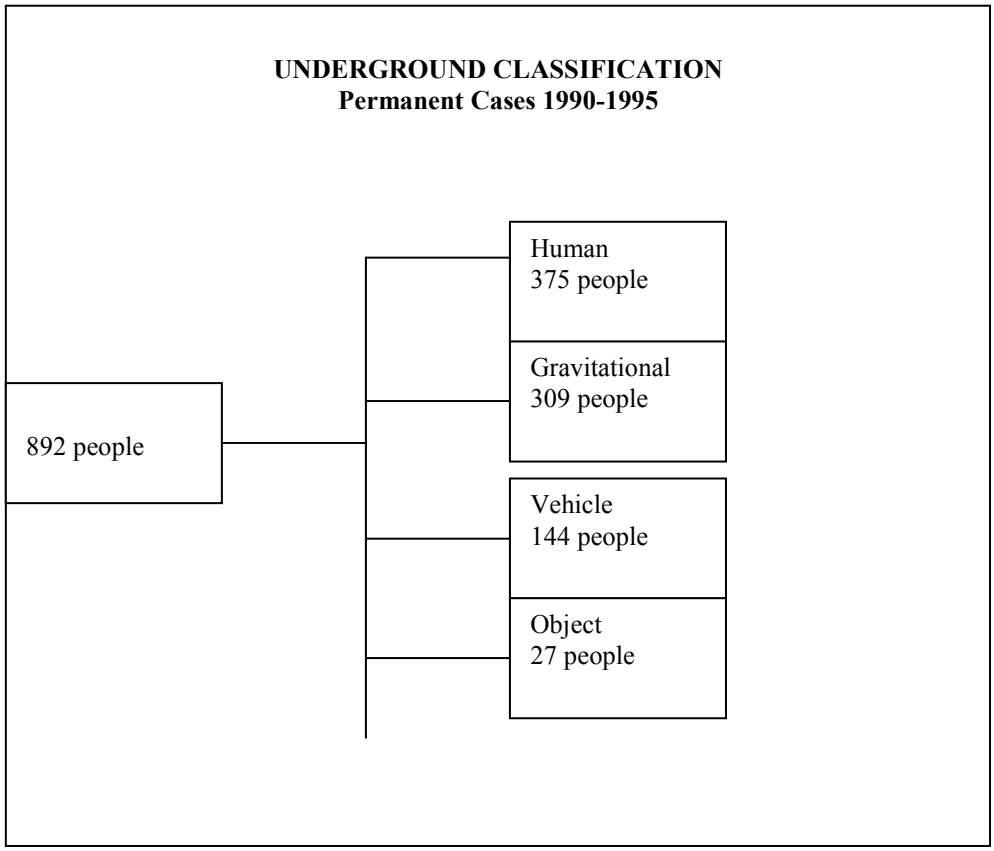


Table 7 Gravitational Energy

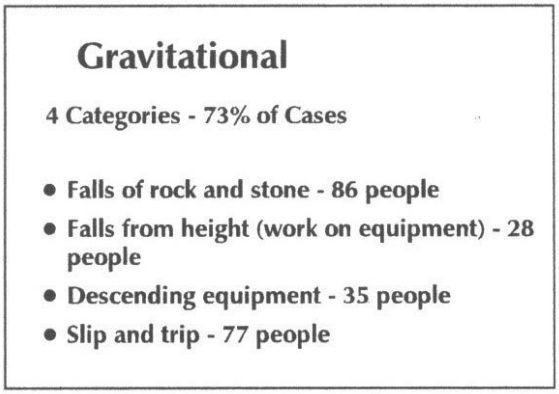


Table 8 Human Energy

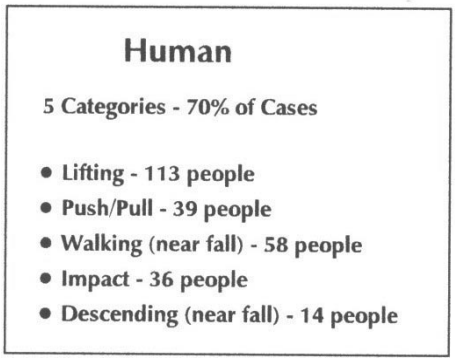
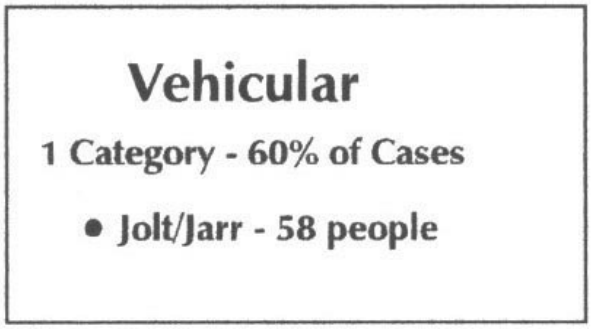


Table 9 Vehicular Energy



In these tables, permanent damage is categorised as 90 days or more of work lost. The power of this study is that it brings emphasis; it allows for appropriate focus because of the better describers present in the pattern analysis. The previous tables can be compared to statistics on workplace injuries in the Coal Mining Industry New South Wales for 1998-2000 as shown in Table 10.

Table 10 Mechanism of Injury for Permanent Disability & "Six Months Plus" cases in Coal Mining Industry – New South Wales 1998-2000

	Workplace Industry anzsic	
	110: Coal Mining	
Mechanism of Injury Disease	**Permanent Disability**	**6 Months and Over**
Falls from a height	7	-
Falls on the same level	29	-
Hitting stationary objects	7	-
Hitting moving objects	-	-
Rubbing and chafing	-	-
Being hit by falling objects	4	1
Being trapped by moving machinery	2	-
Being trapped between stationary and moving objects	4	-
Exposure to mechanical vibration	17	9
Being hit by moving object	5	4
Muscular stress while lifting, carrying or putting down objects	20	-
Muscular stress while handling objects other than lifting, carrying or putting down	4	4
Muscular stress with no objects being handled	2	2
Contact with hot objects	-	-
Slide or cave in	10	6
Vehicle accident	6	4
Unspecified mechanism of injury	2	-
TOTAL	119	30

There is no strong focus on jolting and jarring; the damaging phenomena is possibly camouflaged in "exposure to mechanical vibration". There is no strong focus on issues associated with descending equipment. There is an industry sensitivity to falls of rock and stone which could be either represented in either the "slide or cave in" or "being hit by falling object" classifications of the Table 10.

If non-fatal permanent disability and the understanding of the mechanism of damage is the "signal" to be received and everything else is "noise", then the type of information presented in the previous Table 10 decreases the "signal" to "noise" ratio and does not allow for an appropriate level of discernment.

The problem is even compounded when sites review their own databases which are sure to incorporate less than five days of lost time. In Queensland in 1996 there was a change in our legislation and the employer paid for the first five days. The number of claims reduced from approximately 46 000 to 26 000 (not including travel claims) however, the review of datasets that contain lesser injuries e.g. less than five days, allow for less discernment. Table 11 is a summary of the Queensland injury database, excluding disease, less than five days for the year 1995-1996. This is the last year in which such data is available. "Eyes" and "heads" are 42% of all injuries yet seldom appear in the non-fatal permanent disability studies.

Table 11 Queensland Injury Database Summary of All Industries

Body Location	Percentage of Claims Less Than Five Days
Eyes	13%
Head	3%
Neck	4%
Trunk	22%
Hand	29%
Upper Limb & Shoulders	9%
Other	18%

Examination of the data for lower level injuries indicate that the "signal" to "noise" ratio is such that an appropriate focus is lost. Site incident data is likely to contain those incidents which distract from a recognition of the pattern of non fatal permanent damage and its implications for management risk.

HOW TO OBTAIN THE NECESSARY EMPHASIS

The incident triangle has been a descriptive statistic used in safety literature and safety training for many years. It is illustrated in Figure 3.

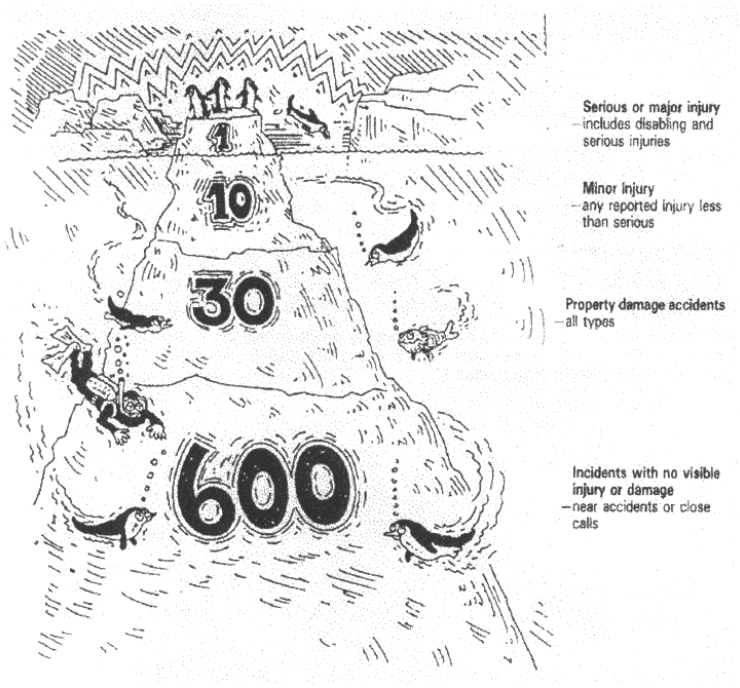


FIG.3- Incident Triangle

This triangle has been made into an inferential statistic such that characteristics at the top of the triangle – that is, high level damage – are inferred from the lower levels. The reader should be aware that the pattern of multiple fatalities is different from the pattern of single fatalities; is different from the pattern of non-fatal permanent disabilities and is different from the pattern of temporary and minor damage. For example, within the coal mining industry "fires, flooding and explosion" are most highly represented in multiple fatalities, whereas single "at work" fatalities involve "gravitational energy - falls of objects" and "vehicular energy" –vehicle to pedestrian

strikes. When one examines some of the previous data given for less than five days off work, the high involvement of eyes and hands become apparent. However, in the realm of non-fatal permanent disability it is very seldom that eyes and hands are involved. It is predominantly the torso.

There is a mythology that site incident databases of reported near misses yield the necessary insight; however this is contrary to the author's experience. The near miss reports (by potential damaging energy) for an open cut metalliferous mine during 2002, are illustrated in Table 12. This table shows the sensitivity to those energies associated with fatality, i.e. vehicles and gravitational energy (falls from height) but does not show sensitivity to the most common sources of non-fatal disability, that is, human energy, vehicular energy - jolting and jarring, gravitational energy - falls to the same level, loss of grip at heel strike and falls while descending equipment (fixed and mobile).

Table 12 Near Miss Reports by Potential Damaging Energy – Open Cut Metalliferous - 2002

Vehicle	Vehicle/Environment	----------	8
15	Vehicle/Animal	----------	8
	Vehicle/Vehicle	----------	3
Object	----------	----------	6
Gravitational	Fall from height	----------	5
10	Falling Object	----------	5
Electrical	----------	----------	3
Machin e	----------	----------	3
Chemical	----------	----------	2
Other pressure	----------	----------	2
Thermal	----------	----------	1
Susceptible part	----------	----------	1

If the proposition is accepted that vehicular energy, gravitational energy and human energy are highly represented in non-fatal permanent disability then one would expect such incidents involving "near misses" would be reported into an incident database. However when the ratio of personal damage incidents to all recorded incidents for the energy types which permanently damage people are examined, it can be observed that there is an apparent sensitisation to vehicle related incidents but a significant desensitisation to human and gravitational incidents. Table 13 illustrates.

Table 13 Ratio of Damaging Incident to All Incidents by Energy Type

	Personal Damage Incidents	**All Recorded Incidents**	**Ratio**
Mobile Equipment	54	366	1:7
Gravitational Energy (Fall of People, Fall of Objects)	106	235	1:2
Human Energy	366	389	1:1

When one further examines the reported incidents for vehicular energy in the above table they do not capture the "jolting and jarring" experience but capture those incidents associated with vehicle loss of control situations. Therefore, an organization can only be disappointed if they believe their site incident database will yield the necessary insights. There are papers which suggest the most comprehensive source of information is found in the experience and knowledge base of the people who complete the work. People do not associate and make the linkage between their experience and the likelihood of non-fatal permanent disability, for example, a miner being jolted and jarred in an underground transport vehicle is simply that – an uncomfortable experience which may create pain and bantering between the driver and passenger. A person completing a heavy lifting task and not experiencing pain is simply completing a "mongrel job". A person descending the boot end of an underground longwall and jumping 800 mm to the ground does not associate the situation with the potential for non-fatal permanent disability.

HARVESTING THE EXPERIENCE OF THE PEOPLE

Harvesting of information is achieved by interviewing individuals or small groups using a framework of focussed questions which cause a person to have a definite frame of reference in organising their thinking patterns during the interviewing process. For example, imagine the difference in the information that can be obtained if one were to ask the following questions:

Question: Where do you think you are most likely to be injured on this site?
Versus the following options:

1. Please describe to me, tasks which you complete that you would subjectively describe as heavy or very heavy lifting/pushing or pulling tasks?
2. Please describe to me where you work at a height where, if you were to overbalance or fall to accommodate some critical information at an appropriate time, you could fall 1 m or more and be seriously injured.
3. Please describe to me surfaces about your workplace where your foot has slipped forward rapidly as you were walking and/or working.

The difference in questioning is very simple, but profound in terms of the results it produces. It is possible to develop a set of focussing questions against those energy types known to damage people e.g. Human Energy, Gravitational Energy, Vehicular Energy, Electrical Energy, or Chemical Energy. There are a number of recorded techniques in the literature for harvesting the "store of" information within a workforce. That which has been recorded over the longest duration is a technique known as Critical Incident Recall (in excess of 90 years). Focussed Recall, and Perception Analysis are other techniques. The process involves the following three steps.

1. Problem identification of potentially permanent damage based on a workforce's experience set against a framework of focussing questions.
2. Prioritisation of problems followed by analysis using an appropriate model to generate solutions.
3. Implementation of solutions followed by an audit to determine effectiveness.

A significant factor in this predictive process is the correct combination of site knowledge combined with outside expertise. That expertise can either be employed into an organization or is transferable into the organization so that the organization itself combines expertise with site knowledge. Expertise should be inherently organised and communicable – experience is not. Therefore, the combination of expertise and experience has the potential to document the detail of experience against the generalised pattern of permanent personal damage.

One of the fundamental principles underlying the harvesting of experience is as follows:

PRINCIPLES:

- **10 PEOPLE EACH WITH 15 YEARS OF EXPERIENCE**
- **150 YEARS OF POSSIBLE EXPOSURE**
- **POSSIBLE LIKELIHOOD OF ONE PERMANENT DISABILITY CASE**

Harvesting the information contained in the store of knowledge of a workforce is a problem identification process. However, it is necessary to have appropriate goals when embarking upon such a process. A summary of appropriate goals could be as follows:

Goal 1 Direct 80% of safety effort towards the prediction and management of future potential permanent personal damage.

Goal 2 **M**aximise understanding of future potential non fatal permanent damage.
This requires that those who are allocated to problem solving be prepared to challenge their own experience base as well as the industry norms with respect to how tasks are completed.

Goal 3 Apply a multi-factorial model in understanding potential future damage as opposed to a single factorial model.
A single factorial model often uses 'cause/effect' terminology wherein an attempt is made to understand basic causes, root causes, and main causes. However the application of a model

where understanding and insight is obtained through asking non-value, non-judgmental, non-emotive questions such as:

1. What did people do and what did people not do that could be essential in the propagation of damage?
2. What features of equipment are present and what features of equipment are absent that could be essential in the propagation of damage?

It is to be noted that the terms "safe" and "unsafe" are not being used in the previous two questions. These are value judgment terms and could result in rejection of information before it is recorded. Judgements with respect to "safe" and "unsafe" are different between cultures, different between and within organizations and different between and within individuals.

Expectation plays an important role in the processing of information with respect to future potential damage and in particular with respect to the selection of appropriate solutions. A common expectation is that 88% of accidents are caused by human error, 10% by machine design and 2% by Acts of God, i.e. the 88:10:2 rule. Not only is this statement scientifically nonsensical, it is also theologically nonsensical. The only correct statement that can be made is that in actual and potential incidents, behaviour factors, design factors and environmental factors were either present of absent in 100% of cases. The correct ratio is 100:100:100. Therefore, when harvesting experience, expect to observe contributions for people, equipment and the working environment.

Unfortunately it would appear that in the 88:10:2 ratio or some variation of it is still in favour and will hinder progress. The Queensland Mines and Quarries Safety Performance and Health Report 1st July 2000 - 30th June 2001 (2002) under equipment causal factors for the year 2000 indicates that no equipment factors were involved in 60% of cases, no environmental factors were involved in 60% of cases, no human factor involved, implying that human factors were involved in 12% of cases. This statement is simply a variation on the 88:10:2 theme and unfortunately helps to promote the mythologies that hinder progress.

If a person were to approach a study of tasks that had the potential to create future permanent personal damage with the following four major areas of control as their dominant information organisers, their expectation would have a significant influence on their final recommendation.

Control Measure 1:	the person was not adequately trained;
Control Measure 2:	the person was not following procedures;
Control Measure 3:	the procedures were inadequate;
Control Measure 4:	the person was not wearing appropriate personal protective equipment.

These categories of control measures are commonly observed on Incident Report Forms. They create an expectation with respect to control measures when incidents are being analysed. When considering the major potential damaging energy source of Human Energy, it is common to find that statements are made with respect to the person not following correct procedures, not adequately trained, the training was not adequate. Having investigated many hundreds of Human Energy/simple lifting permanent damage cases, it is most frequently the case that well established scientific guidelines with respect to acceptable moments (load x distance) of lift are exceeded. The foregoing set of expectations with respect to training and procedures will not yield the necessary gains with respect to the management of Human, Gravitational and Vehicular Energies.

It is possible that the focus on people as a control measure at the point of task has plateaued in terms of its ability to influence future personal permanent damage and that a different and more effective hierarchy of controls has to be more widely applied.

PATTERN OF POTENTIAL DAMAGE ARISING FROM FOCUSSED INTERVIEWS – OAKY CREEK

The pattern shown in Figure 4 arises from the group interviews for the Oaky Creek No. 1 Development Crew. The crew were interviewed in sessions of one and a half to two hours per group of five to seven people. The numbers in Figure 4 simply reflect the individual items for correction. The numbers do not reflect the number of people who raised the issue. Table 14 and Table 15 are a summary of items identified for correction under "human energy", heavy lifting/overexertion for the long wall crew and development crews.

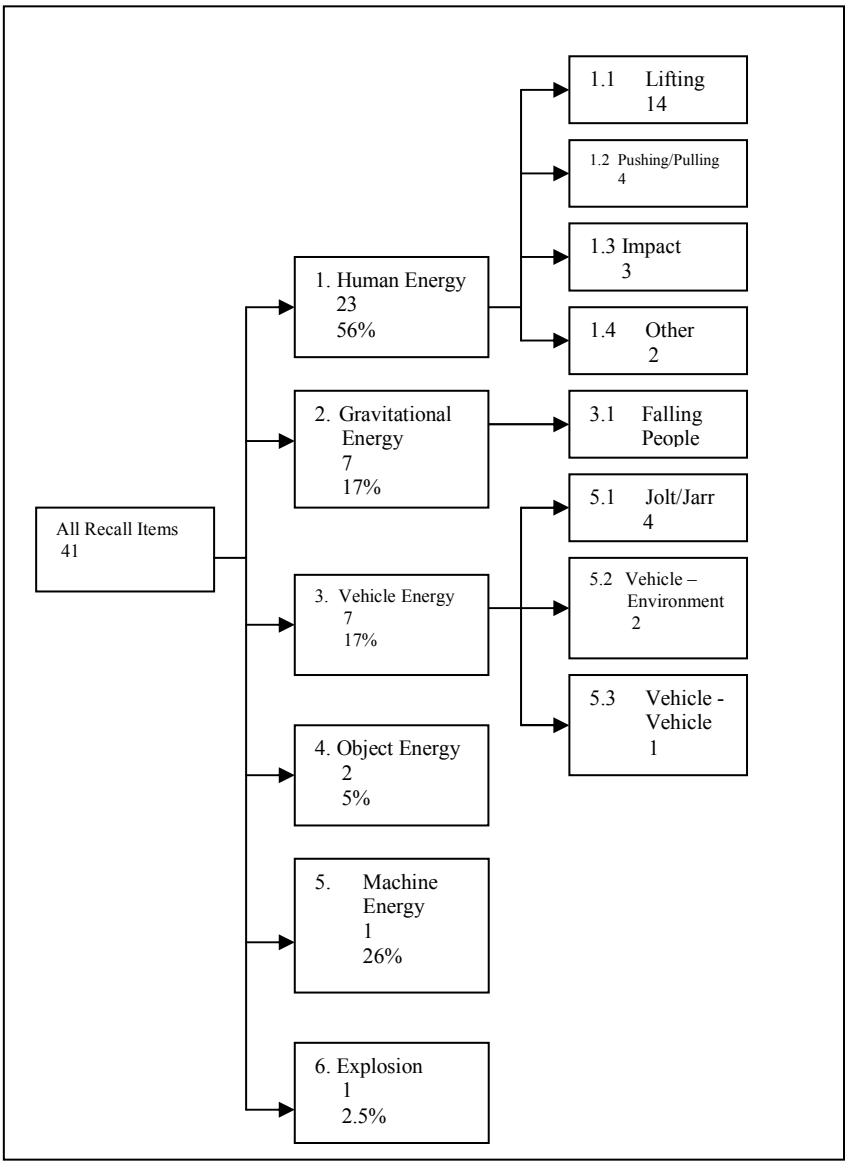


FIG. 4 - Oaky Creek Focussed Recall Taxonomy – Development Crew

Table 14 Items Identified For Correction by Longwall Crew – Human Energy – Heavy Lifting

Item 2.1.1	Lifting Components on to Longwall
Item 2.1.2	Removing Belt Structure
Item 2.1.3	Monorail Removal
Item 2.1.4	Removing Pipes in the Tailgate
Item 2.1.5	Lifting Heavy Coal/Stone
Item 2.1.6	3.3kV Cable – Monorail to Transformer & Transformer to Main Line
Item 2.1.7	High Tension Plugs
Item 2.1.8	Lifting Bretby Cable
Item 2.1.9	Belt Spindles
Item 2.1.10	Installing Dog Bones
Item 2.1.11	Lifting Flights

Table 15 Items Identified For Correction by Development Crew – Human Energy – Heavy Lifting

Item 10.1.1.1	Vent Tube Installation
Item 10.1.1.2	Vent Tubes into/out of Shuttle Cars
Item 10.1.1.3	Installation of Water/Air Pipes
Item 10.1.1.4	Supplying The Miner
Item 10.1.1.5	Moving/Extending Boot End Conveyor
Item 10.1.1.6	Hanging Miner Feeder Cable
Item 10.1.1.7	Installing Cable Bolts
Item 10.1.1.8	Carrying Drums of Oil
Item 10.1.1.9	Lifting DAC Cable Rolls
Item 10.1.1.10	Removal of Electrical Enclosure Barrier – JOY Continuous Miner
Item 10.1.1.11	Changing Shuttle Car/Loader Tyres
Item 10.1.1.12	High Tension Cable Plugs
Item 10.1.1.13	Lift Cylinder Change Out – Tail of Continuous Miner
Item 10.1.1.14	Removing Shuttle Car Tractor Motor

Figure 5 illustrates how the pattern of recalled experience correlates to the pattern of non fatal permanent damage for the industry.

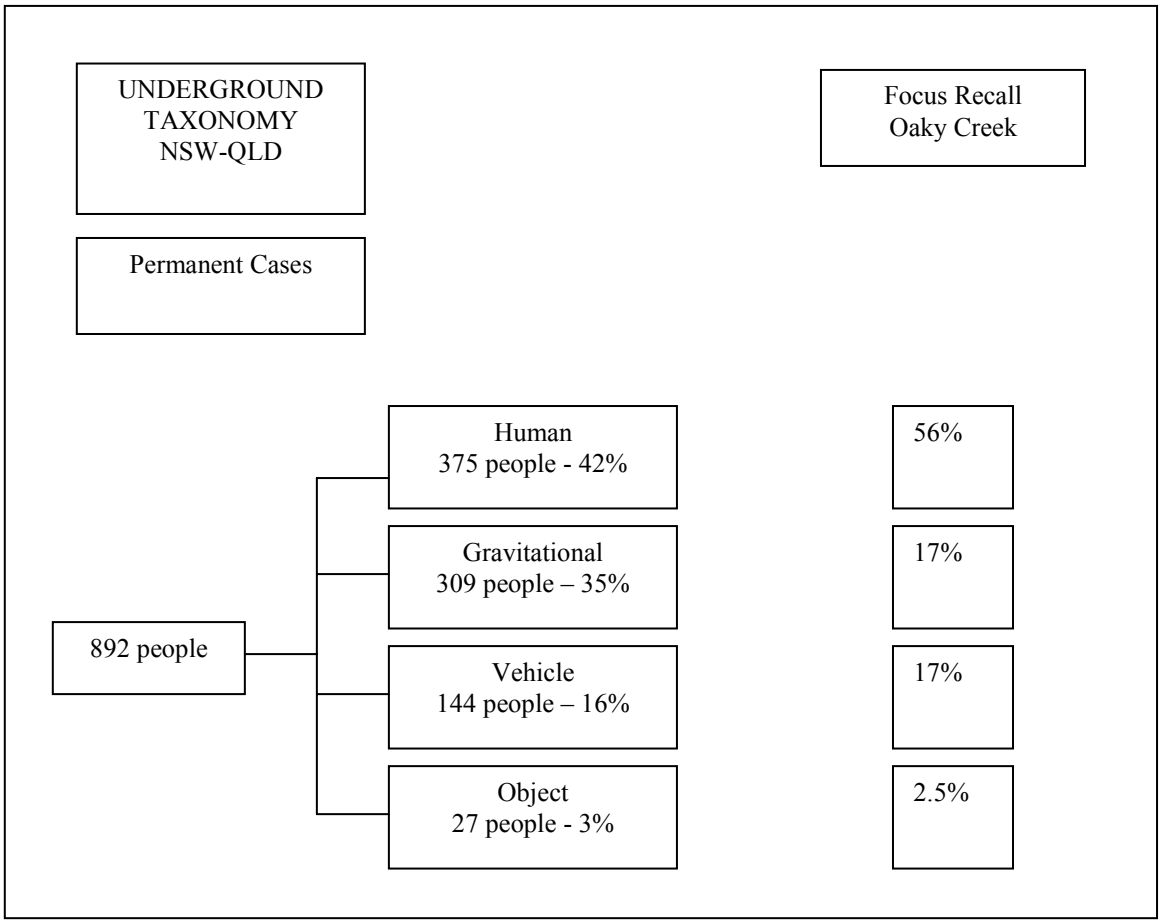


FIG. 5 - Correlation – Oaky Creek Focus Recall to Underground Coal Mine Taxonomy NSW-QLD 1990-1995

AN EXAMPLE

The following two items were captured in respect to monorail removal (human energy/heavy lifting): head impact when jumping off the monorail platform (human energy/impact) and the potential for falling (gravitational energy/fall of person). They are described to show how the recalled and reported information is presented to the client.

Item 2.1.3 Monorail Removal
Frequency of Exposure: Several times per shift
Potential Consequence: Lumbar/cervical disc damage
Damaging Energy Type: Human Energy – heavy lifting/pushing/pulling

Monorails must be removed as the Longwall retreats. The Monorail is used for the support of hoses that deliver energy, e.g. electricity and hydraulic oil etc, to the Longwall. One person completes the task. Work is completed at shoulder height and above. The workperson lifts one end of the Monorail off the supporting chain and then lowers that end of the Monorail until the other end can be disengaged from the mating connection. The item is then thrown into the Monorail pod, to do this task the person stands on the platform. The platform is accessed by a 700mm step up from an immediately adjacent and lower platform. That platform is also longitudinally displaced from the other.

There is potential for impact through head strike on the roof if the platform is too high relative to the roof. The task is described as requiring "moderate strength" if the platform is so located relative to the underside of the Monorail that the person can adopt a satisfactory posture. However, due to the lateral displacement of boot end equipment within the Main Gate, the person can find that the Monorail is significantly horizontally displaced to the side of the platform such that they have to reach beyond the platform.

The task is described as requiring moderate strength when the person can optimally position himself relative to the Monorail which is 1.83 m long and weights 32 kg. It is necessary to understand that the handrails are removable and the platform is able to pivot to a stored position. This allows for removal of the pod by an Eimco when the pod becomes adjacent to a Cut Through.

The ergonomics of the task, as described, were less than optimum. Posture would predictably overload the musculoskeletal structure.

<u>Recommendation 1.</u> It is recommended that this platform be made height adjustable and laterally adjustable via foot control and that such adjustment be completed hydraulically. The adjustable platform could be easily detached from the pod adjacent to the Cut through by having two quick connect hydraulic couplings and it would be possible to leave the platform in a stored position so that it does not intrude into the Main Gate more than currently occurs. It is necessary for this platform to be equipped with a foldable 75 degree ladder to allow for a transition to the immediately adjacent lower platform.

Item 2.3.3 Jumping Off Monorail Platform
Frequency of Exposure: Daily
Potential Consequence: Non-fatal permanent damage – musculoskeletal
Damaging Energy Type: Human energy – impact, Gravitational Energy – fall of person

The monorail platform is attached to the monorail pod. This platform has a height of 1500 mm above floor level and 700 mm above the immediate adjacent platform. The transition from the monorail elevated platform to the lower platform is hazardous. The task has been observed and people either attempt to step down, jump down, or alternatively, seek a very insecure foot hold with their left foot on a bracket on the BSL while boots are muddy and the surface is wet and contaminated. There is a high risk of people slipping on making this transition. The transition is made every 2 m of retreat i.e. up to five times per shift.

On the current platform the handrails are removable and the platform is hinged to allow an Eimco to remove the pod.

This item has been discussed under Section 2.1.3. If not other changes are made with respect to relieving the musculoskeletal stresses in monorail removal, it is necessary to improve the quality of the transition from this elevated platform to the lower platform.

Recommendation 1: Incorporate this item into Item 2.1.3 i.e. an upgraded platform associated with monorail removal. An interim solutions is to place a set of transition steps from the upper to the lower platform.

These items were subsequently audited in November 2002 and the following is a description of the audit results.

Item 2.1.3 Monorail Removal

Overall Audit Assessment:

POOR	FAIR	GOOD	EXCELLENT

Original Recommendations:
It is recommended that this platform be made height adjustable and laterally adjustable via foot control and that such adjustment be completed hydraulically. The adjustable platform could be easily detached from the pod adjacent to the Cut through by having two quick connect hydraulic couplings and it would be possible to leave the platform in a stored position so that it does not intrude into the Main Gate more than currently occurs. It is necessary for this platform to be equipped with a foldable 75 degree ladder to allow for a transition to the immediately adjacent lower platform.

Observation and Comments:
There has been significant work completed in this area. There are now three pods for the receival of monorails as opposed to previously one larger pod. The beam is handled less often e.g. twice instead of six times, and there is a hydraulic platform which is hydraulically retractable. The weight of the monorail beam remains the same at 32 kg, it is recognised that there can be lifting and twisting issues involved with one person moving the beam and hence the recommendation relates to providing two people to release and place a monorail beam.

Recommendations arising:
It is recommended that the task of removing monorail beams and placing them into the pods be completed by two people.

Each of the problems identified in the focussed recall document were systematically audited and additional recommendations made as required. It is considered that there has been a reduction in the potential for non-fatal permanent disability for the Oaky North and Development Crews as a consequence of embarking on the work and implementing the change. Work is still not yet complete, however the authors consider that the "process" is more important than an outcome measure. The difficulty with non-fatal permanent disability is that there are "so many" in the life of a country or an industry but "so few" in the life of an organization. Therefore measuring non-fatal permanent disability using some annual incidence rate with respect to an individual site does not hold a lot of relevance. It is far better to implement processes strongly focused at identifying exposures and then have appropriate models for analysing and implementing change.

CONCLUSION

An has been made to quantify the size and nature of the industrial personal damage problem in terms of the numbers of people involved and the predominant damaging energy types. Reference has been made to the likelihood of non-fatal permanent disability in industry generally and for the coal industry specifically.

The incident rate for non-fatal permanent disability in the coal industry is considered very high at typical 1:200 person years worked. No organization has set a guide as to what is "acceptable likelihood". The author would suggest at least one in 10,000 person years worked which would be a fifty-fold improvement. This would reduce the number of people currently permanently disabled from work in this country from 50 000 per year to 1 000 per year.

The enormous value of the knowledge of the workforce has been expounded. The collection and recording of such knowledge and experience requires a very structured approach using a set of focusing questions that are established against a backdrop of that which is known to permanently damage people. In particular, the questions must contain reference to human energy (heavy lifting/pushing/pulling tasks), gravitational energy, falls of people, falls of objects, vehicular energy (in particular jolting and jarring). Having harvested the store of experience in the workforce it is necessary to have the appropriate goals and expectations in response to handling that information.

It is suggested that the coal industry has a high likelihood of non-fatal permanent disability. It is suggested that there is currently not an appropriate industry focus directed toward that level of personal damage in the industry it is suggested that the industry needs to promote and implement processes which can clearly identify the potential for non-fatal permanent disability and effectively manage the future likelihood of that potential consequence.

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