



# **The effectiveness and impact of the PABIAC initiative in reducing accidents in the paper industry**

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**Greenstreet Berman Ltd**  
for the Health and Safety Executive

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# **The effectiveness and impact of the PABIAC initiative in reducing accidents in the paper industry**

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In the mid-1990's, paper industry injury rates were causing serious concern, and the Paper and Board Industry Advisory Committee (PABIAC) sponsored research to examine the underlying causes. Fieldwork discovered that standards of safety culture and safety management were both variable and generally inadequate. As a result, PABIAC set a target of reducing injury rates by 50% over 3 years and launched an industry wide initiative to improve standards. In May 2001, the Health and Safety Executive (HSE) initiated the research reported here to find out whether the PABIAC Initiative been successful. The work comprised on-site assessments at 8 sites, a questionnaire survey of all UK mills, desktop analysis of injury rate trends, benchmarking against similar initiatives and cost-benefit analysis.

Our evaluation shows that the statistics are consistent with a pattern of improving performance, with major injuries having fallen significantly, but overall do not yet provide conclusive evidence of a sustainable improvement. However safety culture and safety management were found to be much improved and many mills are now implementing effective initiatives that should result in reducing injury rates over the next two years. Costs and benefits in terms of averted accident costs were broadly even. Almost all mills considered the PABIAC Initiative a success and supported its continuation.

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# EXECUTIVE SUMMARY

## 1 BACKGROUND

The major injury rate in the paper industry in the mid-1990s exceeded that of the construction industry (usually considered a high risk industry) and ten mills accounted for about 30% of the major injuries. This was difficult to explain objectively on the basis of hazards, and it was suggested that it was linked to standards of safety management and safety culture. In 1996, prompted particularly by the Graphical, Paper & Media Union (GPMU), the Paper and Board Industry Advisory Committee (PABIAC) decided to sponsor research to test this hypothesis, and investigate both the high injury rate and the apparent disparity between mills. Fieldwork was carried out by the Health & Safety Laboratory at 12 paper mills to look at the standards of safety culture, safety management systems, and technological risk and to correlate them with accident statistics.

Safety culture and safety management factors proved to be important, interlinked, leading indicators. However the study found that standards of safety culture and safety management were both variable and generally inadequate, and concluded that to improve injury rates the paper industry needed to urgently address both of these areas and make major improvements. As a result of these findings and recognition of the need to address the high incidence rates across the industry, PABIAC set itself a nominal target of reducing injury rates by 50% over 3 years by addressing 6 high level objectives:

- Improve health and safety awareness within the industry;
- Improve senior management commitment to health and safety;
- Ensure that everyone is competent to carry out their roles adequately and safely;
- Improve the levels of risk control and decrease technological risk within the paper industry;
- Monitor accidents and feedback progress on achieving the PABIAC target;
- Improve the management of contractors.

These objectives and the programme devised to deliver them are together known as the PABIAC Initiative, which was formally launched following consultation with the industry's Chief Executive Officers in April 1998. The Initiative and the target of a 50% reduction in accident incidence rates were set to run from April 1998 to March 2001.

In May 2001 the Health & Safety Executive initiated a further programme of research to identify whether the PABIAC initiative had in fact been successful in terms of improving performance across the paper industry and to see what could be learned from the experience of individual mills. This was to be done by:

- Revisiting the HSL work by carrying out case study audits at 8 mills;
- Investigating the accident record across the industry;
- Assessing the effectiveness of the PABIAC Initiative, both qualitatively and by means of a quantitative costs/benefit analysis.

Conclusions and recommendations were then derived for the future of the PABIAC Initiative and to identify elements that might be applicable to other industries.

## **2 THE 2001 CASE STUDIES**

### **2.1 Overview**

In the original study, twelve mills were visited. They were selected on the basis of accident performance, geographical location, product group and the number of employees. For the purposes of this study it was decided to revisit 4 from the original twelve to enable a direct comparison between their performance now and that in 1997, as well as four new mills. Although injury rates were not available at the time of selection, the total sample proved to have annual injury rates 70% worse than the paper industry mean in 2000/01.

Approximately two days were spent on each site, including a site tour, a review of safety management systems, interviews and introduction and feedback sessions. Between 20 and 40 people were interviewed during the case study visits. Each element of each of the three dimensions (safety culture, safety management systems and technological risk) was analysed taking into account all the information gathered over the two days. These elements were then collated to provide a single measure for each dimension. The relationship between each of the dimensions and accident statistics was assessed, and scores for the revisited mills compared. Qualitative data was also gathered during the interviews, which provided valuable insights into the practical effect of different elements of the Initiative on safety and on differing approaches to safety culture and safety management.

All the evidence from the case study visits suggests that standards of safety culture and safety management have vastly improved, albeit from a relative poor starting point. Feedback from case study mills supports the study team's conclusion, that the PABIAC Initiative had been a success and that most mills would not have achieved anything like this scale of improvement without it. As the quotes in the text illustrate, there is still variability in standards and there were examples of poor practice. The difference this time is that they seemed to be recognised as such by management and staff, and people seemed to understand what is required to improve matters.

### **2.2 Safety culture**

The mean safety culture scores had improved compared to the original study, with less variability, even though the current sample had worse accident records compared to the industry mean than the original sample. Qualitative observations also strongly support the argument that standards of safety culture have improved significantly. Table 7 in Section 2.7 provides more detail and examples. Positive findings included:

- Greater senior management commitment to safety and more 'walking the talk';
- Far greater understanding within the workplace of individual's safety responsibilities, and greater awareness and ownership;
- Improved competence of first line management and better systems to assist the management of production and safety conflicts.
- A major increase in training resources, and better links to safety management and risk assessment.

However certain activities were still relatively weak across the majority of mills, including competence management and assurance, organisational learning and root cause analysis.

### **2.3 Safety management systems**

Similarly, standards of safety management have also significantly improved and variability reduced since the original study. All of the case study mills now had approaches to safety management that the study team considered reasonable, whereas this was definitely not the case with the original study. Interviewees acknowledged the contribution that the PABIAC Initiative made to facilitating contact between mills and helping them exchange good practice.

Table 8 in Section 2.8 provides more detail and examples. Positive findings included:

- Key elements from HSG65 - 'measure', 'audit' and 'review', though still relatively weak in the majority of the mills examined, had nevertheless improved significantly. They were largely absent when the original case study visits were made.
- Much improved co-operation between management, safety representatives and staff in risk assessment and the development of risk controls.
- The mills with good safety performance had a structured approach to organisational learning, for example, near miss reporting, accident and incident reporting and investigation, audits, inspections etc. Poorer mills did not have these processes.

However standards of safety management were not consistently good in all areas or across all mills. The areas where mills were most likely to need significant improvement were in the completion of comprehensive risk assessments, the systematic provision of safe systems of work and accident investigation.

Most of the case study mills had attempted to implement behavioural-based safety programmes but only one was successful. Feedback suggests that formalised behaviour-based safety initiatives are not appropriate until basic levels of safety management, safety culture, trust and participation have been achieved.

### **2.4 Technological risk**

Although mills all share certain core elements, there is significant variability in plant and operation. A technological risk factor was therefore developed for the original HSL study to discriminate between mills on the basis of their inherent hazards and so provide a measure statistical control when comparing mills. It is acknowledged that an improved definition might be possible, however on balance it was decided that the benefits of consistency between the two studies made it preferable not to change the definition.

The mean of our measure of technological risk had not changed much since the original evaluation. Some trends in the industry lead to lower scores, such as reductions in manpower, changed shift patterns and less overtime. On the other hand, some factors contribute to the higher levels of technological risk, including increased production and mill complexity.



## **2.5 Feedback from case study mills**

On the whole, the case study mills felt that the PABIAC Initiative had been a success. The initiative had prompted them to develop action plans that provided a mechanism to strategically manage safety. It moved them away from a reactive strategy towards a more proactive and systematic approach safety management. Particular improvements identified as occurring since the Initiative began included:

- Recognition by the entire paper industry of the imperative to improve;
- Buy-in by senior management across the industry to the need to improve safety standards;
- A clear statement from the both the HSE and the trade unions that they considered the paper industry's safety performance to be unacceptable;
- Action plans that allowed mills to formalise their strategy and manage the process;
- A shared vision across the industry which facilitated improvements;
- Capital investment to support Making Paper Safely.

Difficulties that individual mills encountered when implementing the initiative included:

- The target setting nature of the Initiative and the risk of de-motivation when injury rate targets were not achieved;
- A lack of site-wide ownership of the Initiative;
- Failure to implement elements of the Initiative due to inadequate consultation and participation;
- The strategic nature of the action plans was contrary to their usual reactive approach;
- The action plans originally were not prioritised according to the outcome of risk assessment as few mills had these in place, and therefore the plans were not based on risk or risk control;
- Disillusionment over the benefits of implementing Making Paper Safely, with a belief that the financial costs would not contribute to reducing the real causes of accidents;
- Training was not integrated and there was not perceived to be a direct safety benefit.

## **3 CHANGES IN INJURY RATES**

### **3.1 At industry level**

The purpose of this part of the research project was to examine accident (RIDDOR) data provided by the HSE to investigate changes in the paper industry during the period of the PABIAC Initiative.

The research team's expectation was that, for the majority of the industry and certainly for the poorer performers, initiatives such as PABIAC take several years to have an impact on injury rates. One would expect to see a period of awareness-raising at senior industry management level, resulting in increased emphasis on safety and rising awareness at mill level. Initiatives and action plans would then be developed and progressively implemented.

Lagging indicators such as accident statistics ought then to start to fall, although this would not show up immediately in full-year statistics. This hypothesis reflects conventional models of culture change and also practical experience from other initiatives, including the off-shore oil & gas industry's Step Change programme (see 3.3 below).

Industry-wide employment dropped between 1996 and 2000. Once account is taken of reduced employment, a comparison of injury rates per 100 000 employees for 1996/97 and 2000/01 shows little change in the overall injury rate (-2.0%) or in the over three day injury rate (+3.3%). There was a marked decrease in the major injury rate (-26.6%). Therefore, although the picture is less clear-cut than one might have hoped at the beginning of the Initiative:

- The decrease in the total *number* of accidents (consisting mainly of over three day accidents) is roughly in proportion to the decrease in the number of employees during this time period across the industry as a whole. However, the decrease in the number of major accidents exceeds the decrease in workforce size.
- The industry has downsized but production has increased at the same time, so fewer people are doing more. However there was no associated increase in accidents.
- Accident rates immediately prior to the initiative tended to show an upward trend, and following the initiative there appears to be a downward trend. General manufacturing injury rates have not shown a downward trend during the same time period as the initiative.

In terms of the actual performance of the mills:

- The better mills prior to the Initiative tend to still be the better mills (i.e. there is consistency over time with respect to performance).
- The biggest improvements in the industry have been in the worst performers, whilst 'typical' mills have changed little since the Initiative.
- Small mills have shown the greatest improvement in major injury rate, but their over three-day rates have not improved.
- Packaging, tissue and other products had fairly high major injury rates prior to the Initiative, these fell to levels close to that of graphics and newsprint.

Injury rates did not appear to be linked to profit, capital employed or capital expended at an industry level. However, based on this sample of 10% of the industry, it seems that the degree of organisational change is likely to be reducing the beneficial impact of the Initiative. There was no change in the pattern of accident causation as a result of the PABIAC Initiative.

### 3.2 Case study mills

The original HSE RIDDOR data and the model from that study that correlated accident performance with safety culture, safety management and technological risk were updated to provide an injury rate prediction model. It explained 56% of the variance in injury rates for that period.

The 2001 case study scores were then fed into the model to generate predicted 2001 mill injury rates. These predictions were compared to actual rates to validate the model. The sample is small, and one of the mills was treated as an outlier, but comparison of injury rates based on the predictive model with actual injury rates nevertheless supports the validity of the conclusions of both the original and the current study, that improved safety culture and safety management lead to reduced injury rates, with safety culture scores being the most significant.

For those which had been revisited, injury rates at two mills had improved by around 50% and rates at one had slightly worsened (although standards of safety management and culture were improving). Rates at the fourth mill (the outlier mentioned above) had worsened markedly. The circumstances at this mill and the justification for treating it as an outlier are discussed in section 2.7.2.

### 3.3 Comparison with the offshore industry 'Step Change' scheme

It would clearly be helpful to be able to benchmark the PABIAC Initiative against similar industries. The offshore industry's Step Change in Safety Initiative is the most obvious comparison. It was launched in September 1997 with an objective of a 50% improvement in industry safety performance over the next three-year period. The headline target was therefore the same as PABIAC's, and there are also some similarities between the two industries. For instance, the offshore sector involves a relatively small number of firms and is homogenous in terms of the types of hazards and technology. A small number of trade associations represent the vast majority of firms. It is also regarded as a relatively high-risk sector in industrial safety terms, although the nature and scale of the risks differ from those of the paper industry.

Many of the Step Change elements also had similar objectives to PABIAC Initiative elements, including: improved networking, cross industry safety leadership, improved risk assessment and a focus on safety culture. However as the initiatives were tailored to the different needs of the two sectors, comparisons need be interpreted cautiously.

The rate of fatal and major injury in the off-shore sector appears to have *increased* for the first 18 months or so, reducing again to about the same level at the end of the third year as it was at the outset of the initiative. The total injury rate was about 25% lower at the end of year three than at the outset, but the 50% overall reduction target was not achieved. At the three-year point, PABIAC therefore appears to be comparable with the Step Change Initiative. There were however marked improvements in offshore safety performance in year four, perhaps as the improvements initiated fed through into accident statistics. By March 2001 there had been a 43% improvement in the total injury rate and a 26% improvement in fatal and major injury rate compared to 1997.

## **4 QUALITATIVE SURVEY FEEDBACK**

The case studies and statistical analysis provide a measure of the effectiveness of the PABIAC initiative in reducing accidents. So far as possible, the data was collected and analysed by research team members so that it would be objective and independent. However there are significant limitations in the information that can be collected in this way, and so a postal survey was included in the programme to obtain additional qualitative information on the effectiveness of the individual elements of the Initiative and on the mills' perception of the Initiative.

Although almost half the mills disagree with the proposition that the Initiative has to date delivered a reduction in accident costs, they do agree that standards of safety culture and safety management have improved markedly, and over 80% believe it has motivated senior management - a vital intermediate step. The survey results were on the whole positive. The vast majority of responding mills agree that the benefits arising from the PABIAC Initiative justify the costs and more than half the mills regarded nearly all of the elements of the PABIAC as effective or very effective.

The survey results are therefore consistent with the conclusions from the case study and injury rate analysis. That is, that the Initiative has been effective at stimulating management action, and the development of safety culture and safety management on site, but that these improvements have not yet fed through into accident statistics.

## **5 COST BENEFIT ANALYSIS**

The final part of our study provides an assessment of the quantifiable costs and benefits of the PABIAC Initiative, based on self-reported costs estimates provided by mills and PABIAC partners. Given the limited amount and quality of information available on the costs and benefits, this study can only provide an initial opinion on the balance rather than a precise assessment, but it is an important aspect of the overall evaluation.

Ideally, a cost-benefit assessment compares the full cost of an intervention with the total benefits of an intervention. Such benefits would include the value of averted accidents and incidental benefits such as improved productivity. Also, ideally, the costs and benefits would be clearly linked to and arising from the intervention. However in this instance the following points limit the assessment:

- Mills have not recorded initiative-related costs.
- Whilst the PABIAC Initiative was launched in 1998, many mills only made progress in implementing changes in the year 2000. Thus, there is a limited period for benefits to materialise.
- It is reasonable to assume that many of the actions associated with the PABIAC Initiative have incurred a significant one-off cost the benefits of which would have been accrued over a longer period stretching into future years. Currently available data does not provide a sound basis to predict future benefits or separate out one-off and recurring costs.
- Mills did not keep records that would allow them to readily provide information on any quantifiable on-going incidental benefits such as improved productivity.
- Whilst the number of injuries has fallen during the period of the PABIAC Initiative and feedback from mills does suggest that the PABIAC Initiative has led to safety improvements, the attribution of this trend to PABIAC is not certain.

We asked mills, HSE, trade unions and trade associations to estimate staff time expended. We then assigned nominal costs to that time. The average time per site was multiplied by an average daily employment cost. The questionnaire asked for equipment costs for equipment modifications and repairs. The three-year cost per mill averages £234,500, or a little over £78,000 per annum. With 88 mills, this corresponds to a total cost for the three-year period of £20.7m. Other stakeholder costs amount to around £0.9m.

In an attempt to check the validity of the subjective evaluations and cost estimates, we have also compared the reported PABIAC related costs against those reported by firms in other sectors. The industry's self-reported costs are ranked where one might expect them to be, which suggests that they are reasonable.

The quantifiable “benefit” is limited to the estimated number of averted injuries; there is no information on the impact on cases of occupational ill health or additional spin-off benefits. Industry data was used to estimate employer costs, which were then added to the ‘willingness to pay’, NHS and loss of societal output components of the Department of Transport ‘value of life’ figure. We then multiplied the cost per injury type by our estimate of the number of averted injuries to get a total value. An allowance is made for a fall in non-injury accidents.

The three-years costs for the Initiative were estimated above at £21.6m. The corresponding benefits in terms of averted injuries and other losses are estimated at £19.1m. The ratio of quantifiable costs to the value of reduced injuries is therefore approximately 1.1 to 1 for the three years to date. Given the potential level of error in the data and the potential for a reduction in cases of ill health and additional but unquantifiable future safety and commercial benefits, it is probably only safe to conclude that the costs and benefits to date of the PABIAC Initiative are about equal.

## **8 CONCLUSIONS AND RECOMMENDATIONS**

Comparison with the off-shore industry's Step Change programme supports the view that, given that much of the first year of such initiatives inevitably focuses on awareness raising, more significant improvements in injury rates might be expected from year four onwards provided that the changes have acquired the momentum to become self-sustaining. One might conclude that the three-year term of the Initiative target was with hindsight too short to achieve the size of reductions being sought.

Major and fatal injury rates have reduced by about a quarter across the entire industry. This has, however, not yet been matched by other performance measures. The statistics are consistent with a pattern of improving performance, but in themselves they do not provide conclusive evidence of a sustainable major improvement. What gives us confidence is the very strong improvement in understanding of - and commitment to - safety culture and safety management found at the case study mills, and the initiatives they are now implementing.

There is still a long way to go, but standards are rising and the feedback from all involved is that much of this is due to the PABIAC Initiative. Furthermore, the Initiative is recognised as being broadly appropriate and cost-effective and the consensus seems to be that it should be continued, albeit with more flexibility to keep it relevant to mills at all stages of development.

## Conclusions

1. Standards of safety culture and safety management have improved since the original study. No change was identified in technological risk scores.
2. The PABIAC Initiative was a useful framework for improving standards of safety management and safety culture across the paper industry.
3. Injury rates have reduced across the paper industry. The major injury rate has reduced by 26%; other measures are expected to follow.
4. The PABIAC Initiative would appear to have a major role in this reduction in injury rates.
5. An injury rate target at a mill level does not provide a good measure of progress.
6. The PABIAC Initiative was cost neutral.
7. The evaluation was carried out very soon after the three-year point. This was too early to be able to evaluate quantitative impact on injury rates. However it did provide a good qualitative picture of the effectiveness of the Initiative, and it was carried out at the right time to feed into consideration of the Initiative's future direction.
8. Safety improvements in the paper industry are still required to bring it in line with UK Manufacturing.
9. Progress may already be sustainable in some mills, but for the industry as a whole the Initiative has to be continued to maintain it.
10. The Initiative needs to be more targeted and flexible to meet the needs of individual mills.
11. The PABIAC Initiative succeeded because of a number of features that are specific to the paper industry, but that with care similar approaches could be adopted in other industries.
12. If an analogous Initiative were to be implemented in another, larger, sector, there might be a need to break it down into smaller 'homogenous units with a common identity and representation e.g. regional agricultural groups.

## Recommendations

1. The PABIAC Initiative should be continued.
2. PABIAC should consider promoting other performance measures to gauge progress in health and safety.
3. The initiative should be modified to consolidate on its successes.
4. The next phase of the Initiative should have a 'brand name' to ensure continued buy-in.
5. The notion of continuous improvement should remain a key element of the Initiative, perhaps through the use of accident reduction rolling targets, e.g. 10% reduction per year.
6. HSE should continue to exert influence on CEOs.
7. The elements of tripartite collaboration and partnership should be continued.
8. The elements of the Initiative should be reviewed and enhanced so that they can be applied flexibly to suit the maturity of individual mills in terms of safety management.
9. Prior to commencing an initiative, the evaluation methods and criteria need to be designed and built into the Initiative.
10. Research needs to be carried out to explore the feasibility and value of determining cost effectiveness.

# 1 INTRODUCTION

## 1.1 BACKGROUND

The major accident incidence rate in the paper industry in the mid-1990s exceeded that of the construction industry (usually considered a high risk industry) and ten mills accounted for about 30% of the major injuries. This was difficult to explain objectively on the basis of hazards, and there were suggestions that it was linked to standards of safety management and safety culture. In 1996, prompted particularly by the Graphical, Paper & Media Union (GPMU), the Paper and Board Industry Advisory Committee (PABIAC) decided to sponsor research to test this hypothesis and determine the underlying reasons for the high injury rate and the apparent disparity between good and poor performers.

The present author and her colleague Dr Nick Hurst developed the research methodology whilst employed at the Health and Safety Laboratory. Fieldwork was carried out at 12 paper mills across Great Britain covering a range of sizes, geographical locations, injury rates and technologies. The purpose was two fold: to uncover the factors underlying poor performance and to identify common features in good performers.

Three main dimensions were considered during the fieldwork:

- Safety Culture, e.g. communications, senior management commitment to health and safety and individual hazard awareness;
- Safety Management Systems, e.g. use of an HSG65 framework and assessment of the quality of risk assessments, policy and operating procedures;
- Technological Risk, e.g. risk inherent in the type of mill, including speed of the paper making machine, age of the equipment and the number of paper breaks.

These three dimensions were then used to construct an injury rate prediction model that accounted for 56% of the variation in injury rates. More accurate historic injury rate data was used in this study, which results in a lower figure than the 74% identified in HSL (1998). Safety culture dominated this predictive model (i.e. a mill that had a good safety culture typically had low injury rates) but both safety culture and safety management factors proved to be important leading indicators. They are closely interlinked, and the study concluded that to improve injury rates the paper industry would have to simultaneously address both safety culture and the standard of safety management.



## 1.2 THE PABIAC INITIATIVE

As a result of these findings and recognition of the need to address the high injury rates across the industry, PABIAC set itself a nominal target of reducing injury rates by 50% over 3 years. This was supported by 6 high level objectives:

- Improve health and safety awareness within the industry;
- Improve senior management commitment to health and safety;
- Ensure the provision of necessary knowledge and skills at all levels so that everyone is competent to carry out their roles adequately and safely;
- Improve the levels of risk control and decrease technological risk within the paper industry;
- Monitor accidents and feedback progress on achieving the PABIAC target;
- Improve the management of contractors.

These objectives and the programme devised to deliver them are together known as the PABIAC Initiative, which was formally launched following consultation with the industry's Chief Executive Officers in April 1998.

The Initiative and the target of a 50% reduction in accident incidence rates were set to run from April 1998 to March 2001. Given that any changes on site would take time to show up in accident statistics and that the Initiative included an initial awareness-raising phase, a more realistic timeframe might have been 5 years. However setting a challenging target of 50% over 3 years was seen by PABIAC as more likely to stimulate action within the industry.

Central to the Initiative was the production of action plans by individual UK paper mills setting out the steps they would take to improve their safety culture and safety management, and thereby play their part in meeting the Initiative's objectives and reduce their injury rate. A series of regional seminars were run throughout the UK to provide mills with a starting point. The intent of these action plans was for the mills to formalise and document their risk assessment and risk control processes. Guidance to the mills helped ensure that action plans were SMART (specific, measurable, achievable, realistic and timely), and that they were developed, implemented and monitored with the cooperation and participation of both management and employees.

The HSE, trade unions and the Paper Federation also supported a range of additional activities as part of the PABIAC Initiative, including:

- Presenting material at seminars and training events on the PABIAC Initiative;
- Continually emphasising the importance of the PABIAC Initiative and maintaining its profile;
- Organising training events for employers and employees on health and safety;
- An audit programme to assess progress and the effectiveness of the action plans;
- Collection of accident data.

### 1.3 THE CURRENT STUDY

In May 2001 the HSE initiated a further programme of research to identify whether the PABIAC initiative had in fact been successful in terms of improving performance across the paper industry and to see what could be learned from the experience of individual mills. There were four main objectives:

- Revisit the HSL work to determine the role of the PABIAC Initiative in achieving change in the industry in terms of injury rates, safety management, safety culture and technological risk. The findings from this case study phase are described in section two of the current report.
- Investigate the accident record across the industry and validate changes in the accident performance. The statistical analyses of injury rates across the paper industry are reported in section three.
- Assess the effectiveness of the PABIAC Initiative, in terms of the costs and benefits of the various actions of all participants in this process from industry, trade unions, and the HSE. The intent is to determine the value for money of the Initiative, and to identify those elements of the partnership that were particularly effective in motivating change. The effectiveness of the PABIAC Initiative is discussed in section 4, and the quantitative assessment of costs and benefits delineated in section 5.
- To make recommendations to PABIAC about its work and proposals for further work to ensure the continued improvement of safety standards within the paper industry. Our conclusions and recommendations are in section six.

The targets identified within the Department of Environment, Transport and Regions (DETR) document 'Revitalising Health and Safety – Strategy Statement' and the emphasis it placed on partnerships and employee involvement as a means of improving accident performance led to the inclusion in the study of a further subsidiary objective, to identify elements of the Initiative that might be applicable to other industries.

## **2 FIELD STUDIES**

### **2.1 INTRODUCTION**

This section reports on the outcome of a series of field studies carried out with the intent of replicating the HSL study to identify the impact of the PABIAC Initiative on measures of:

- Safety culture;
- Safety management systems;
- Technological risk;
- Injury rates.

In the original study twelve mills were visited. They were selected on the basis of accident performance, geographical location, product group and the number of employees. For the purposes of this study, it was decided to revisit 4 from the original twelve to enable a direct comparison between their performance in 2001 and in 1997 (HSL, 1998), as well as four new mills.

Following consultation with the HSE, the Paper Federation of Great Britain, and the GPMU, four mills from the original twelve were selected. Of the original twelve mills, one had closed down and four good performers had remained good performers. These were excluded on the basis that they would have nothing to contribute to the evaluation. A decision was made to select mills for revisit where things had changed during the duration of the initiative, either for the better or worse, to identify the impact and successes or failures of the initiative on accident performance.

The remaining four mills were selected to try and ensure that the sample as a whole was broadly representative of the British paper industry in terms of location, product, and size and had a range of injury rates. The sites selected ranged from approximately 120 through to over 500 employees.

### **2.2 METHOD**

#### **2.2.1 Protocols**

The methodology and research protocol used in the HSL study was reviewed. The intention was to use the same scales of safety culture, safety management systems and technological risk to identify changes. The dimensions for safety culture and technological risk were not modified, whilst the safety management system scale was enhanced to incorporate elements of HSG65 omitted from the first study, namely measure, audit and review. These elements were weak across all mills in the original study, and therefore served no purpose and were not incorporated into the scores. However it was speculated that these elements would now be in place due to the emphasis placed on mills adopting HSG65 compatible safety management systems.

Question sets were developed to support the collection of this information. The main elements are shown in Table 1 with the detail in Appendix 1.

**Table 1:** Safety culture, safety management and technological risk scales

<i>Scale</i>	<i>Examples of constituent elements</i>
Safety culture	Commitment to safety, visibility, production/safety balance, competence, stress, blame, safety focus of organisation, feedback, quality of supervision, etc
Safety Management Systems (SMS)	Policy, organising, planning & implementing, measure, audit and review, etc.
Technological Risk	Input materials, speed of machine, complexity of process, overtime, shift teams, etc.

A question set was also drawn up to help evaluate the PABIAC Initiative (see Appendix 2) by identifying how mills met the targets and requirements of the initiative. Some pertinent findings from this questionnaire are reported here but the majority are discussed in section 4. In addition, the HSE site inspector for each site was interviewed to supplement the mill specific data and explore their perception of the impact of the PABIAC Initiative on the performance of a specific site.

### **2.2.2 Case study visits**

The eight mills were visited over a two-month period during the summer of 2001. Each provided background information in advance, including:

- PABIAC action plans;
- Organisation chart;
- Accident history;
- Any recent changes (e.g. new equipment, changes to senior management, redundancies etc);
- Annual report.

These were studied prior to the visit so that an understanding of the mill and recent events could be used where appropriate to tailor question sets or seek a deeper understanding of certain key issues.

Approximately two days were spent on each site, with the visit having four main elements:

- A site tour;
- A review of safety management systems;
- Interviews;
- Introduction and feedback sessions.

The site tour typically took place at the start of the first day, with the interviews and the safety management review taking the remainder of the time.

Between 20 and 40 people were interviewed during the case study visits. The interview participants were from all levels of personnel, including maintenance and production teams. Interviews with shop floor personnel were typically carried out in small groups of 2 or 3. Experience has shown that the benefits of this format in terms of helping put participants at ease while discussing sensitive issues, stimulating debate and pulling out examples outweigh the potential disadvantages such as peer pressure effects. Shop floor personnel were interviewed in their workplace in quiet locations, e.g. sound refuges, smoking rooms and control rooms. Interview participants typically included:

- Mill Manager;
- Operations/Production Manager;
- Maintenance/Engineering Manager;
- Health and Safety Manager;
- Health and Safety Representatives;
- First line managers/supervisors/foremen;
- Members of operational and maintenance staff.

A presentation was made at the end of each case study visit to provide feedback to managers and safety representatives. This gave an opportunity for the site to comment on the preliminary findings and for additional issues to be addressed.

Each element of the three dimensions was then analysed taking into account all the information gathered over the two days. These were scored out of ten with rationale and justifications for the scores provided. These elements were then collated to provide a single measure for each of the three dimensions of safety culture, safety management systems and technological risk.

### **2.2.3 Data Analysis**

Changes in performance were assessed in a number of ways:

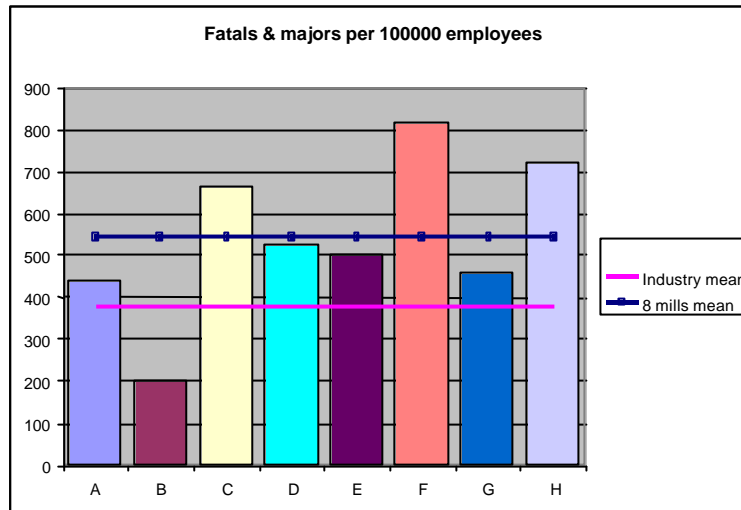
- Compare the scores from safety culture, safety management and technological risk with the scores from the original study for each revisited mill;
- Compare the mean scores in this study with those in the previous study;
- Review the qualitative information and interviews for each dimension;
- Collate scores across dimensions and with accident statistics.

## **2.3 SAFETY PERFORMANCE OF CASE STUDY MILLS**

Three measures of safety performance were used in the original study:

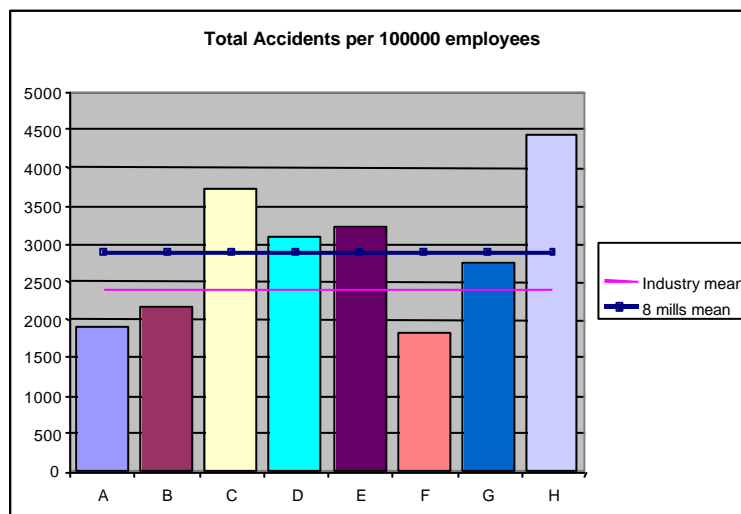
- A measure based on fatal and major accidents per 100 000 employees;
- A total rate based on fatal, major and three day accidents per 100 000 employees;
- A weighted injury rate per 100 000, being the weighted sum of fatal, major and three day accidents, using a multiplier of 10 for fatalities and 3 for major accidents.

Figure 1 below shows the safety performances of these mills based on a mean of the previous five years performance as measured by fatal & major accidents. Most of the mills, with the exception of mill B, have rates above the industry mean. In fact the mean of the 8 mills for fatal and major injury rate was 25% above the industry mean. The detailed accident data was only obtained following the selection of the case study mills; it was not intended to select poor performers.



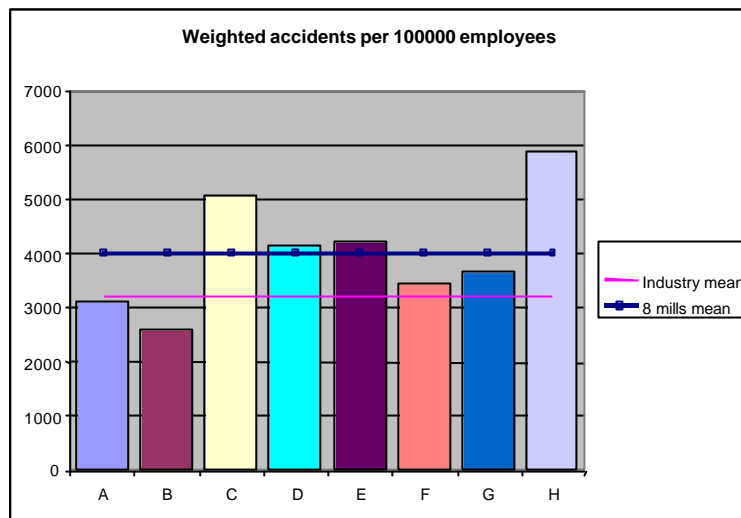
**Figure 1:** Fatal and major injury rate for the 8 case study mills

The pattern is slightly different for the total injury rate with the differences not being as great; see Figure 2. The implication of this is that the mills selected have a greater proportion of severe accidents compared to the rest of industry and relatively fewer three-day accidents, which in itself may arise from some element of under-reporting.



**Figure 2:** Total injury rate for the 8 case study mills

The weighted injury rate (Figure 3) shows a similar pattern to that of the total injury rate.



**Figure 3:** Weighted injury rate for the 8 case study mills

Examination of these measures of injury rate suggests that the mills selected for this study varied from the industry average and were poorer performers in all measures of injury rate.

Table 2 shows the industry mean injury rates for fatals and majors for the years 1996/97 and 2000/01, for the case study mills in the HSL study (1996/97), and for the current study (2000/01). This shows that the mills selected then were more representative of the safety performance of the industry. In the original study the mills' injury rates were slightly above the industry mean, whilst for the current study the single year mean is almost 70% higher than the industry mean, as well as being 12% worse than the 12 visited in the HSL study.

It is important that this is borne in mind when changes to the measures of safety culture, technological risk and safety management systems are evaluated. The mills in this study are worse than average performers and are not representative of a random sample of UK Paper Mills. The statistical analysis in this report and any changes identified therefore need to be interpreted with care.

**Table 2:** Mean major (inc fatals) injury rates

	<i>Major injury rate/100000</i>	
	<i>96/97</i>	<i>00/01</i>
Industry mean	434	319
Case studies mean	476	535

## 2.4 CHANGES ON A CASE-BY-CASE BASIS

This section explores whether the four revisited mills had improved in terms of safety performance and their scores on safety culture, safety management and technological risk.

The findings from the revisited mills are:

- Mills D & E, whose injury rates have each improved by nearly 50%, have better scores now than in the previous study.
- Mill B, whose injury rates have almost doubled since the previous study, had worse scores on safety culture and safety management systems, with increased levels of technological risk.
- Mill A had slightly increased injury rates, however the improved scores on safety culture and safety management suggest the increased injury rate could be linked to the increase in Technological Risk or other factors at that mill.

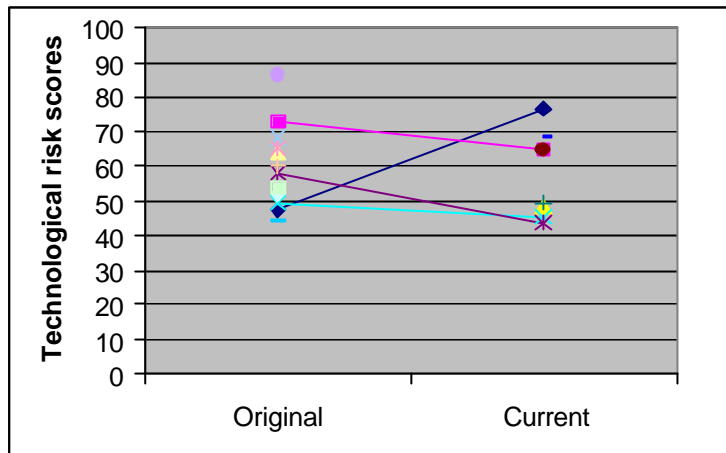
Therefore, based on this admittedly small sample of revisited mills, we are reasonably confident that the original injury rate prediction model holds, i.e. that improved standards of safety culture and safety management would lead to a reduction in injury rate.

**Table 3:** Changes in the 3 dimensions for the revisited mills

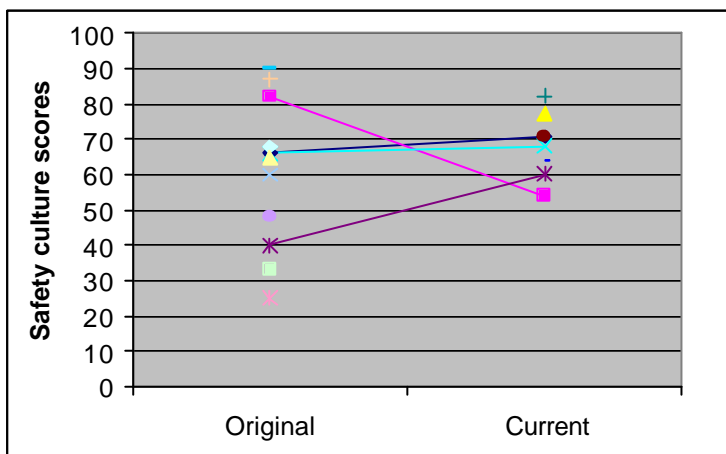
<i>Mill</i>	<i>Injury rate</i>	<i>Safety culture</i>	<i>Safety management systems</i>	<i>Technological risk</i>
A	<b>ALL MEASURES INCREASED SLIGHTLY</b>	Improved	Improved	Increased
B	All measures doubled	Deteriorated	Deteriorated	Increased
D	All measures decreased by ~50%	Improved	Improved	Same
E	All measures decreased by ~50%	Improved	Improved	Decreased



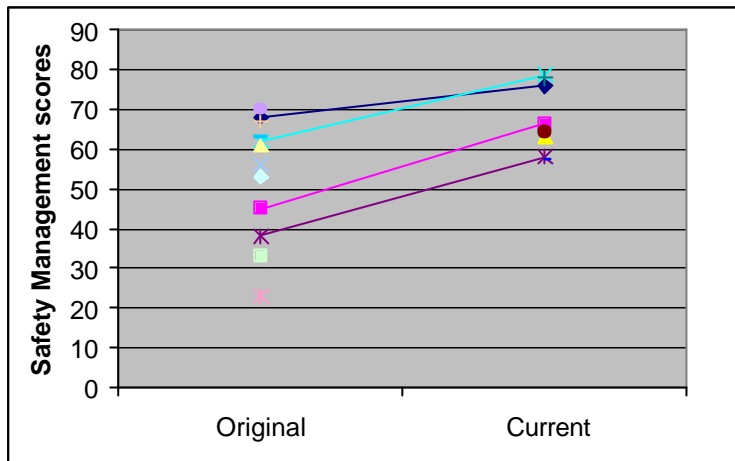
The graphs shown below compares the safety culture, safety management system and technological risk scores as well as the changes in injury rates obtained in 1996/97 and 2001.



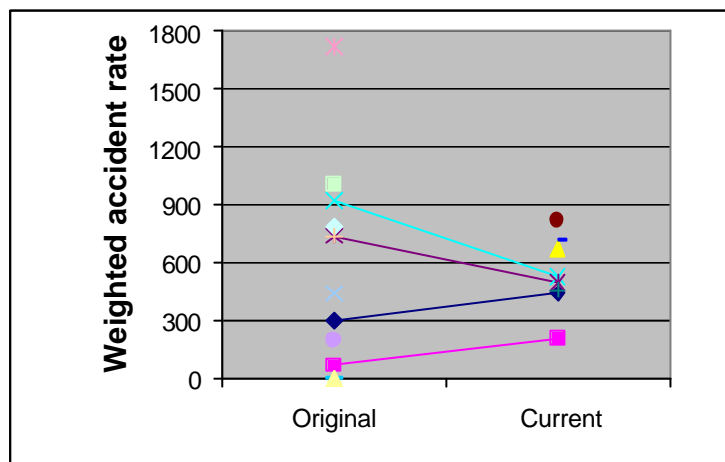
**Figure 4:** Technological risk scores



**Figure 5:** Safety culture scores



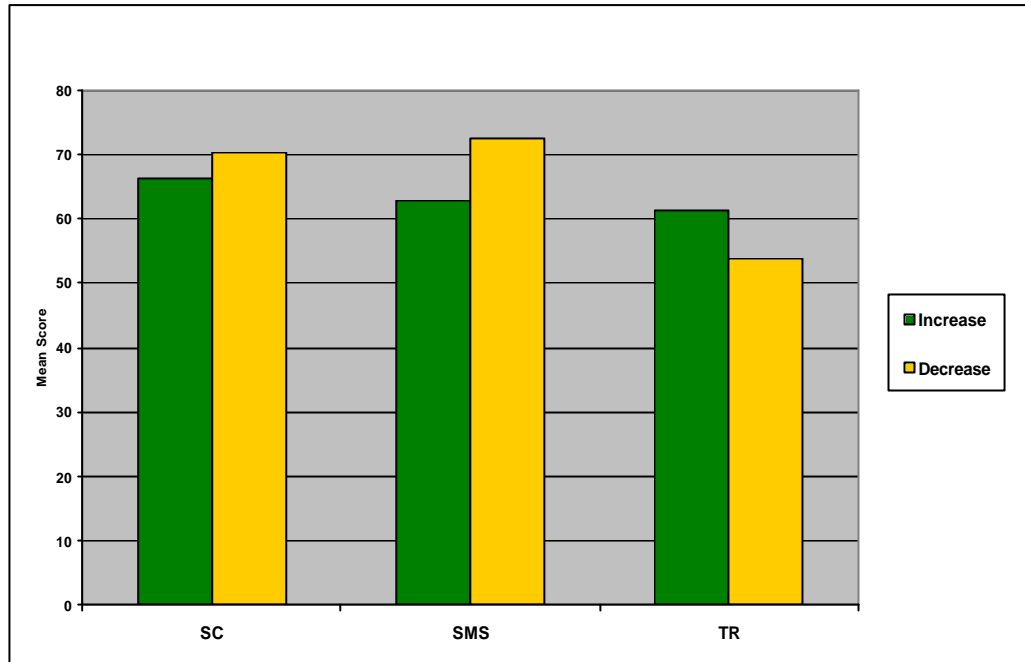
**Figure 6:** Safety management scores



**Figure7:** Weighted injury rate

Comparing each measure over time, there would appear to be a distinct overall improvement in the SMS scores, but little discernable improvement in the other scores (with the possible reduction of the lower tail of safety culture scores). As noted earlier the sample has major injury rates that are almost 70% worse than would be expected from a random sample from the paper industry.

To investigate the differences further, the eight case study mills were divided into two groups; those who had injury rates that improved since the 1996 and those with rates that had deteriorated over the same period. Figure 8 charts the mean score for safety culture, safety management and technological risk for these two groups.



**Figure 8:** Increased/Decreased injury rate with SC/SMS/TR scores

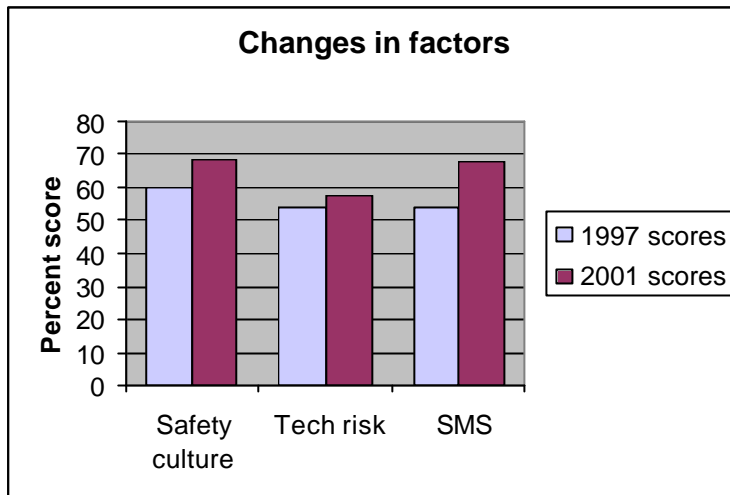
This shows that mills whose injury rate improved (i.e. decreased) had higher scores on safety culture and safety management, and lower technological risk, compared to the group whose injury rate got worse. This 5 point difference on the safety culture scale and 15 points on the SMS scale would be expected to result in about a 15% reduction in the weighted injury rate (per 100 000).

In addition, safety performance data for the 12 mills in the original study was updated and analysed. With such a small set of data, firm conclusions are difficult. Alternative interpretations are possible, but the safety performance data would be consistent with improving safety culture and management at those mills that scored poorly in the original study and largely unchanged safety culture and management at the better mills (see Appendix 5).

## 2.5 CHANGES IN MEAN SCORES

The next stage of the analysis compares the mean scores for the 8 mills in the current study compare with the mean scores from the 1997 study.

The mean scores attained on the elements of safety culture, safety management and technological risk have all increased since the previous study – see Figure 9 below. The only statistically significant improvement is that for safety management systems. However, as will be discussed later, whilst the means may not have improved by much, there is less variability and good standards of safety culture and safety management were more commonly found across the eight mills, even though the sample was deliberately selected to include relatively good and bad performers.



**Figure 9:** Safety culture, safety management and technological risk scores in current study compared with HSL study

Table 4 below shows that the standard deviation for both safety culture and safety management has significantly decreased in this study compared to the original, demonstrating that the mean is more representative of the mills than was the case in the HSL study.

**Table 4:** Means and standard deviations from the mills in the two studies

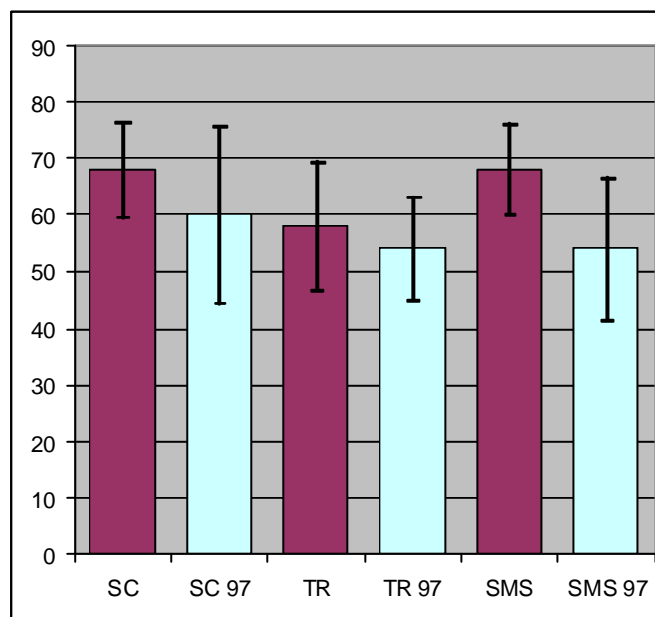
<i>Year</i>	<i>Safety culture</i>		<i>Technological risk</i>		<i>Safety management</i>	
	<i>1996/97</i>	<i>2001</i>	<i>1996/97</i>	<i>2001</i>	<i>1996/97</i>	<i>2001</i>
Mean	60	68	54	57	53	67
Standard deviation	21	9	12	12	17	9

Technological Risk has stayed relatively constant with a similar distribution of scores, however both safety management and safety culture have improved. In particular, when the confidence limits are calculated the improvements look more meaningful (see Table 5 below) bearing in mind, of course, the limited validity of confidence limits as a measure in a small non-random sample.

**Table 5:** Means and confidence limits from the mills in the two studies

<i>Elements</i>	<i>Year</i>	<i>Mean</i>	<i>95% Confidence limits</i>
Safety Culture	2001	68	62-74
	1997	60	48-72
SMS	2001	68	61-74
	1997	54	44-64
Technological Risk	2001	57	47-64
	1997	54	47-61

These confidence limits are plotted on Figure 10. Standards have improved across the 8 mills taken as a whole, and that indeed for safety culture and safety management the findings suggest improved standards across the whole industry, as opposed to the previous study which had a mix of excellent and poor standards of safety culture and safety management. Technological risk has stayed fairly constant across the industry.



**Figure 10:** 95% Confidence limits

## 2.6 TECHNOLOGICAL RISK

Although mills all share certain core elements, there is significant variability in plant and operation. A technological risk factor was therefore developed for the original HSL study to discriminate between mills on the basis of their inherent hazards and so provide a measure of statistical control when comparing mills. The issues considered within this factor are shown in Table 6 below.

It is acknowledged that an improved definition might be possible, for instance levels of turnover and absenteeism are not independent of the factors that underpin safety culture and management systems. However the weighting on these factors is small and on balance it was decided that the benefits of consistency between the two studies made it preferable not to change the definition, provided that its limitations were accepted.

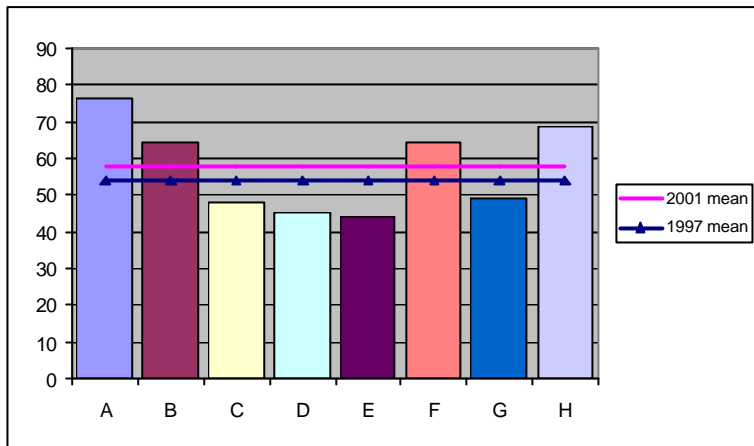
**Table 6:** Technological risk factors

<i>People</i>	<i>Process</i>
<ul style="list-style-type: none"> <li>• Number of employees</li> <li>• Type of shiftwork</li> <li>• Overtime</li> <li>• Turnover</li> <li>• Absenteeism</li> </ul>	<ul style="list-style-type: none"> <li>• Input materials</li> <li>• Complexity of process</li> <li>• Number of paper breaks</li> <li>• Production levels</li> </ul>

Some trends in the industry lead to lower scores, such as reductions in manpower, changed shift patterns and less overtime. On the other hand, some factors contribute to the higher levels of technological risk. These include:

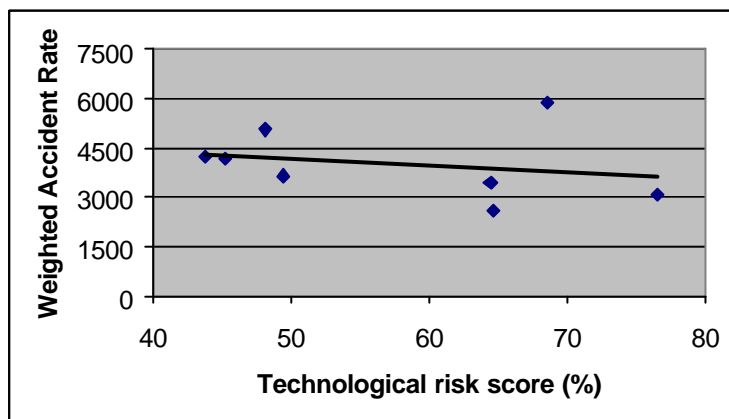
- Increased production levels;
- Increased levels of complexity;
- Greater numbers of paper breaks than those acknowledged in the first study. This is possibly linked to increasing performance demands, including optimising production.

The assessed technological risk scores for the 8 mills are shown in Figure 11 below. The scores have increased from the 1997 mean of 54 to 57 in the current study, however the difference is not great. In fact when the confidence limits are considered there is little variation between the two, e.g. 1997 confidence limits were 47 and 61, with 2001 being 47 and 64.



**Figure 11:**Technological risk for the 8 mills

When technological risk is plotted against weighted injury rate the relationship runs counter to that identified in the previous study. Those mills with higher levels of technological risk have lower injury rates, which might suggest that the industry has greater control over its inherent hazards than it did in the previous study.



**Figure 12:** Technological risk and weighted injury rates

## **2.7 SAFETY CULTURE**

### **2.7.1 Introduction**

This section reviews key changes between the current study and the original, discusses essential elements for a positive safety culture in the paper industry, and links individual mill scores to injury rate. Standards of safety culture appeared to be much improved in this study. Key areas of improvement are summarised in Table 7 at the end of this Section, including:

- Greater commitment to safety by senior management, including the explicit demonstration of this - 'walking the talk';
- Greater understanding within the workforce concerning individuals' safety responsibilities, and improved awareness and ownership;
- Improved competence of first line managers and better systems to assist in the management of production/safety conflicts. Furthermore they are also more likely to feel supported by senior management in making these decisions;
- The workforce at the majority of the case study mills stated that they would stop production if something were unsafe;
- An awareness of the importance of selecting appropriate initiatives. For example, mills recognised that they needed to improve standards of safety management and workforce-management trust before embarking on behavioural safety schemes.

Many of these changes can be linked to the PABIAC Initiative, for example:

- Chief Executives Day – senior management from the entire industry attended annual days highlighting the importance of improving safety performance across the industry. The focus was means to improve safety culture and safety management across the industry.
- Increased levels of training within the mills, and the emphasis on a greater understanding of individual and collective safety responsibilities.



## 2.7.2 Findings from the 8 mills

Elements of best practice on safety culture from the case study mills included senior management commitment, clear and accepted standards of safety performance, inviting comments and feedback from the shop-floor (and being seen to act upon these), and the very real involvement through action teams and other consultative processes. Where these were in place, mills not only had better-performing safety management systems, showing the importance of safety culture in developing an effective safety management system, but also a more holistic view of safety.

Safety culture weaknesses were still noted across the case studies, although these were less prevalent:

- Ineffective line management, arising from inconsistent safety messages, and / or communication blockages;
- Lack of workforce involvement and consultation;
- The perception that accidents are inevitable misfortune, or due to worker incompetence / a lack of common sense on the shop floor;
- An absence of an overall belief in safety within the mill, sometimes linked to a lack of safety leadership.

None of the mills were excellent in all areas; some of those with the better safety cultures still had areas where attention was required.

### ***Accepted levels of safety-related behaviour***

Mills with good safety cultures typically had accepted definitions and standards of safety related behaviour. Employees understood what was required of them in terms of safety performance, understood the rationale for safe systems of work and personal protective equipment and complied with these systems, as well as knowing the consequences of failing to comply (e.g. increase accident potential, discipline). Typically, good mills had got this message across by 'getting people on board' by a variety of methods:

*We surveyed the workforce on what they understood safety to be, and went from there;*

*We focussed on attitudes, training, systems of work and involvement;*

*It's about hearts and minds and leadership, far more than it's about systems. Had various methods of 'encouragement'; the most important was demonstrating that we mean what we say about safety.*

These comments come from managerial staff at three different Mills; comments from the shop floor show how this worked in practice:

*[Wet end operative] The job takes longer now because of safety, but you don't mind because you can see how it can save you from losing a hand or a foot in the long run;*

*[Paper technician] Safety's good, we've got behavioural safety teams now, and we have briefings about safety, what should be done and how people should behave;*

*[Safety Rep] Safety's changed; if you pointed something out, it used to be "Oh, it'll do for now", but now they just get things sorted straight away.*

Mills where everyone was 'singing from the same hymn sheet' and had a shared understanding of the importance of safety and risk control had good safety cultures.

A number of the mills had tried to improve safety attitudes and safety behaviours through behavioural safety initiatives, however only one out of the eight case studies had successfully implemented a scheme. At one of the mills their 'Behaviour Based Safety' scheme had been labelled: '*Big Brother Spying*', and was seen as management abdicating responsibility for managing safety. The following statements summarise the general opinions of behaviour-based safety:

*It's a joke here, half-cocked. Management should fully support it – they don't. Management should trust us to do observations; people can't be bothered and don't volunteer.*

*People don't have the bottle to challenge people. Management's response is to threaten discipline for not observing. So observations tend to be on unsafe conditions rather than behaviour.*

*It was implemented wrong, and is used as a 'catch-people-out' scheme. The culture is not right; people are defensive and have their backs up.*

The overall conclusion on behaviour based safety is that it is not an appropriate mechanism to improve safety culture until basic levels of safety management and safety culture have been achieved. There needs to be high levels of trust and a common understanding between management and the workforce concerning the purpose of such initiatives.

### **Key role of line management**

Line management and supervision was a continuing problem within mills, and recognised as central to improving safety culture. One production manager stated:

*We're improving performance, but will only get a big difference when most of the semi-management people work to the safe approach. The culture's not there for everyone yet, it needs to be a peer condition, where it's unacceptable to them to see people acting unsafely.*

In a mill with less of an issue at line management level, a machine operative commented how 'you can't be unsafe now, the others won't let you'; an example of peer pressure. A member of senior management, from the same mill, explained how there was an initial problem with 'how to get line management buy-in', suggesting:

*We targeted the supervisors from the start, as they're the important ones. If the supervisors don't buy in, no change will occur, as they're here 24/7.*

This recognition of a common pitfall and the need to achieve supervisory buy-in is one of the key factors in achieving safe attitudes at all levels. However this was not easily achieved, for example one safety adviser stated:

*Some line managers have bought in, some haven't - it's causing the risk assessment drive to fail. The next step is to introduce key performance indicators, which will allow us to give people a good kicking if they're not up to scratch. KPIs will make people accountable.*

In this mill their reaction to a lack of buy-in by supervisors and the consequent lack of follow-through in terms of supervisory responsibilities was to apply pressure to those involved, which may prove counter-productive unless support and training are also provided to achieve successful buy-in.

### **Workforce involvement and communication**

Another key element of safety culture concerns workforce involvement and consultation. The better mills, with successful line management buy-in, had recognised the need for involvement, seeing supervisors as the key to the success or failure of improved safety performance. Poorer mills failed to recognise the importance of workforce involvement in terms of developing accepted safety measures, which led to increased enforcement and also resulted in a failure to modify the failing systems.

‘Effective means of communication’ was raised as one of the significant elements of a good safety culture. Poor communication had various knock-on effects, including lack of involvement and consultation. This was an issue for many of the mills, and not only the poorer safety culture performers. Impacts were wide and varied, with one of the main implications being ‘missed opportunities’, where shop-floor personnel had recognised either problems or solutions that had not been followed up, for example:

*Risk assessments are a laugh - they haven't got all the working procedures in place yet. So they look at a job, see it's unsafe, a ticket gets issued - but there's no procedure for doing it. You ask how you should be doing it, management say they don't know, so then Maintenance will work unsafely to put the controls in place*

In this example risk assessments lead to maintenance jobs, but no safe systems of work are in place for carrying out the maintenance work. So risk assessment is not used holistically to ensure adequate risk control.

*With accidents, they go on about the guarding, but the de-manning has meant that we've lost lads for cleaning. The pulpers used to be swilled regularly, and were always kept clean. Now there's not enough time and if you walk in slippery areas, you're going to fall over.*

A further comment from a Machine-Man illustrates the awareness of the workforce and also shows the impact of involvement:

*Older people find it harder to get used to all the guards; it's been fine for years, so why are we suddenly doing it now? It's very frustrating. Moving parts are the biggest problem; it takes an hour and a half to take the guard off on a Saturday morning to get underneath. But 'Design' is starting to see the operators' point of view, they ask for our opinion on what they have to do, and we suggest things that are better.*

### **Safety belief across the company**

An organisation-wide belief in safety is a key element of safety culture. This is manifested in a number of ways, for example belief that accidents are preventable and can be controlled by safety initiatives. In good safety cultures all levels of staff exhibit these beliefs. However, there were also instances where accidents were described by both managers and staff as inevitable, there was disillusionment or frustration with the ‘latest safety initiative’ on the shop-floor, and safety was perceived as an unattainable goal.

During the study it was found that mills with a poor safety culture perceived workers as lacking common sense. Comments from management suggesting this included:

*People are long serving here - familiarity with the machine breeds contempt;*

*There's an invincibility, they think "it's not going to happen to me";*

*There's a difference between accidents where it's caused by a real problem, like the machine, and those where it's due to complacency...*

On the whole, people on the shop-floor tended to be aware of this as a postulated reason for high injury rates, and were fundamentally opposed to the idea that they would put themselves unnecessarily at risk. However, perception plays an important part in this argument; workers at many of the mills displayed a 'macho' attitude towards hazards seen as inherent to the job. No one voiced the opinion that the implementation of safety management systems will be inhibited if people do not understand that accidents are preventable.

### **Commitment to safety improvement**

All mills appeared to be committed to improving their safety performance and achieving the PABIAC objectives. However intentions and commitment did sometimes falter, as the following quote from a Senior Manager at a poorer-performing mill illustrates:

*It's difficult to get the value across in terms of culture - management commitment's lacking, there's a lack of buy-in to the process; supervisors at the sharp-end end up straddling the fence - safety's a chore, an extra burden on the workforce. There's a macho environment of risk-taking.*

However, he clearly understood what needed to be done, and went on to describe the inadequacy of communications, lack of audit and feedback, the need for more safety awareness, problems with getting the message through, and the need for better in-house enforcement. Other personnel, both management and shop-floor reiterated this awareness of the direction the company needs to move in, suggesting that audits are 'getting stronger', that communication is improving with increased safety meetings, that workers are more involved in safety matters.

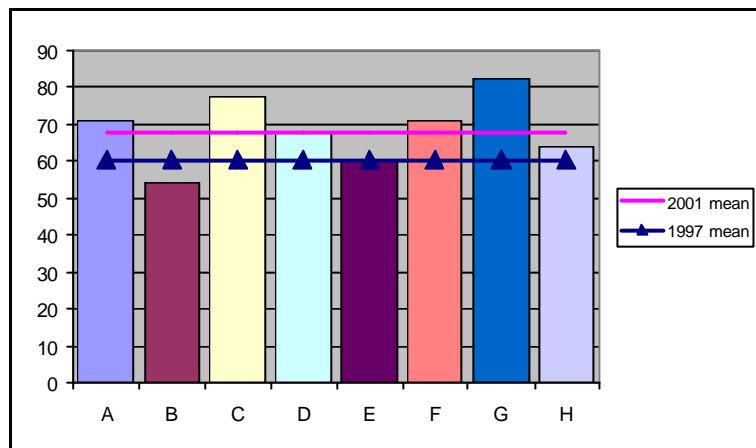
This is a story common to many of the poorer mills. Where safety culture was lacking in fundamental areas, these mills tended to recognise their failings and were striving to improve, making good starts with a pragmatic awareness of the uphill struggle and the time required to turn around a mill's safety culture. A comment from a mill with one of the poorest safety culture scores illustrates this, describing how change will eventually come about:

*Some old-timers still remember when we were pressurised to cut corners - it'll take time to change. We'll get there eventually. Some teams are quite new: noise and ergonomics are just getting established; we're looking for volunteers for safety teams. We need to get performance measurement live, and carry on fine-tuning the policies and procedures.*

### 2.7.3 Relationship between safety culture and injury rates

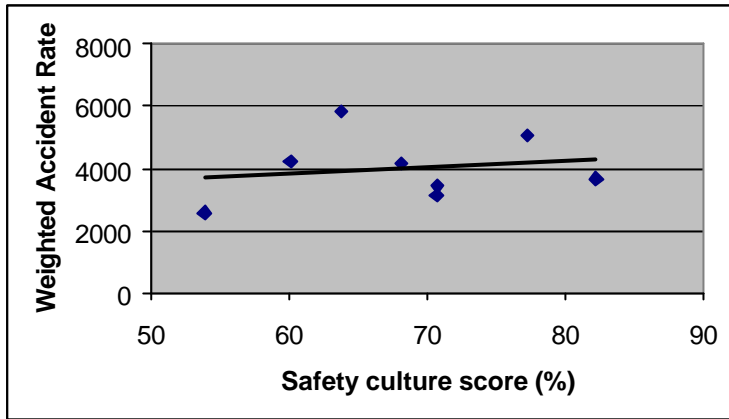
The safety culture scores are displayed in Figure 13.

- The safety culture mean has improved from 60 (with 95% confidence limits that the mean lay between 48 and 72), to 68 with confidence limits of 62-74.
- There is less variability in the scores attained this time, compared to the previous study.
- Only one out of the eight mills in the current study has a score below the mean from the previous study.
- There are fewer very good mills in the current study; this is probably because the sample was predominantly composed of mills with poor and average injury rates. However on a positive note, there were fewer mills with poor safety culture scores.



**Figure 13: Safety culture scores by mill**

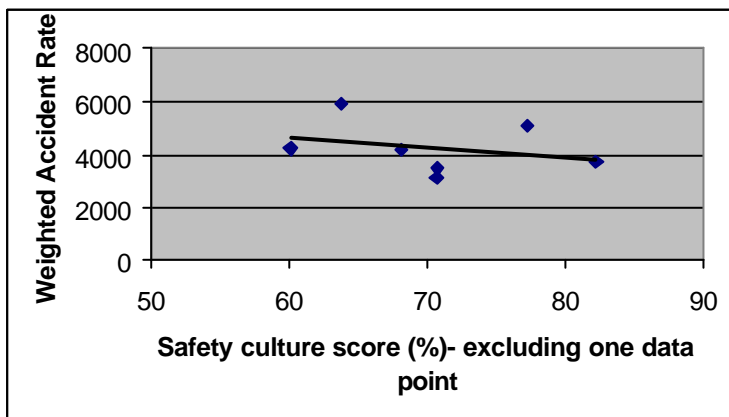
When the safety culture scores are plotted against injury rate, the pattern of the scores against injury rate is not consistent with that previously found or that anticipated (see Figure 14). It would be expected that a mill with a good safety culture would have a good accident record, and one with a poor safety culture score would have a high injury rate. However the data appears to suggest that a poor safety culture correlates with a low injury rate.



**Figure 14:** Safety culture scores and weighted accidents

On detailed examination, it was found that one mill was skewing the data. The mill in question was part of the original study and had scored highly at that time, but its safety performance has deteriorated dramatically in the intervening years. There seem to have been a number of contributory factors, but management noted that under-reporting of accidents prior to the start of the PABIAC initiative meant that when reporting improved the injury rate target was unachievable, which led in turn to disillusionment and demoralisation about safety performance.

The combination of factors present at this mill is exceptional, and in using the results of the research to help understand the underlying factors governing safety performance it therefore seemed valid to concentrate on the remaining 7 mills. When this mill is omitted, the pattern is as expected, i.e. a mill with a good safety culture score has a low injury rate and vice versa. The strength of the relationship is difficult to see as both measures are clustered around mid-range performance and therefore the correlation is still not strong (see Figure 15 below).



**Figure 15:** Safety culture scores (one mill omitted) and weighted accidents

#### **2.7.4 Conclusions on safety culture**

The key findings on safety culture from the case studies are:

- Safety culture has on the whole improved across the mills revisited;
- There are now better standards of safety culture in the case studies, in particular leadership, line management and safety attitudes have improved;
- The mean score on safety culture has improved since the original study;
- The relationship from the original study generally holds, namely that mills with high safety culture scores will have lower injury rates;
- Based on our qualitative and statistical analysis, when the sample is adjusted to take the outlier into account, it seems reasonable to predict that standards of safety culture will have improved across the industry.

**Table 7: Safety culture issues in HSL study and current study**

<i>Safety culture element</i>	<i>HSL study (1997)</i>	<i>Current study (2001)</i>
Commitment to safety by senior management	<p>Widely differing levels of Mill Manager/senior management involvement.</p> <p>Majority of Mill Managers were largely invisible on the shop floor.</p>	<p>A large proportion of Mill Managers understood the concept of visibility and ‘walking the talk’.</p> <p>Higher levels of awareness of their responsibilities and accountabilities, as well as an understanding of the challenges of managing the safety/production balance.</p> <p>PABIAC Initiative emphasised the importance of senior management commitment to safety. A number of elements of the initiative focused on this.</p>
Commitment to safety of first line managers	<p>The quality of supervision was weak in most of the mills.</p> <p>Role perceived as being predominantly production oriented.</p>	<p>Standards of supervision have improved in the main. Supervisors still feel there is a conflict between safety and achieving production goals.</p> <p>Better mills had systems in place to manage these conflicts, and the support of senior management was acknowledged.</p>
Individual safety awareness	<p>The full range of attitudes was found, from strong safety awareness with committed and aware employees through to blasé and unaware of the physical hazards and necessary risk controls.</p>	<p>Far greater understanding across the industry of the importance of safety, a greater degree of ownership of safety and better levels of safety training.</p>



<i>Safety culture element</i>	<i>HSL study (1997)</i>	<i>Current study (2001)</i>
Resources allocated to safety and training	<p>Predominantly mandatory skills training.</p> <p>No links to risk assessment, safe systems of work and training.</p>	<p>Massive increase on the amount of time and money spent on training and safety since previous study.</p> <p>A number of computerised safety management systems.</p> <p>Weaknesses still in the areas of competence, links to risk assessment and safe systems of work, and training matrices (i.e. a system that recognises when someone is doing a job that they are not competent in).</p>
Production/safety balance	<p>Wide variation in the way this was managed.</p> <p>Not all workforces had the power to halt production in unsafe circumstances.</p> <p>Mixed messages concerning the relative priority of safety and production.</p> <p>Particularly challenging for first line managers to manage this balance.</p>	<p>The production/safety balance appears to be significantly better managed now.</p> <p>The workforce at the majority of mills said they would stop production if something was unsafe.</p> <p>Some of the mills however had to use the GPMU 'Say No to Unsafe Jobs' campaign.</p> <p>Did not appear to be as important an issue as in the first study. However a number of the mills are currently undergoing production outages due to a poor economic market.</p>
Accident causes/ Claims/Sick pay	<p>Fairly widespread belief that accidents happen as a result of negligence and bad-luck.</p> <p>Provision of sick pay and claims increases the likelihood of accidents.</p>	<p>This factor was still prevalent, though predominantly in those mills with poor safety culture and safety management scores.</p>

<i>Safety culture element</i>	<i>HSL study (1997)</i>	<i>Current study (2001)</i>
Response to accidents/ Organisational Learning	Wide range of findings on this issue, ranging from a belief that accident reporting and investigation was onerous, through to necessary for management action and understanding.	Again widely variable in terms of reporting, investigating and learning from accidents.  Best practice at one of the mills involved a process of collecting all data: accident, incident and near miss, carrying out investigations, feeding back the findings to all relevant personnel.
Financial health	Widespread change.  Restructuring and de-manning.	Many of mills currently undergoing significant organisational change, either in ownership, headcount, mechanisation etc.  Also some of the mills were under severe financial pressure as a result of the strength of the pound, and impending recession.
Safety focus of organisation	Variable in efficacy of safety committees.  A range of behavioural safety schemes in use, or in development.  Overall not much activity on safety.	Most mills had dramatically modified their safety committee structure to address internal communications.  The PABIAC Initiative meant that many more safety initiatives were underway within the mills.  Behavioural safety initiatives had been abandoned at most of the mills (only one of the 8 had a moderately successful initiative). It was recognised that Behavioural Safety was not an appropriate mechanism to improve safety culture until basic levels of safety management had been improved.

## **2.8 SAFETY MANAGEMENT SYSTEMS**

### **2.8.1 Findings from the 8 Mills**

Standards of safety management have significantly improved since the original study. In particular this is demonstrated by the existence in mills' safety management systems of the 'measure', 'audit' and 'review' elements from HSG65, which were not evident in the original study. A key element of the mills visited with good safety management systems was the way that they actively used these organisational learning elements, whether it was audit data, accident and near miss root causes, or accident statistics. Key areas of improvement are summarised in Table 8 at the end of this Section, including:

- Far better safety policies, including roles and responsibilities as well as codes of acceptable behaviour;
- Massive improvements in the communications pathways, including appropriate levels of briefings, toolbox talks etc.;
- Improved cooperation between management, safety representatives and employees in the development of risk controls;
- Some examples of excellence in terms of linking job descriptions, safe systems of work, training schemes and competence;
- Most mills had systems in place for reporting accidents that appeared to work effectively;
- PABIAC Action Plans were used as a tool for tracking progress on these items;
- Most mills carried out some level of audits and inspections.

#### ***Training***

Training was one of the key areas of action for all mills. Many attributed to this to PABIAC, though some interviewees also cited downsizing and multi-skilling programmes as drivers.

Two main types of training were included. Generic safety training included NVQs and the IOSH Managing Safely course. Additional more specific training was either routine skills renewal by the mill, or to provide competence in a new area. In the latter category, this tended to be driven either by the need to increase diversity of employee skills as a result of downsizing, or accompanying a new initiative (for example, employees carrying out risk assessments). A best practice approach drawing from all mills would include:

- Systematic identification of individual training needs;
- Allocation of human and financial resources, specific to training requirements;
- A system for monitoring employee competence and automatic identification of training renewal needs;
- In-house training to accompany mill safety initiatives (e.g., risk assessment / audit training);
- Systematic inductions, including contractors; and
- Reduced reliance on 'sitting with Nelly' as a training tool.

On the whole, mills tended to have recognised the inconsistency in the ‘sitting With Nelly’ approach to worker training, moving towards induction according to working procedures and a more systematic process of competence checking. However training application and ensuring competence was still problematic at most mills. Shortcomings include: a lack of methods for ensuring that people could safely carry out their jobs; reliance on individuals recognising the limits of their competence; poor linkages between safe systems of work and risk assessment within training; reliance on informal assessment methods. The following are typical quotes from case study mills:

*Learn not to put your hand in moving parts. It's down to you to think about what you know and what you don't know.*

*Use gut instinct to work out if someone is safe on the job.*

*Management try to intimidate us to sign off someone as proficient. But I won't tick off until someone is safe and competent.*

### **Risk assessments**

The quality of risk assessments was hugely variable, both across and within the eight mills. Elements of best practice included:

- A defined and communicated methodology;
- Workforce involvement in, or ownership for, conducting assessments;
- A clear system for prioritising and implementing controls (whether technical or procedural);
- A defined method for feeding results of assessments into related documentation, for example systems of work, identification of training needs, operating procedures; and,
- Process for assessment review.

Practice considered poor included assessments that were:

- Lacking clear standards and methodology - in identification of activities / locations to be assessed, or in carrying out the assessment itself to certain defined standards;
- Conducted in an ad hoc fashion across tasks / departments;
- Written but not communicated;
- Communicated but not used, for example, lack of impact on safe systems of work, or controls not implemented;
- Resulting in risk control procedures written but not used; and
- With outcomes quantified in an ad hoc fashion across departments, so priorities in risk control did not reflect levels of risk.

Risk assessments are more effective with employees involved in the process, and mills successful at risk assessment used shop floor personnel to develop them. This tended to foster employee acceptance and use, not only of the assessments and controls, but also of accompanying procedures or systems of work. One mill had attempted to create risk assessment teams within each shift, although only one of these was reported as fully functioning. This same mill had also identified the necessity of ‘active’ assessment, with the results being fed into safe systems of work and to be used to identify multi-skilling requirements.

One of the better performing mills attributed increased attention to risk assessment to both the PABIAC Initiative and a HSE improvement notice, with a Services Manager stating that this joint impetus allowed him to justify increased employee time spent on conducting assessments. The Safety Adviser of the same organisation suggested that PABIAC:

*Has helped with a uniform approach to both risk assessment and safe systems of work. We're trying to increase implementation of a common approach to both.*

The practice of using assessments to 'feed forward' into areas such as work statements, training needs and so on was clearly identifiable within the mills where risk assessments were perceived as useful, and more than a paperwork exercise. A supervisor described how this works in practice, also reiterating the link with other aspects of the SMS:

*With the risk assessments, we go through them based on our own experience, note down the hazards and the way we overcome them. Then you have to assess it according to a scale, and then write the system of work, taking the risk assessment into account. Then they're issued to the whole crew on the job, plus they get a long method statement.*

When a wet-end operative from the same mill was asked about risk assessments, he explained the process:

*They're done by the people familiar with the job, we're used to them now as they're part of the induction. Sometimes we do find things that have been changed - you just raise it and re-do the assessment.*

### **Safe systems of work**

The process of developing, documenting and adhering to safe working practices was in various stages at the mills. The following four comments showing the range of achievement:

*No Safe Working Procedures have been issued yet - we've got a problem with involvement;*

*Procedures are done for 50-60% of operations;*

*They now insist on a method statement and a toolbox talk before we do any work;*

*Everything's got a safe system of work now, most of the time it works - now everyone sings from the same hymnbook.*

A paper technician from this mill added, 'they're there for a reason - no-one will do any job until they've read all the paperwork ... it's supported by the training.' This element of acceptance was lacking in some of the poorer performers, an operative from one such mill stating:

*We've got safe working procedures, like for how to clean a piece of kit. The co-ordinator makes you go through them, but most aren't complete. It's just words.*

As with risk assessment, safe systems of work require the involvement and ownership of those actually carrying out the work activities. Where involvement was gained through either a link to the risk assessments, or procedures developed through worker consultation, the safe systems were both used and praised as having greater relevance to tasks.

### **Near miss / incident reporting and investigation**

Six of the eight mills reported increased focus on near miss and incident reporting, with one of the best performers suggesting a possible reason for their success:

*Reporting is increasing, possibly due to the increase in money churned into visible corrective actions. We wanted to create the impression that reporting was important, that it has to be done, and results in action to change things.*

A second mill described a positive outcome as ‘*encouraging discussion of all incidents*’, a third noted wider management impact, as ‘*whilst the system’s only been there for a couple of months, it’s good for making people accountable*’.

However, although most of the mills seemed to be focussing attention in this area to some degree, the overall rate of reporting could still be vastly improved, as could the methods of devising and implementing corrective actions. Critical to the continued efficacy of reporting schemes is the role of investigation to identify root causes and implement corrective actions. The most effective schemes were those where all incidents were investigated with a team composed of management, safety reps and employees using some sort of root cause analysis technique; the findings from the investigation were then reviewed by management and discussed at the appropriate safety committee. A culture of following up accidents and informing personnel of the outcome supported this effective process.

### **Proactive methods for instigating improvements**

All mills had some form of reactive monitoring (even where this was only accident reporting), but only a few had systems for proactively seeking areas to improve. One method adopted was a specific procedure whereby employees could fill in a form identifying action needed and suggesting a control method. This was received well across the organisation, with the Mill Manager suggesting:

*Lots of the workforce were unsure about using the Performance Action Requests at the beginning, which was a trust issue. Now they’re used widely - the system’s working.*

In this instance, ‘Performance Action Requests’ (PARs) are initiated by an employee. Their shift manager logs the request and passes it to an appropriate person for action, and provides feedback to the originating employee. A comment from the shop floor reiterates how this is working:

*You fill out PARs when you think something’s dangerous - it goes to the shift manager who makes comments to send for action. It seems to work.*

Another method, with similar outcomes, is the creation of safety-dedicated teams. In the mill where this was working particularly well, each department was charged with identifying its own areas for improvement. A supervisor commented:

*The Safety Action Teams work better. You look at your own area, and it involves more people. We get them to do their own risk assessments and safe systems of work.*

An operative involved in an Action Team pointed out, *'it's nice to have involvement, we try to get more than just a shopping list of actions'*. This raises the main positive and negative issues associated with this type of monitoring system; namely that involvement improves the quality of the process on one hand but on the other there is a danger that the process continues collecting a long list of maintenance items. Workforce participation, improved communication and the maintenance of a proactive attitude towards safety are enhanced by these processes.

The mills' experiences highlighted the need to ensure effective feedback loops, as it appeared that reporting 'into a black hole' was hugely detrimental to both further use of the system, and the perception of the efficacy of mill management. When issues were not resolved quickly enough, people got disheartened and systems fell into disuse. Mills seen to be the most effective were carrying out monitoring to ensure that improvement systems didn't just generate lists of 'jobs to do', and were also not being misused as a method of 'jumping the queue' on engineering tasks.

## **Review**

This final element of SMS covers reviewing both performance and systems to ensure that they are achieving the required objectives. Despite the fact that most mills now had systems for measuring and auditing performance, the link back to see whether or not systems were achieving the required objectives and subsequent revision of systems was rarely present. Most of the mills did not have fully developed review processes, although a number of mills did have a system for keeping action plans up to date.

### **2.8.2 Improved safety management and links with the PABIAC initiative**

The mills reported a clear link between the PABIAC Initiative and improvements in safety management systems. Key features that could have affected performance include:

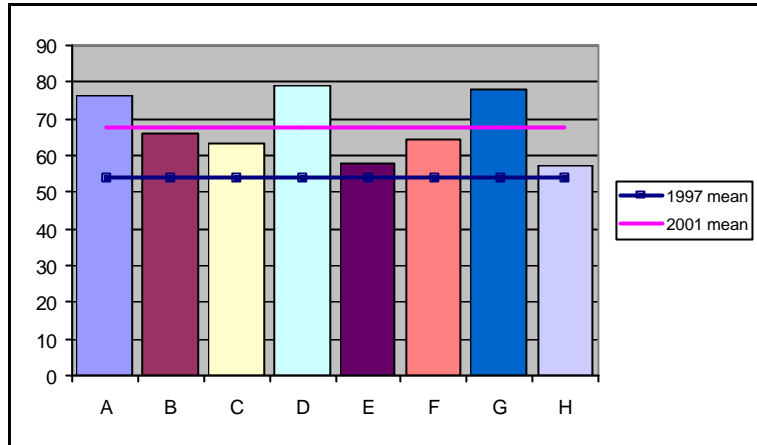
- PABIAC Initiative emphasis on improving standards of safety management and adopting HSG65 across the industry;
- Safety management is a relatively easy and tangible issue to address and develop - the required standards are clearly defined and well recognised;
- Increased safety resource in the mills;
- Increased amount of HSE inspector's time as well as increased enforcement action. A number of the mills had Improvement Notices issued during the initiative to improve standards of safety management, e.g. risk assessments, safe systems of work etc.

### **2.8.3 Relationship between safety management and injury rates**

The following chart (Figure 16) presents the Safety Management Systems (SMS) scores from the current study for the eight mills, along with the means from this study and the original. All mills achieved better safety management scores than the mean from 1997. There is less variation in the standards of safety management in this study, and the standards of safety management have significantly improved since the original study.

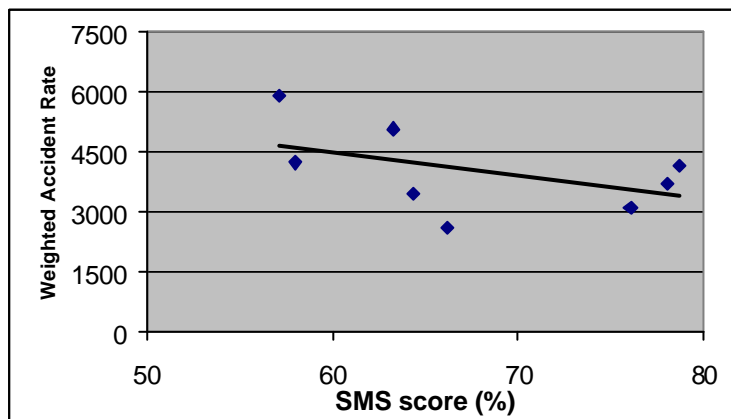
In the 1997 study the mean SMS score was 54 with 95% confidence limits between 44 and 64, whilst in the current study the mean score is 68, with upper and lower confidence limits of 74 and 61. There is less variability in the scores in the current study than in the original, with fewer noticeably poorer or noticeably better mills.

These results suggest that the mean score for the industry is likely to fall between 61 and 74, whereas the 20% difference in the previous study made the scores a less reliable guide to the standards of safety management across the industry as a whole.



**Figure 16: Safety management system (SMS) scores**

Based on Figure 17 below<sup>1</sup>, there appears to be a relationship between good SMS scores and good safety performance, as measured by weighted injury rates. This can be interpreted as meaning a mill with a better safety management system will have lower injury rates, whilst a poorer SMS score correlates with higher injury rates.



**Figure 17: SMS scores and weighted injury rate**

<sup>1</sup> Note this includes the mill excluded on safety culture



#### **2.8.4 Conclusions on safety management systems**

The safety management case study findings mirror those for safety culture.

- Standards of safety management have improved markedly across the mills revisited.
- Improvements were noted in training and, with greater variability, in safe systems of work and risk assessment. Event investigation has improved but systems for proactive instigation of improvements were less effective.
- Most mills had systems for measuring and auditing performance, but feedback to revision of management systems and policies was much less common.
- Mills reported a clear link between improvements in safety management and the PABIAC Initiative.
- High safety management scores generally correlate with lower injury rates.
- Based on our qualitative and statistical analysis, it seems reasonable to predict that standards of safety management will have improved across the industry.

**Table 8:** Safety management issues in HSL study and current study

<i>Safety management systems element</i>	<i>HSL study (1997)</i>	<i>Current study (2001)</i>
Policy	<p>A generic document with no supporting materials.</p> <p>Poor (or non-existent) communication to the workforce.</p>	<p>Mills typically had better policy documentation - typically communicated, briefed, and displayed on notice boards.</p> <p>Supported by a clear understanding of roles and responsibilities, clear standards of acceptable behaviour.</p>
<p>Organising:</p> <ul style="list-style-type: none"> <li>▪ Control</li> <li>▪ Cooperation</li> <li>▪ Communication</li> <li>▪ Competence</li> </ul>	<p>Risk assessment not used as a method of risk control.</p> <p>Few systems of identifying training needs, providing job descriptions or appraising performance.</p> <p>Cooperation and mechanisms to cooperate were rare in the mills. Participation in the management of safety was not apparent.</p> <p>Widely variable standards of training.</p>	<p>Most mills had revised their communication systems, to increase their effectiveness.</p> <p>PABIAC initiative was cited as the reason underlying the massively improved cooperation between management, safety representatives and employees in the development of appropriate risk controls.</p> <p>Some excellent examples of job descriptions, safe systems of work, training schemes and competence assessment.</p> <p>Few mills had robust systems to trigger when training and competence assessment is required.</p>
Planning and Implementing	<p>Variable standards of risk assessment</p> <p>Failure to recognise the importance of involvement in the workforce to develop appropriate and accepted control mechanisms.</p> <p>Behavioural safety was adopted by a number of the mills.</p>	<p>Risk assessment, as a measure of risk control was not used in all mills. Only a couple had complete and adequate risk assessments. Some mills were integrating risk assessments with safe systems of work. Processes typically involved consultation and participation.</p> <p>Behavioural safety had been attempted by the majority of the mills and had been abandoned in all but one. Reasons for their failure included a poor culture, lack of management backing, a blame culture etc.</p>

Measuring	<p>Lack of incident and accident reporting. It was considered onerous and linked to incentive/reward schemes.</p> <p>A suggestion that not all accidents are reported.</p> <p>Accident and incident investigation was not common.</p>	<p>Most mills appeared to have good mechanisms for reporting accidents. In fact most mills appear to report all accidents, though incident and near miss reporting is less common. Incident, damage and near miss reporting systems operated with variable success across the mills.</p> <p>Investigations occurred where necessary, although the better mills carried out some level of risk assessment on all incidents. Root cause analysis was patchy.</p> <p>Feedback mechanisms' notifying the outcome of investigations and subsequent actions was unusual.</p> <p>The PABIAC Action Plan placed an emphasis on tracking performance against the items within the plan. This was used to varying standards of success.</p>
Auditing	<p>Not assessed in the original study due to its widespread absence across the element. This is reinforced in the findings from the interim PABIAC audit.</p>	<p>Mills from larger multi-national or multi-company environments typically had corporate audits.</p> <p>Most mills had hierarchies of audits and inspections.</p>
Review	<p>Not assessed in the original study due to its widespread absence across the element. This is reinforced in the findings from the interim PABIAC audit.</p>	<p>Typically the mills were poor on this element.</p>

## 2.9 PREDICTED INJURY RATES

### 2.9.1 Introduction

The analysis detailed in Appendix 3 shows that there were positive correlations between all three dimensions used in the study. For the 8 mills, the findings were as follows:

- A weak correlation between the safety culture and SMS scores;
- A moderate correlation between safety culture score and the technological risk score indicates a tendency for mills with *greater* technological risk to have a *better* safety culture;
- A near perfect correlation between the safety management score and the technological risk score indicates that mills with the greatest technological risk are those with the best safety management systems.

The closeness of the correlation between these two measures means that it is extremely difficult to disentangle their *independent* relationship to other factors (e.g. injury rates). Note that the relationship between technological risk and the other two ‘safety’ measures is the reverse of that noted in the original study.

### 2.9.1 Relationship between factors and injury rate

The weighted injury rate has been used in this part of the analysis. This combines minor accidents, major accidents and fatalities into a single injury rate with progressively greater weight being given to more serious accidents.

In the original study, the relationship between weighted injury rate and the three dimensions assessed during the case studies was as follows:

- Negatively related to safety culture, i.e. the higher the safety culture score the lower the injury rate;
- Negatively related to safety management systems, i.e. the higher the safety management score the lower the injury rate; and
- Positively related to technological risk, i.e. the higher the technological risk score the higher the injury rate.

The analysis in Appendix 3 for the current study indicates that the relationship with injury rates is the same as in the original study for safety culture and safety management systems. However contrary to expectation *lower* (better) injury rates are observed in mills with *greater* technological risk. It is tempting to suggest that this is because technological risk is subordinate to safety management, but the sample is far too small to draw this conclusion.

## 2.9.2 Mill-by-mill analysis and the prediction of injury rates

Section 7 of the original HSL report dealt with the explanation and prediction of injury rates as a function of safety culture, safety management systems and technological risk. This was explored using multiple linear regression, and a similar approach is adopted here.

The sample of eight mills is not statistically robust enough to develop a new model, in particular since the variability in the scores is small and the random variation in injury rates will probably mask its influence. To determine whether the relationship observed in 1996/97 holds for 2001, actual injury rates were therefore compared with predictions obtained by inserting the case study scores into a linear model derived on the basis of data collected for the original study.

A good match would help validate the relationships observed and the predictive rule derived in 1996/97. The model would have provided a valid prediction for both an independent new sample of mills and a repeated sample of mills where there have been clear changes in the safety measure scores. The argument that changes in injury rates can be attributed to changes in safety culture, safety management systems and technological risk would therefore be strengthened.

### ***The predictive linear rule***

The linear regression method described in Section 7 of the original HSL report was used to model the relationship between the three factors and the annual weighted injury rate. The mean annual weighted injury rate from the two years prior to the PABIAC Initiative was used as the dependent variable (i.e. 1996/97 and 97/98) and the following linear rule was derived:

$$\text{Expected injury rate} = 9244 - 88(\text{SC}) - 16(\text{SMS}) + 25(\text{TR})$$

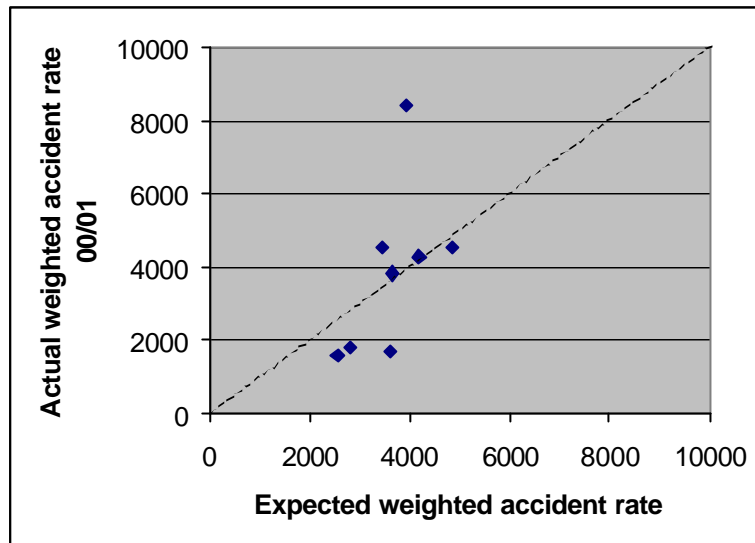
This rule accounts for 56%<sup>2</sup> of the variance in the annual injury rate (adjusted  $R^2 = 0.561$ ). No variable is independently significant in the equation. However the overall relationship *is* statistically significant i.e. the formula and combination of factors is very likely to predict injury rate (see Appendix 3).

The equation can be interpreted as follows: “Holding other variables constant we expect fewer accidents the greater the safety culture score, the greater the safety management score, and the lower the technological risk score. The ‘impact’ of each unit change in safety culture score is about 5 times greater than each unit change in the safety management systems score, and about 4 times greater than each unit change in the technological risk score.”

This model was then applied to data from the current study. Appendix 3 (Table 3) shows the results of using the regression equation to predict the weighted injury rate for each mill using the 2001 safety culture, safety management and technological risk scores. The results are shown in Figure 18 below. There is a moderate to strong positive linear relationship between predicted and actual injury rates that accounts for 31% of the variance in the data. The dashed line on the chart represents a perfect match between predicted and actual data, and therefore the closer the points are to the line, the better the model is at predicting the injury rate.

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<sup>2</sup> More accurate historic injury rate data was used in this study, which results in a lower figure than the 74% identified in HSL (1998).



**Figure 18:** Actual weighted injury rate versus predicted

The ‘difference’ criterion can be assessed by examining the deviation of actual injury rates from the line of perfect prediction (shown as dotted line on Figure 18). It would seem that the ‘vertical difference’ is relatively small for 6 out of 8, moderate for 1 and large for 1 case (the outlier mentioned previously). This is verified when the mean expected injury rate for the 8 mills (3633) is compared to the mean actual injury rate (3840) which is only 5.4% different.

The actual injury rates for 2000/01 were compared to the actual injury rates before the initiative to look for patterns in injury rates across time to which the model could be attributed. It was also noted that the qualitative analysis in the previous sections of this report on safety culture and safety management revealed significant improvements. Taking all the evidence together, although the sample was small (8 mills), it therefore seems reasonable to attribute an important portion of the variation in injury rates between mills and across time to differences and changes in safety culture, safety management systems and technological risk.

## **2.10 ADDITIONAL COMMENTS ON CASE STUDY MILLS**

This section supplements the performance and injury rate assessment by capturing subjective impressions as to which aspects of the Initiative proved most effective and those that caused difficulties. The case study research team's perceptions are set out below, followed by comments from HSE operational inspectors who had been involved with the case study mills.

### **2.10.1 Case study perceptions of the PABIAC Initiative**

The activities that mills carried out to reach the target set by the PABIAC Initiative varied considerably. The following are some of the activities viewed as helping mills to improve which were more prevalent at the better performing mills:

- All mills had to develop action plans, which were then used to programme the various activities as well as monitor progress;
- Review of safety management systems in light of the Initiative;
- Training, in particular IOSH managing safety course to achieve line management commitment to safety;
- Implementation of a range of performance indicators from first aid accidents, through to time lost, near misses, behavioural safety scores, audit scores etc;
- Setting of targets, recognising the difficulty of monitoring performance only using injury rate targets;
- Endorsement and support of the GPMU 'Say No to Unsafe Jobs' scheme;
- Setting up teams to implement safety improvements, to try and get local ownership of issues;
- Implementation of technical guidance Making Paper Safely (MPS);
- Conduct of risk assessments linked to safe systems of work and appropriate control systems.

On the whole, the case study mills felt that the PABIAC Initiative had been a success. The initiative had prompted mills to develop action plans that provided a mechanism to strategically manage safety. It moved them away from the traditional reactive approach to safety management. Particular improvements identified as occurring since the Initiative began included:

- Recognition by the entire paper industry of the imperative to improve, i.e. raising the industry's awareness to the fact that injury rates in the industry were unacceptably high;
- Buy-in across the senior management group to the need to improve standards of safety across the industry;
- A clear statement to the industry that HSE and the trade unions no longer considered the paper industry's performance to be acceptable, and that the focus would be on improving standards across the board;

- Action plans that allowed mills to formalise their strategy for improving safety management, and provided a tool for managing the process;
- Particularly effective elements were: action plans, increased safety awareness at all levels, the sharing and benchmarking elements of the initiative, the focus on HSG65 and safety management;
- A shared vision across the industry, both within and between mills which facilitated significant improvements;
- Capital investment to support implementation of Making Paper Safely.

Difficulties that some mills encountered when implementing the initiative included:

- The target setting nature of the Initiative and the potential for de-motivation when injury rate targets were not achieved;
- The lack of site-wide ownership of the Initiative;
- Failure to implement the Initiative due to inadequate consultation and participation;
- The strategic nature of action planning, which ran contrary to their usual reactive approach;
- Action plans ought to have been prioritised according to risk, but this was not possible where the risk assessment process was at an early stage;
- Disillusionment over the benefits of implementing Making Paper Safely, with a belief that the financial costs would not contribute to reducing the real causes of accidents;
- Training was not integrated and it was perceived that there was no direct safety benefit.

On the whole the case study mills believed the introduction of the PABIAC Initiative had led to major changes. The Initiative raised the awareness of everyone, particularly senior management, as to the unacceptably high injury rates across the industry and provided an approach, via action planning, to help the mills address these issues. For the good mills the action plan approach formalised existing plans and arrangements and was an excellent means to manage the improvement process.

Poorer mills found the action plan approach extremely difficult, and found that it took two years to actually develop and implement a usable plan, leaving only one year of the Initiative for carrying out the actions and no time for results to feed through. A possible explanation for this is the link between developing a usable action plan through a participative and involved process and a good safety culture. From the research we have shown the links between poor safety culture and safety management with high injury rates, these are the same mills that encountered difficulties with the action planning process.



## 2.10.2 HSE Operations Inspectors' perceptions of the PABIAC Initiative

The findings reported in this section are based on interviews, mill returns and reports derived from HSE factory inspectors. Each inspector was interviewed to gather their perceptions and opinions concerning the site, as well as how effective the PABIAC Initiative had been at achieving change.

HSE Inspectors on the whole found the PABIAC Initiative extremely useful and believed it to be the main reason for changes in safety across the industry. A summary of their opinions is given below:

- Increased contact time and the focus on the paper industry meant that a concerted effort could be made to assist the mills improve;
- Increased contact time meant that there was more consistency in terms of the content of inspection and the standards applied, and also facilitated the sharing between mills in terms of best practice;
- Increased contact time also meant that general inspectors were given an opportunity to become more expert in the issues pertinent to the paper industry;
- Action plans were extremely useful and provided an excellent tool to guide inspections; in particular “they stopped the old arguments about why its impossible to improve”;
- The change of emphasis towards safety management and action plans meant that HSE’s focus shifted towards ensuring a mill ‘was capable of managing its hazards’, for instance in terms of management ability, or knowledge in terms of safety. This helped FOD intervene and help.

When asked whether the changes were self-sustaining, feelings were mixed. The inspector of a poor mill commented:

*...ended up having to take (safety manager) round the mill to highlight typical hazards for him. Once I went through the handholding phase they seem to be getting on OK, and if they stick to the action plan they should progress. But I remain unsure of their ability to do this without close supervision.*

Views from inspectors were also mixed on the issue of target setting:

*The hard target was a good stick – it stopped the industry just drifting along. It was probably pitched just right, as even though they whinged about it, it made them take action. If they had longer time or less to aim for, they’d have been complacent - as would we.*

*It’s a time-consuming process catching up with safety, turning it around and then making improvements. In general mills have accepted this state of play, that it will take longer than 3 years to see the effects of the work.*

*...think that the focus is wrong. For example a mill examined their accident data and found they had a problem with eye injuries. To reduce these accidents they instigated a massive PPE drive, all personnel to wear goggles the minute they get on site. It's a farce; focusing on accident stats and letting that dictate what you do. It's a very blunt and primitive tool. So the focus is on levels of compliance, They need tangible targets for training, procedures, PPE and stuff, but even then an accident may happen. The accident does not prove they are not improving.*

### **2.10.3 Overall case study conclusions**

The main conclusions are as follows.

- The mean safety culture and safety management scores have increased since the original HSL study i.e. the standard has improved.
- There is far less variation in the standards of safety management and safety culture than in the original study. This supports the idea that almost all mills have made efforts to improve accident performance by endeavouring to improve safety culture and safety management.
- Specific changes observed in safety culture since the first study include:
  - a greater commitment to safety by senior management and more explicit demonstration;
  - far greater understanding within the workplace of individual's safety responsibilities, and greater awareness and ownership;
  - improved competence in first line managers and better systems to assist in the management of production and safety conflicts.
- Standards of safety management were still variable, though many more mills had systems in place for managing safety. One particularly variable element is the ability of mills to learn and improve through the collection and investigation of accidents and near misses.
- Technological risk as interpreted in this methodology has remained fairly constant across the industry. Factors that would tend to reduce it have been balanced by the impact of the organisational changes the industry has been undergoing.
- Comparison of injury rates based on the predictive model with actual injury rates supports the validity of the conclusions of both the original and the current study, that improved safety culture and safety management lead to reduced injury rates.

## 3 CHANGES IN INDUSTRY INJURY RATES

### 3.1 INTRODUCTION

The purpose of this part of the research project was to examine accident data to investigate changes in the paper industry during the period of the PABIAC Initiative. This section of the report summarises the main features of the analysis and the results. The detail is included in Appendix 4.

The source data comprised accidents reported under RIDDOR covering fatalities, major accidents and over three-day accidents. Information was provided by the HSE for the 5 year period 1996/7 to 2000/01. The PABIAC Initiative ran from April 1998 to March 2001, so data was available for the 2 years before the start of the Initiative though to its conclusion.

The scope of the analysis included:

- Changes in the number of accidents;
- Analysis of industry wide figures: per 100 000 employees and per 100 000 tonnes of production;
- Analysis mill by mill: for weak & strong performers, by size of mill (employees and output) and by product.

### 3.2 NUMBER OF ACCIDENTS

Table 9 shows how injury rates changed between the period before (1996/7 & 1997/8) and in the first two years (1998/9 & 1999/2000) of the Initiative, and between the period before (1996/7 & 1997/8) and in the final year (2000/01) of the Initiative. This includes data for mills that closed since 1996.

**Table 9:** Changes in numbers of accidents for paper industry as a whole

<i>Accident Type</i>	<i>During vs Prior</i>	<i>Final Year (00/1) vs Prior</i>
Majors (inc. fatal)	-23%	-35%
Over Three Day	-11%	-17%
All	-13%	-20%

More mills have closed than have opened. So if only mills that produced throughout the five-year period are considered, the percentage changes are as shown in Table 10:

**Table 10:** Changes in numbers of accidents for those mills open throughout the period

<i>Accident Type</i>	<i>During with Prior</i>	<i>Final Year (00/1) with Prior</i>
Fatals & Majors	-19%	-30%
Over Three Day	-8%	-13%
All	-10%	-16%

Overall, accidents have reduced since the introduction of the PABIAC Initiative, and in particular the change in major (inc. fatal) accidents was significantly reduced. Only the reduction in major accidents (which includes fatal accidents) is statistically significant. Statistical analysis suggests a downward trend in injury rates.

‘Major’, ‘over three day’ and ‘all accidents’ all correlate positively with each other, i.e. there is consistency in terms of performance. Mills with higher than average numbers of over three day accidents tend to have higher than average numbers of major accidents. Mills with higher than average numbers of accidents in one year tend to have higher than average numbers of accidents in other years. This relationship is strongest for the number of over three day accidents (year-on-year) and for the number of all accidents (year-on-year), unsurprisingly as over three day accidents is the main component of ‘all’ accidents. Raw data on the number of accidents will almost certainly reflect mill size (among other things), so injury rate provides a more meaningful measure (see section 3.3 below).

The data supports the notion that ‘chance’ factors play a role in determining the *severity* of an accident. The number of major accidents in a given year is (usually) more closely related to the number of over three day accidents in the previous year than to the number of major accidents in the previous year. In other words, the number of over three day accidents *this year* provides a better indicator of the number of major accidents *next year* than does the number of major accidents *this year*.

These figures need to be interpreted in the light of any changes in the size of the industry (measured by output, number of employees, man-hours worked<sup>3</sup>, etc) that occurred in this period. These aspects are considered in the following sections.

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<sup>3</sup> Information not available at an industry level

### 3.3 OVERVIEW OF INJURY RATES

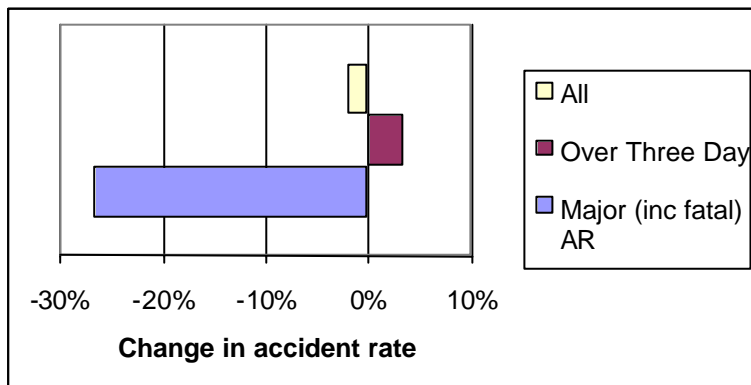
#### 3.3.1 Injury rate per 100 000 employees

Industry-wide employment dropped from 23 000 in 1996 and 18 800 in 2000 - an 18% decline. Based on these figures, a comparison of injury rates per 100 000 employees for 1996/97 and 2000/01 shows little change in the overall injury rate (-2.0%) or in the over three day injury rate (+3.3%). There was a marked decrease in the major injury rate (-26.6%).

The decrease in the total *number* of accidents (consisting mainly of over three day accidents) is therefore roughly in proportion to the decrease in the number of employees during this time period across the industry as a whole. However, the decrease in the number of major accidents exceeds the decrease in workforce size.

**Table 11:** UK paper industry: Injury rate per 100 000 employees

	<i>Major (inc. Fatal)</i>	<i>Over Three Day</i>	<i>All accidents</i>
1996/97	434.8	1987.0	2421.7
2000/01	319.1	2053.2	2372.3
Change	26.6% reduction	3.3% increase	2% reduction



**Figure 19:** Change in different measures of injury rate

(a negative score indicates a reduction)

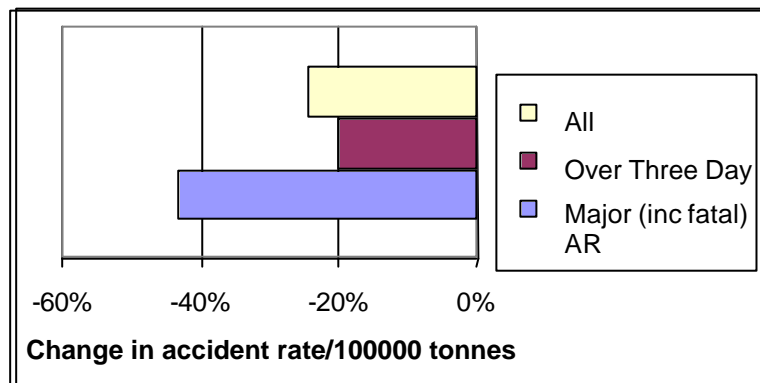
### 3.3.2 Injury rate per 100 000 tonnes production

Despite a decreasing workforce, the production of the industry has increased (from 6 224 600 tonnes in 1996 to 6 605 300 tonnes in 2000). This represents an increase in the output per operative from 270.6 tonnes to 351.3 tonnes (+29.8%).

Based on these industry-wide production figures, a comparison of injury rates per 100 000 tonnes produced in 1996/97 and 2000/01 shows marked improvement in the overall injury rate (-24.5%), the over three day injury rate (-20.4%), and in the major (including fatal) injury rate (-43.5%).

**Table 12:** UK paper industry: injury rate per 100 000 tonnes production

	<i>Major (include. Fatal)</i>	<i>Over Three Day</i>	<i>All accidents</i>
1996/97	1.607	7.342	8.948
2000/01	0.908	5.844	6.752
Change	43.5% reduction	20.4% reduction	24.5% reduction



**Figure 20:** Change in injury rates by levels of production

Overall/over-three-day injury rates have changed little and major injury rates have fallen by about one quarter over a period of time when industry efficiency has increased by about one quarter.

Based on the case study visits, this has been achieved by a combination of: delayering (i.e. reduction in supervision and line management); multi-skilling; contractorisation; more efficient papermaking machines; and the automation and mechanisation of certain parts of the process. Some of these factors might tend to reduce the potential for accidents whilst others might increase it, but more detailed analysis is not possible on the basis of the data available to the research team.

### 3.4 ANALYSIS MILL-BY-MILL

The intention of this analysis is to use injury rates (per 100 000 employees) to track changes before and after the start of the PABIAC Initiative (April 1998) at mill level.

Accident data was available for 109 mills that operated in the time period 1 April 1996 to 31 March 2001. Of these 109 mills, 21 were screened out for various reasons (see Appendix 4), leaving 88 mills for detailed analysis. Four different injury rates per 100 000 employees were analysed: minor injury rate, major injury rate, overall (unweighted) injury rate, and a weighted injury rate (weighting: minor = 1, major = 3, fatal = 10). Rates were calculated on the basis of 2001 employment figures; earlier figures were not available.

#### 3.4.1 Changes in rate

Changes in the mill-by-mill injury rates between the two years leading up to the start of the Initiative and the three years during which it operated generally mirror the industry wide figures. The main results are:

- 33% reduction in the mean major injury rate (or a 26% reduction when a factor to correct for reduced manpower is taken into account);
- 18% reduction in the mean weighted injury rate (or a 9% reduction when a factor to correct for reduced manpower is taken into account);
- 5% reduction in the mean over three day injury rate (or a 5% increase when a factor to correct for reduced manpower is taken into account);
- 10% reduction in mean overall injury rate (no change when a factor to correct for reduced manpower is taken into account).

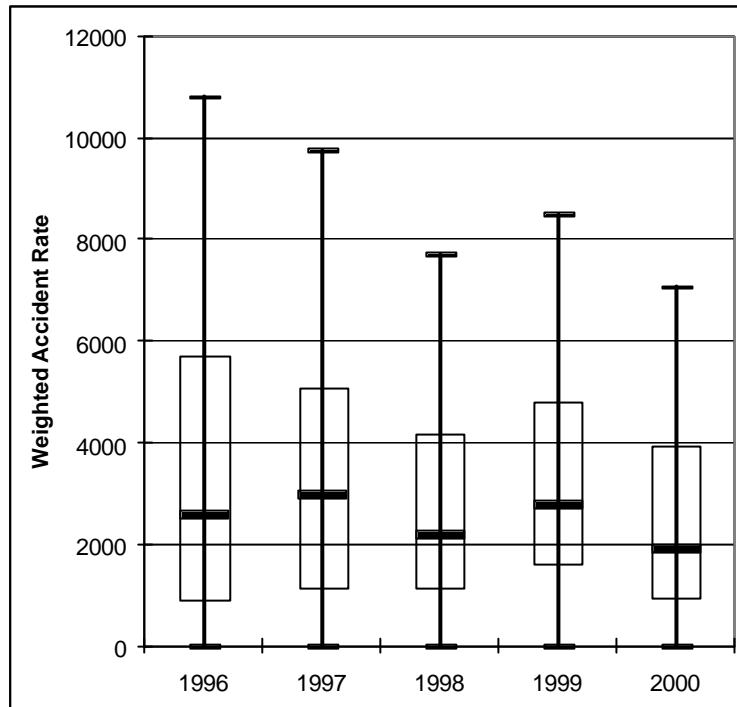
**Table 13:** Mean (standard deviation) annual mill injury rate per 100 000 employees

	<i>Over Three Day</i>	<i>Major (inc. Fatal)</i>	<i>Overall</i>	<i>Weighted</i>
Pre-initiative 1996-1998	2005 (1543)	448 (506)	2453 (1814)	3431 (2701)
During initiative 1998-2001	1902 (1161)	298 (276)	2201 (1302)	2814 (1696)

Injury rate reductions were statistically significant for major accidents and for the weighted injury rate.

The standard deviations shown in Table 13 indicate reduced variation in injury rates over time. The pattern of change is illustrated in Figure 21 below, which plots the distribution of mills according to injury rates.

The horizontal lines (reading from the bottom up) show the minimum, lower quartile, median, upper quartile and maximum values. Some outliers exist beyond the maximum – these are omitted according to a predetermined algorithm.



**Figure 21:** Box plot showing distribution of injury rates across the industry

Figure 21 shows that the reduction in injury rates following the introduction of the PABIAC Initiative is predominantly concentrated in the upper ('worst') quartile.

Where improvement has occurred, it appears to be predominantly among the 'weaker' mills – coming closer to the median performance (which changed little). In other words, fewer mills have very high injury rates, whilst the injury rate of the 'typical' mill has changed little since the initiative. Note that statistically there was little room for improvement among the 'best' mills.



### 3.4.2 Changes in injury rates for ‘weak’ and ‘strong’ performers

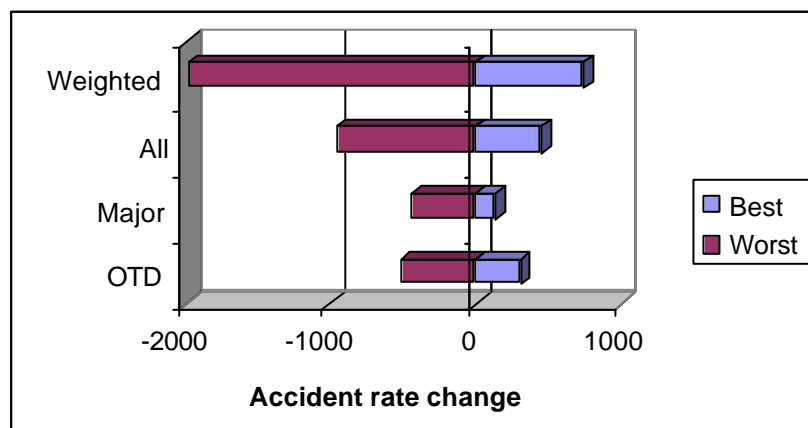
To investigate this result in more detail, mills were split into two groups according to their pre-initiative weighted injury rates. These ‘weak’ and ‘strong’ performers were then compared to see if improvements were dependent upon performance prior to the initiative.

There are important difficulties associated with interpreting this type of analysis. Even if there were no overall change in injury rates we would expect, on average, the best performers to get worse, and the worst performers to get better. This is the statistical phenomenon of ‘regression to the mean’. If some of the fluctuation in injury rates is due to chance, then we would expect that some mills in the ‘top half’ in a given year would be in the ‘bottom half’ the following year. Similarly, we would expect that some mills in the ‘bottom half’ in a given year would be in the ‘top half’ the following year. We looked for changes over and above those attributable to chance fluctuation.

The detailed analysis reported in Appendix 4 shows that the better mills prior to the HSE Initiative tended to be the better mills after the initiative. In other words there is some consistency over time as to which mills have better injury rates.

Also, although ‘best get worse and the worst get better’ on all measures as anticipated, the improvement of the ‘worst’ half always exceeds the deterioration of the ‘best’ half. This means that the better mills (in terms of safety performance) have improved least over the duration of the Initiative.

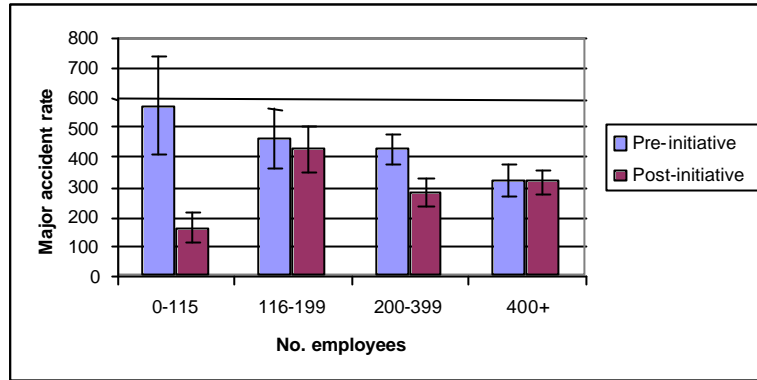
Based on the case studies, the reason for this would seem to be that good mills already managed safety in a relatively systematic and thorough manner and therefore any improvements would be harder to achieve. On the other hand, poor mills with no systematic process for managing safety, carrying out risk assessments and implementing risk controls would almost certainly be able to improve standards of health and safety and achieve quick wins. Fundamentally, safety management systems are easier and quicker to change than safety culture.



**Figure 22:** Change in performance of best and worst performers according to injury rates

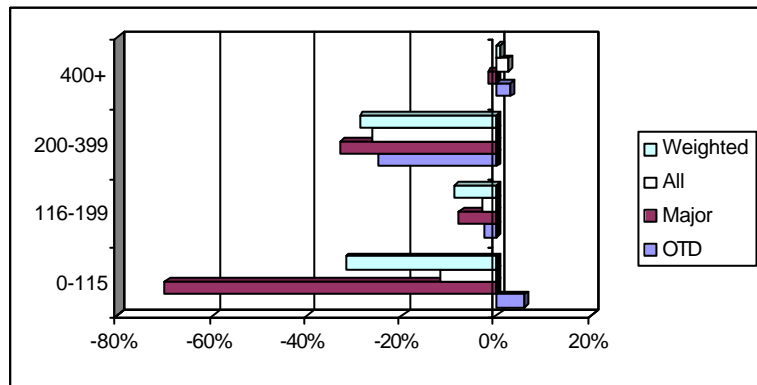
### 3.4.3 Changes in injury rate by size of mill

The mill accident data set was split up into quartiles based on their number of employees. Each group consisted of 22 mills. Injury rates for the four groups in 1996/7 and 2000/01 were then compared. The main results of the analysis are shown in Figures 23 and 24 below.



**Figure 23:** Major injury rate broken down according to the number of employees in a mill

A one-way ANOVA was used to examine differences between the four groups for the four injury rates both before and after the PABIAC Initiative. Only one of these analyses was statistically significant – that for the major injury rate after the PABIAC Initiative. There was a marked improvement in the major accident performance of the smallest mills but as Figure 24 shows, the over three-day rate actually increased over the same period. This raises questions about the likelihood of the improvement being sustained.



**Figure 24:** Percentage changes in injury rate measures according to number of employees

### 3.4.4 Changes in injury rate by output level

Typically mills employing greater numbers of employees tend to produce more paper. Therefore this analysis would be expected to overlap considerably with that reported in the previous section. Mills were grouped by the following output categories:

**Table 14:** Number of mills in terms of output capacity

<i>Annual Output (tonnes)</i>	<i>&lt;10K</i>	<i>10-25K</i>	<i>25-50K</i>	<i>50-100K</i>	<i>100-250K</i>	<i>&gt;250K</i>
Number of mills	12	19	18	18	12	6

The pattern of data is similar to that based on the number of employees and production level. Injury rates were again reasonably similar, and there were no statistically significant differences between groups. Prior to the PABIAC Initiative, mills with either very high or very low output levels had higher injury rates than was the norm for the industry. Following the initiative, the performance of these mills is now much more in line with those with intermediate levels of production, suggesting that these have improved more than the intermediate mills during the PABIAC Initiative.

### 3.4.5 Changes in injury rate by type of production

Product type information was available for 85 of the 88 mills being analysed. The breakdown of mills by product type was as follows:

**Table 15:** Number of mills per product group

<i>Product</i>	<i>Graphics</i>	<i>Newsprint</i>	<i>Packaging</i>	<i>Tissue</i>	<i>Other</i>
Number of mills	27	3	23	14	18

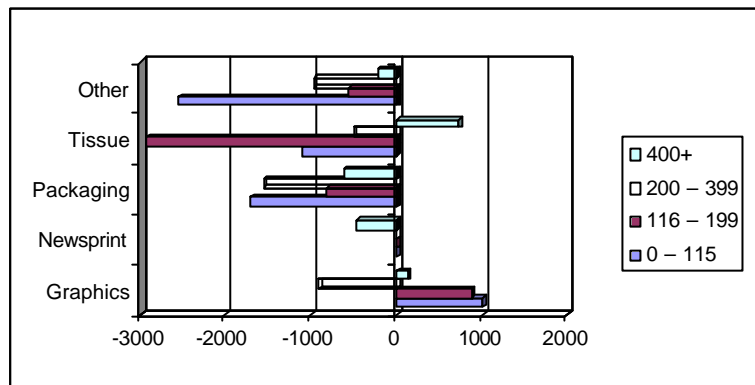
Over three day and all accidents rates were very similar for all types of mill. Prior to the initiative, major injury rates were somewhat higher in mills producing packaging, tissue or 'other' products. These fell to levels close to those for the graphics and newsprint sectors. Fairly large reductions in the weighted injury rates are apparent for the packaging and 'other' sectors of the industry. Differences in injury rates by product (pre- and post-initiative) were examined using a one-way ANOVA. No differences were statistically significant.

### 3.5 MULTIVARIABLE ANALYSIS OF CHANGES IN INJURY RATES

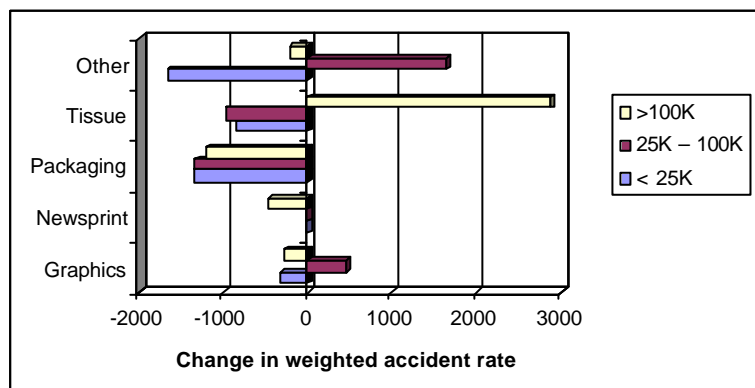
The multivariate analysis described in Appendix 4 notes some changes in injury rates over time for the industry in relation to sector, size and production, namely:

- Small mills have achieved improvement in their injury rates;
- Mills producing packaging, 'other' and (to some extent) tissue products have also improved their injury rates.

These results may not be independent, so further analysis was carried out to see which factors might be most important. Injury rate change data was plotted by size and product type (see Figures 25 and 26) to help determine whether one factor may be more important than the other but the results were inconclusive, as were attempts to consider mill size and production level together.



**Figure 25:** Change in injury rate according to product and number of employees



**Figure 26:** Change in weighted injury rate according to production levels and product

### 3.6 REASONS FOR CHANGE IN INDUSTRY INJURY RATES

Uncovering the trends within the accident statistics was an important objective of the research. However the question remains, to what extent were they influenced by the PABIAC Initiative? To help provide the answers, further analysis was carried out to establish whether:

- There really was a meaningful reduction in injury rates linked to the start of the Initiative, or whether injury rates were already decreasing and the trends identified above were simply a continuation;
- The trends in injury rates could be associated with the scope of the Initiative, or whether they were merely mirroring those in industry generally;
- The changes could be accounted for by other factors not addressed in the analysis, particularly financial factors such as profitability.

#### 3.6.1 Impact of the Initiative on injury rates

To investigate whether the injury rates have fallen as a result of the Initiative, the trends in weighted injury rates before the Initiative were compared with those following its introduction. A regression analysis was applied to the weighted injury rate data on a mill-by-mill basis in the form of an 'interrupted time-series analysis'.

The findings from the regression analysis are shown in Figure 27 below.

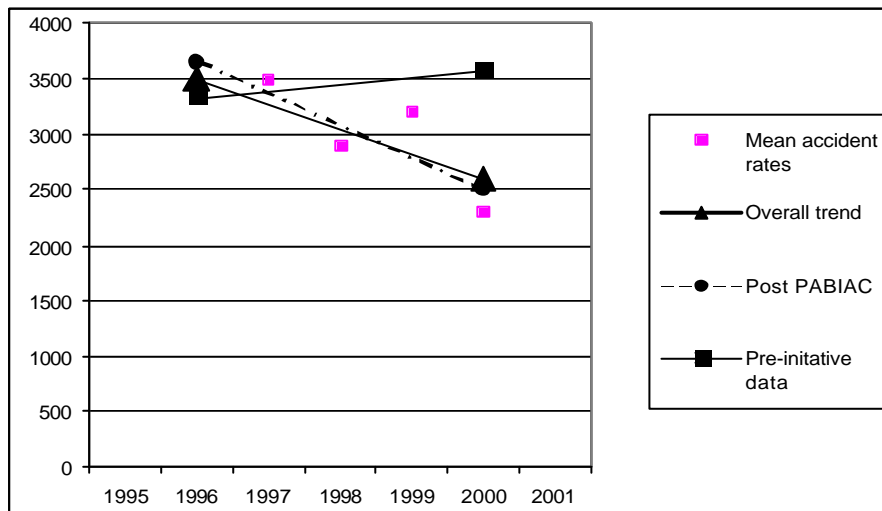


Figure 27: Weighted injury rate and various trend data

In the two years prior to the initiative (96/97 and 97/98) there was an upward trend in weighted injury rates, although it is not statistically significant. In the three years following the start of the PABIAC Initiative (98/99, 99/00, & 00/01) there was a decrease in weighted injury rate, although this is again not statistically significant.

Taking all five years together, there was a statistically significant downward trend, corresponding (when modelled by linear regression) to a reduction in the weighted injury rate of 237 per annum.

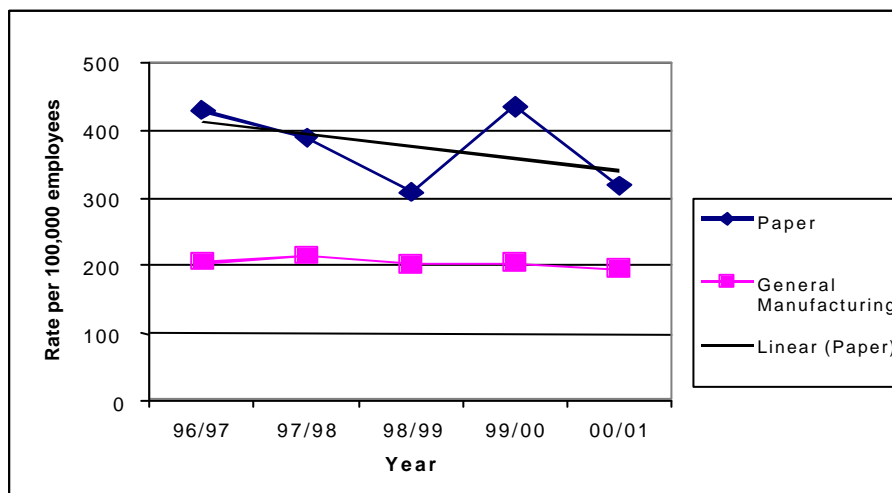
The downward trend during the Initiative (post PABIAC line on Figure 27 above) is slightly steeper than the five year overall trend. Although this analysis is based on a small set of data and cannot be claimed to be robust, the improving trend over the five years could be attributable to improvements beginning in the first year of the PABIAC Initiative (1998/99).

An attempt was also made to investigate whether the causes of accidents had changed as a result of the PABIAC Initiative. There were some changes in the pattern e.g. a reduction in 'struck by' accidents, but the components of the Initiative e.g. risk analysis did not focus on particular potential causes and so it has not proved possible to demonstrate any significant link between a particular reduction and the Initiative.

### 3.6.2 Comparison with rates in general manufacturing

Figure 28 below compares the changes in major injury rate for the paper industry with the rates for general manufacturing, based on HSE annual reports, for the five years from 1996/97 to 2000/01. Whereas the paper industry major injury rate shows a downward trend, the major injury rate for general manufacturing was almost unchanged.

No evidence has been gathered that suggests that the characteristics of the paper industry significantly differ from those of general manufacturing industry. Therefore, it is reasonable to speculate that general manufacturing has been undergoing similar changes to that of the paper industry, e.g. decline of manufacturing, strong pound, downsizing etc. and that therefore these general economic trends are not responsible for the reduction in injury rates.

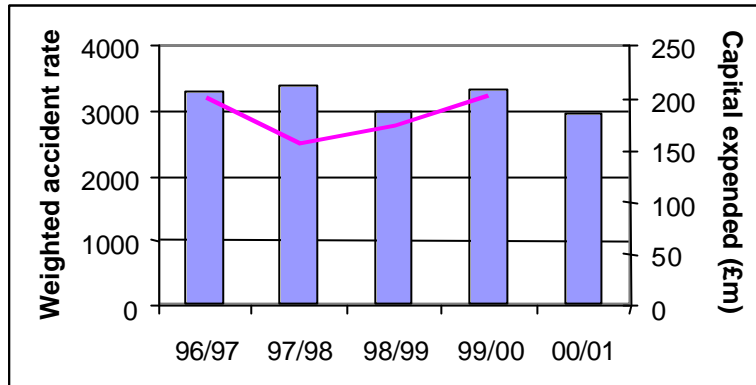


**Figure 28:** Comparison of paper and general manufacturing major injury rates

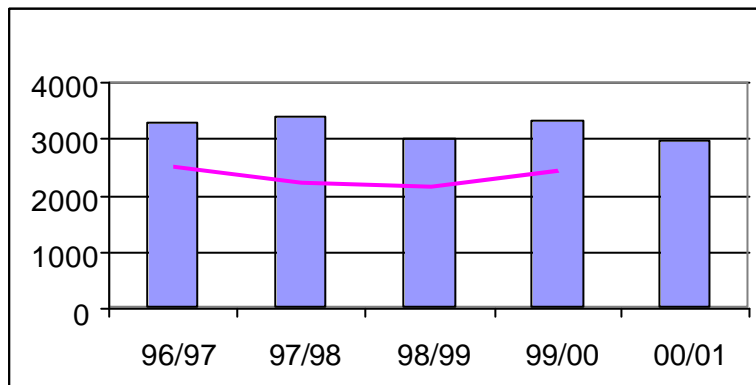
### 3.6.3 Correlation with economic factors

The previous section suggested that general economic conditions were not responsible for trends in paper industry injury rates. This section considers the potential influence of economic factors more specific to the industry. Information was available from the Paper Federation on capital expenditure, capital employed and profitability for the industry as a whole.

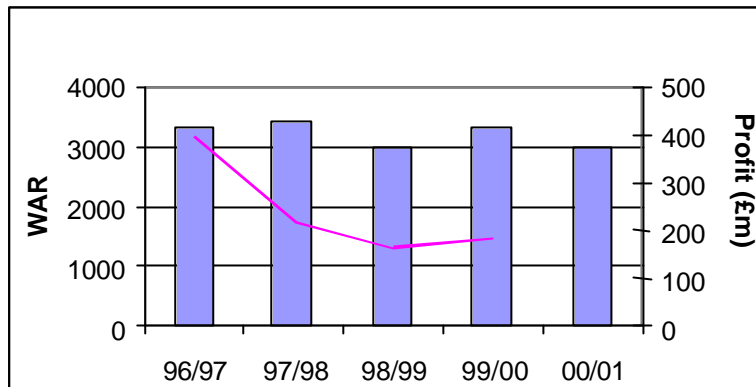
Figures 29 to 31 plot these factors (solid lines) against weighted injury rate (bars). Based on the limited data available, no obvious relationships are apparent. It is worth noting that industry injury rates fell during a period of low profitability.



**Figure 29:** Weighted injury rate and capital expended (£m)



**Figure 30:** Weighted injury rate and capital employed (£)



**Figure 31: Weighted injury rate and profit**

### 3.6.4 Impact of organisational change on the case studies

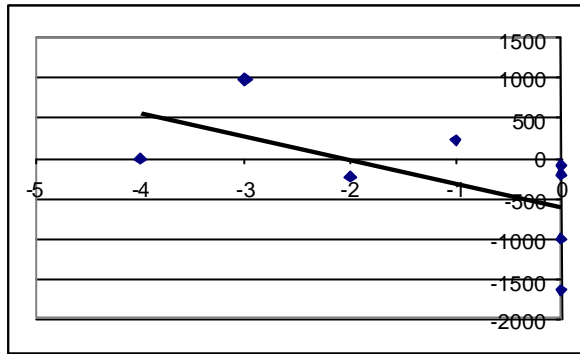
The previous section suggested that general economic conditions were not responsible for trends in paper industry accident trends. The Paper Federation also suggested that organisational changes such as automation, mechanisation and shift pattern changes had been steadily implemented for the last decade or so. Therefore, reductions in injury rates at an industry level could not be attributed to these key organisational events.

However at a mill level, organisational change might be expected to have an impact. It was therefore considered necessary to look at the role of organisational change in the case study mills through its impact on the three dimensions (safety culture, safety management and technological risk) and on injury rate. An organisational change checklist was defined, including the following factors:

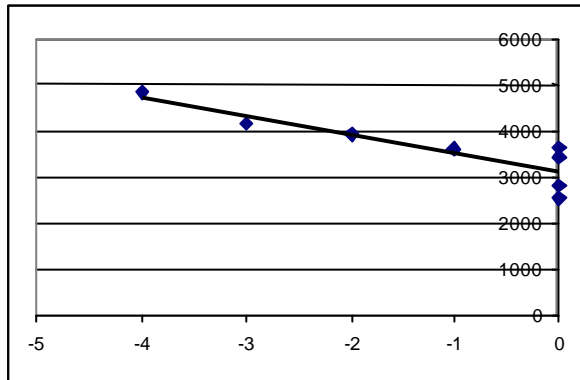
- Corporate influence;
- Company takeover;
- Large intake of new staff;
- Investment;
- New Mill Manager;
- Poor financial circumstances;
- Automation;
- Change in organisational structure;
- Shift / working hour changes;
- Downsizing.

For each of the eight case study mills, these factors were considered by the case study team and scored on the basis of a judgement as to whether they: did not occur or had no influence (0), had a positive influence (+1) or had a negative influence (-1). These were summed to generate an crude organisational change index, which was plotted against: change in injury rate, predicted weighted injury rate, actual weighted injury rate, and three dimensions (safety culture, safety management systems and technological risk). The results are plotted on Figures 32 to 37 below.

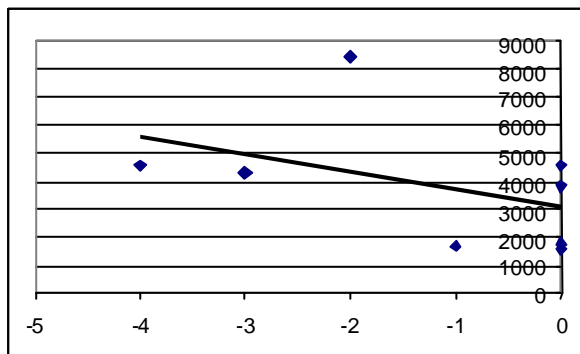




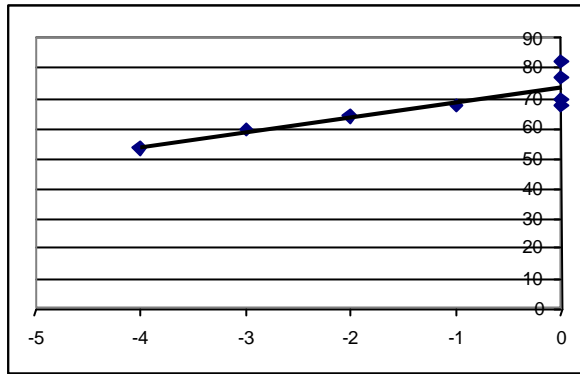
**Figure 32:** Organisational change and actual change in injury rates



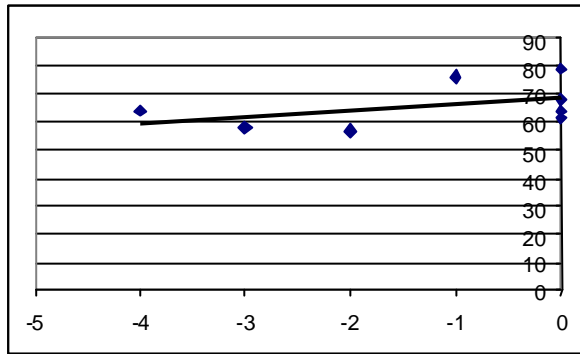
**Figure 33:** Organisational changes and predicted Weighted Injury rate (WAR)



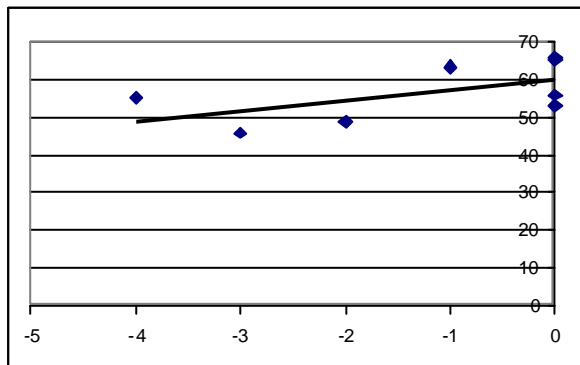
**Figure 34:** Organisational changes and actual WAR



**Figure 35:** Organisational change and safety culture



**Figure 36:** Organisational change & SMS



**Figure 37:** Organisational change & TR

This analysis appears to suggest that negative organisational change has a detrimental impact on safety that is reflected in both direct measures and predictive indicators of safety management and safety culture. We were unable to test whether the converse holds, i.e. that positive organisational change will lead to a reduction in injury rate.

- The more negative organisational changes an organisation has, the greater the increase in injury rate will be (see Figure 32). The fewer negative organisational changes an organisation undergoes the more likely there are to have been improvements in injury rate (during the period of the PABIAC Initiative).
- Figure 34 plots actual weighted injury rate against organisational change. The pattern is similar - the greater the negative organisational change, the higher the weighted injury rate. There is one outlier to this model, which throughout the study has injury rates higher than expected by external stakeholders or anticipated by the safety measures.
- The organisational change plots also shows a strong linear relationship with the injury rate prediction model (see Figure 33), and with the three dimensions of the model (e.g. safety management systems, safety culture and technological risk, Figures 35, 36, & 37). The directions of these relationships suggest that the greater the number of negative changes the lower the safety culture score, the lower the safety management system score and the lower the technological risk score. These strong relationships explain the links with the predicted weighted injury rate.

Based on this sample of 10% of the industry, it can be speculated that the extent of organisational change across the industry has had a significant effect on injury rates.

### **3.7 OVERALL CONCLUSIONS ON CHANGES IN INJURY RATES**

Industry-wide employment dropped between 1996 and 2000. Based on these figures, a comparison of injury rates per 100 000 employees for 1996/97 and 2000/01 shows little change in the overall injury rate (-2.0%) or in the over three day injury rate (+3.3%). There was a marked decrease in the major injury rate (-26.6%). Therefore, although the picture is less clear-cut than one might have hoped at the beginning of the Initiative:

- The decrease in the total *number* of accidents (consisting mainly of over three day accidents) is roughly in proportion to the decrease in the number of employees during this time period across the industry as a whole. However, the decrease in the number of major accidents significantly exceeds the decrease in workforce size.
- Injury rates have decreased even when compared with production levels, i.e. the industry has downsized, but increased production, so arguably fewer people are doing more, but there was no associated increase in accidents.

In terms of the actual performance of the mills:

- The better mills prior to the Initiative tend to still be the better mills (i.e. there is consistency over time with respect to performance).
- In terms of improvement the worse half of the mills always got better, more than the better mills got worse. i.e. the biggest improvements in the industry have been in the worst performers, whilst 'typical' mills have changed little since the Initiative.

- Mills with higher than average numbers of over three day accidents tend to have higher than average numbers of major accidents.
- There is also a year on year trend with mills with larger number of accidents one year, also having higher than average accidents the following year.
- Small mills (less than 115 employees) have shown the greatest improvement in major injury rate, but their over three day rates have not improved.
- Packaging, tissue and other products had fairly high major injury rates prior to the Initiative, these fell to levels close to that of graphics and newsprint.
- Based on this sample of 10% of the industry, the extent of organisational change across the industry may have had a significant adverse effect on injury rates.

## 4 QUALITATIVE SURVEY FEEDBACK

### 4.1 INTRODUCTION

The case studies and statistical analysis provide a measure of the effectiveness of the PABIAC initiative in reducing accidents. So far as possible, the data was collected and analysed by research team members so that it would be objective and independent.

However there are significant limitations to the information that can be collected in this way, so a postal survey was included in the programme to obtain additional qualitative information on the effectiveness of the individual elements of the Initiative and on the mills' perception of the Initiative.

Questionnaires were received from 37 mills, representing 42% of the industry. The results are shown in Figures 38 to 41 and Tables 16 to 18. The upper and lower 95% confidence intervals have been plotted on the figures. The main findings are summarised below.

Respondents from mills (mainly safety managers) believed the Initiative was required and worthwhile and delivered improved safety, even if some aspects were less effective. They believe the benefits were primarily a change in safety culture and commitment to safety. The benefits of the Initiative are not yet fully reflected in accident statistics.

### 4.2 PERCEIVED BENEFITS OF THE INITIATIVE

Table 16 and Figure 38 summarise the responses to questions about the benefits of the PABIAC Initiative, which were mainly aimed at identifying 'spin-off' benefits such as productivity, staff relations, morale and absenteeism. Mills are unsure that the Initiative has yet delivered many of these benefits. Of the seven possible benefits, there is only one which a majority of mills agree has been attained so far by the Initiative, namely "motivated senior management" - perhaps the most important 'precursor' measure on the list - on which 83.7% of mills agree.

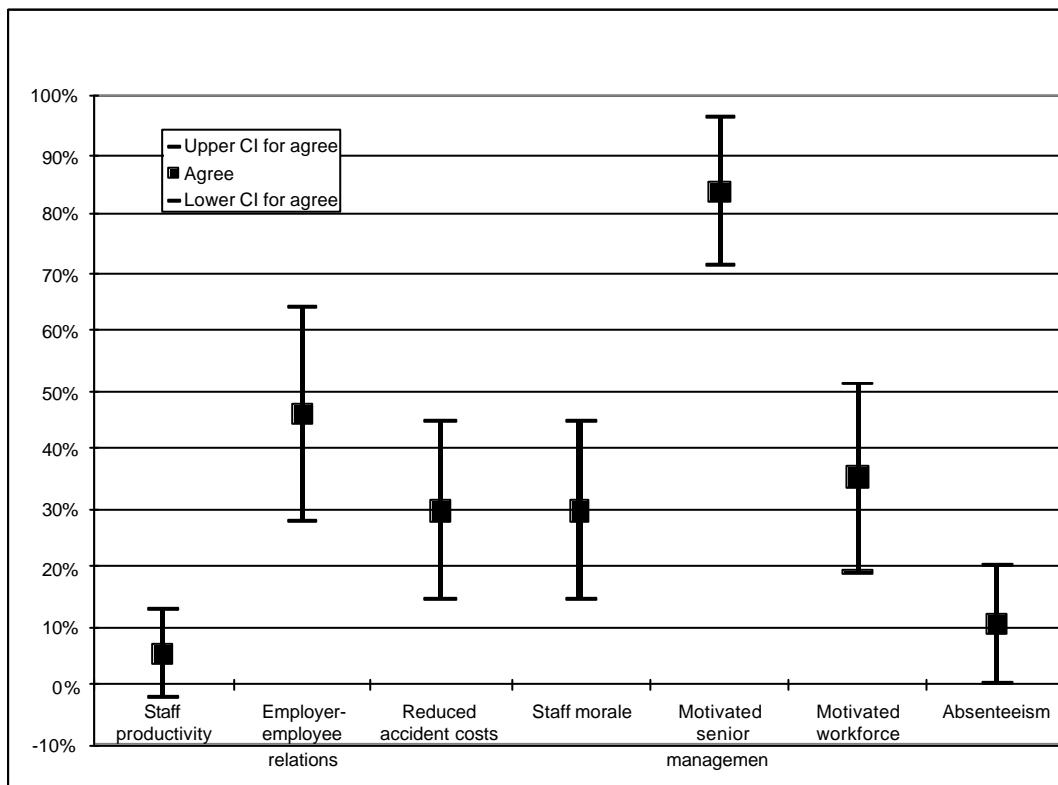
As regards the other benefits:

- Whilst 45% agree that the PABIAC Initiative has helped improve employer-employee relations, 46% are unsure of this. Similarly, whilst slightly more than half are unsure if it has motivated the workforce, 35% agree that it has compared to just 8% who disagree;
- Mills are split on whether the Initiative has yet helped reduce accidents costs or improve staff morale;
- Whilst about half of the mills are unsure whether the Initiative has helped reduce absenteeism or improved productivity, far more mills disagree than agree that it has helped on these points.

**Table 16:** Did the PABIAC initiative help improve each of... (n = 37 mills)

	<i>Strongly disagree</i>	<i>Disagree</i>	<i>Neither agree or disagree</i>	<i>Agree</i>	<i>Strongly agree</i>
Staff productivity	13.5%	27.0%	54.1%	5.4%	0.0%
Employer-employee relations	2.7%	5.4%	45.9%	35.1%	10.8%
Reduced accident costs	5.4%	43.2%	21.6%	21.6%	8.1%
Staff morale	2.7%	32.4%	35.1%	21.6%	8.1%
Motivated senior management	2.7%	5.4%	8.1%	48.6%	35.1%
Motivated workforce	0.0%	8.1%	56.8%	35.1%	0.0%
*Absenteeism	10.3%	31.0%	48.3%	6.9%	3.4%

\*29 mills responded on this point.



**Figure 38:** Mills perceptions of PABIAC benefits (n=38)

## 4.2 EFFECTIVENESS OF INDIVIDUAL PROGRAMME ASPECTS

Table 17 and Figure 39 summarise the responses from mills regarding the effectiveness of the individual elements of the Initiative included in the questionnaire.

Nearly all of the elements of the PABIAC Initiative were regarded as effective or very effective by more than half of the mills. The results for each of the elements of the PABIAC Initiative are summarised below in an approximate rank order.

Three-quarters or more of the mills agreed that the following 5 aspects of the Initiative were effective or very effective:

- The encouragement of workforce involvement (90%);
- Action plans (87.5%);
- The commitment of senior management (84.4%);
- CEO briefings (75%), and;
- The industry wide nature of the Initiative (75%).

Training, safety representative work and the focus on HSG65 were considered to be effective by about 70% of mill respondents. Whilst less than three-quarters, this is still a high level of agreement on the effectiveness of these elements.

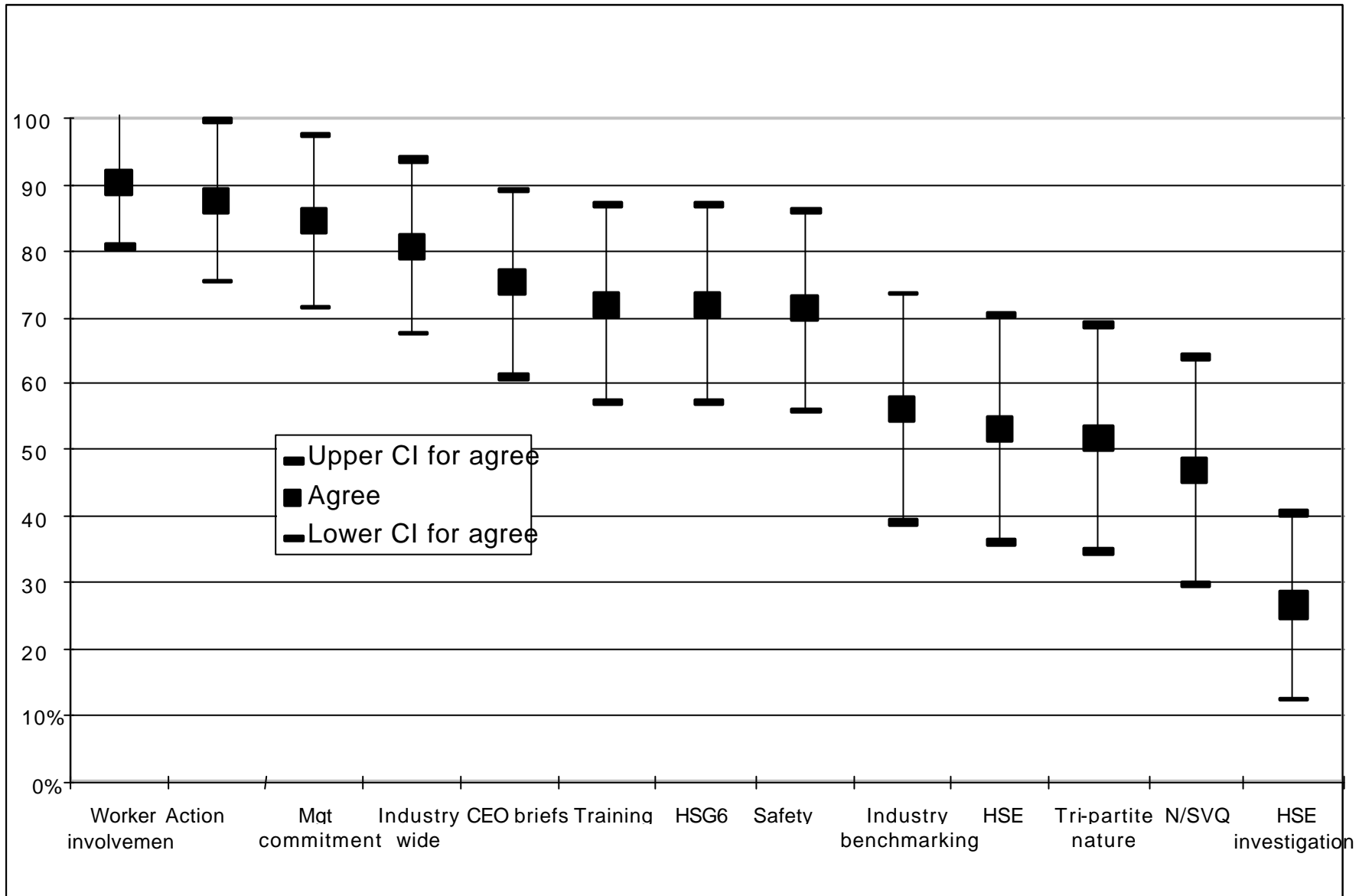
About half of respondents agreed that industry benchmarking, HSE contact N/SVQ and the tripartite nature of the Initiative were effective or very effective. It should be noted that more mills agree that these elements were effective than disagree, but with a significant proportion unsure on these elements. Thus, on balance mills “favour” these elements but with a broader range of opinion than the other elements.

Only 26% agreed that HSE accident investigations were effective or very effective, although this outnumbers those who disagree. A slight majority of 53.3% were unsure about the effectiveness of HSE accident investigations. These were not, of course, specifically an element of the Initiative.

**Table 17: Effectiveness of each aspect of the PABIAC initiative (n = 33 mills)**

	<i>Very ineffective</i>	<i>Ineffective</i>	<i>Unsure</i>	<i>Effective</i>	<i>Very effective</i>
Worker involvement	3.2%	3.2%	3.2%	48.4%	41.9%
Action Plans	0.0%	0.0%	9.4%	50.0%	37.5%
Senior management commitment	0.0%	6.3%	6.3%	50.0%	34.4%
Industry wide aspect	0.0%	3.2%	16.1%	54.8%	25.8%
Tri-partite nature	3.2%	9.7%	32.3%	32.3%	19.4%
Safety representative work	0.0%	12.9%	16.1%	51.6%	19.4%
CEO briefings	0.0%	9.4%	12.5%	59.4%	15.6%
Training	0.0%	3.1%	18.8%	56.3%	15.6%
HSG65 focus	0.0%	3.1%	21.9%	56.3%	15.6%
HSE contact	3.1%	18.8%	21.9%	40.6%	12.5%
N/SVQ	3.1%	15.6%	28.1%	34.4%	12.5%
Industry benchmarking	6.3%	9.4%	25.0%	50.0%	6.3%
HSE accident investigations	3.3%	16.7%	53.3%	23.3%	3.3%





**Figure 39:** Perceived effectiveness of each aspect of PABIAC (n = 33)

(CI = Confidence Interval)

### 4.3 PERCEIVED COST-EFFECTIVENESS

The results in Table 18 and Figure 40 indicate that:

- The vast majority (84%) of responding mills agree that the benefits arising from the PABIAC Initiative justify the costs;
- About half of the responding mills agree that the Initiative was cost-effective.
- About 40% agree that the Initiative was more cost-effective than the alternatives, with 35% unsure on this point;
- A minority of the responding mills disagree that the Initiative was cost-effective or better than the alternatives, with a small minority unsure on these points.

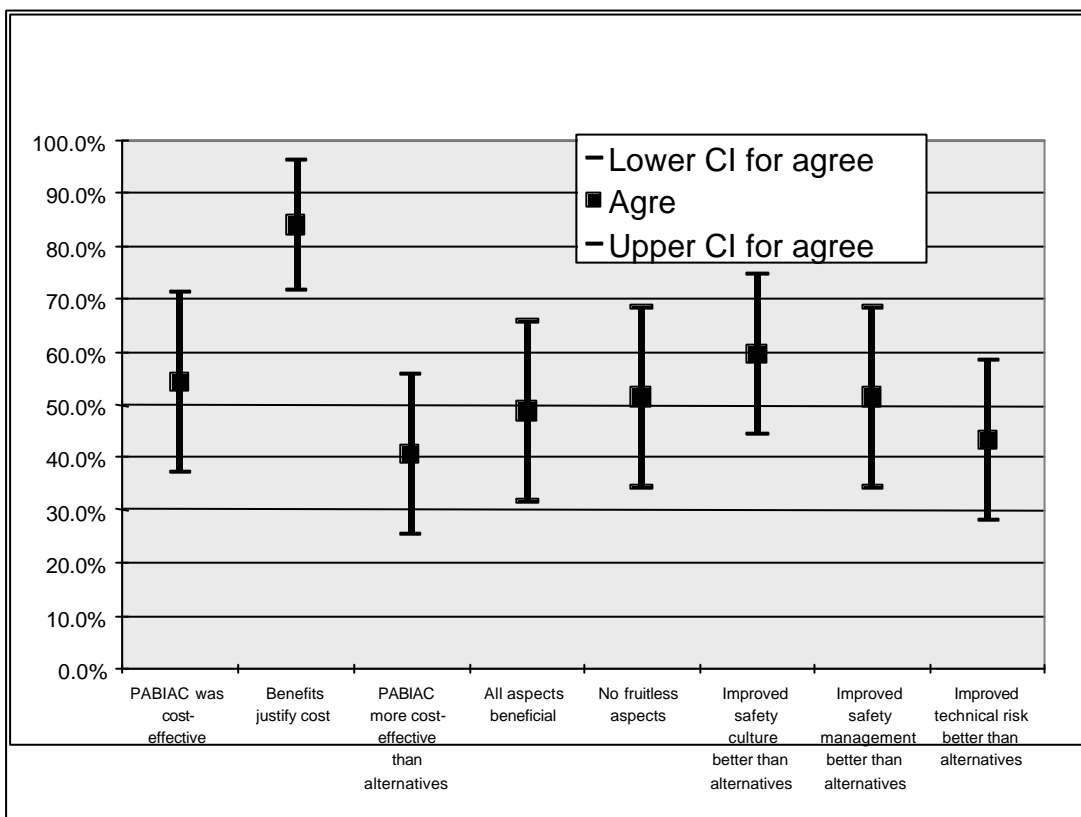
These findings are possibly explained by the fact that about half of the respondents from mills indicated that some aspects of the Initiative were not beneficial and required some fruitless work.

**Table 18** Perceived Cost-effectiveness of PABIAC initiative (n = 37 mills)

	<i>Strongly disagree</i>	<i>Disagree</i>	<i>Neither agree or disagree</i>	<i>Agree</i>	<i>Strongly agree</i>
Improved safety culture better than alternatives	2.7%	21.6%	16.2%	48.6%	10.8%
Improved safety management better than alternatives	0.0%	27.0%	21.6%	40.5%	10.8%
Benefits justify cost	0.0%	10.8%	5.4%	75.7%	8.1%
PABIAC more cost-effective than alternatives	0.0%	21.6%	35.1%	35.1%	5.4%
PABIAC was cost-effective	2.7%	24.3%	18.9%	51.4%	2.7%
Some aspects not beneficial	0.0%	29.7%	18.9%	48.6%	2.7%
PABIAC required some fruitless work	5.4%	35.1%	10.8%	45.9%	2.7%
Improved technical risk better than alternatives	2.7%	16.2%	37.8%	43.2%	0.0%

In Figure 40 below we have added together the per cent of respondents who either agreed or strongly agreed with each statement and plotted the resulting value. Thus, for example, 51.4% agreed that PABIAC was cost-effective whilst 2.7% strongly agreed with this statement. This equals 54.1%. The upper and lower confidence intervals show the range within which it is expected (with 95% confidence) that the “true” result lies. Note that the sense of two questions has been inverted, to allow them to be plotted.

As with all sample-based statistics, the “true” result that would be derived if 100% of the population responded may be different from the result derived from the sample, which was not random. However, the confidence interval provides an indication of the range within which the “true” result can be expected to lie.



**Figure 40: Perceived cost-effectiveness (37 mills)**

(CI = Confidence Level)

#### **4.4 ADDITIONAL MILL COMMENTS**

A number of mills provided some additional comments. These are summarised below for completeness. No further explanation is available.

##### **Drivers for safety improvements**

A few mills indicated that they were already improving safety prior to the launch of the Initiative and felt that there would have been significant change without the Initiative. However, it was also indicated that the Initiative acted as a catalyst, especially for senior management.

##### **Aspects that were beneficial**

The comments on individual aspects of the Initiative were consistent with the other survey findings.

- The CEO meetings and advisor groups were very useful and helped ensure that CEO's took the Initiative seriously;
- The action plans were effective;
- The emphasis on workforce involvement was essential.

##### **Ineffective elements**

Two mills queried the value of the work of HSE inspectors, but no specific points were made.

##### **Timescales**

It was suggested by a couple of mills that the 3-year time span was too tight and that a 5 to 10 year period was more realistic.

##### **Costs and benefits**

A number of concerns were expressed regarding cost-effectiveness, including:

- Two mills were concerned that the costs of the Initiative may place them at a competitive disadvantage relative to overseas competitors;
- The high profile of the campaign meant that money was spent on "tolerable" risks.

Another mill indicated that there was no short-term cost-benefit, but that it was reasonable to suppose there would be a positive benefit in the longer term. These cost concerns were mentioned by a very small number of firms and were not elaborated upon in the written responses.

## **4.5 COMPARISON WITH OTHER SAFETY INITIATIVES**

### **4.5.1 Background**

It would clearly be helpful to be able to benchmark the PABIAC Initiative against similar initiatives in other industries, both in terms of approach and effectiveness. This was not a primary objective of our research project, but some information was available on the UK offshore oil & gas industry's 'Step Change' safety initiative and we have therefore been able to make limited comparisons.

The Step Change in Safety initiative was launched in September 1997 with a target of a 50% improvement in the whole industry's safety performance over the next three years. The headline target was therefore the same as PABIAC's, and there are also some similarities between the two industries that resulted in a degree of convergence between the two initiatives. For instance, in the offshore sector:

- There are a relatively small number of firms and sites;
- The industry is homogenous in terms of the types of hazards and technology;
- There are a small number of trade associations that represent the vast majority of firms;
- It is regarded as a relatively high-risk sector in industrial safety terms.

Many of the Step Change elements had similar objectives to PABIAC Initiative elements, including:

- Improved networking;
- Cross industry safety leadership;
- Safety representative networks;
- Improved risk assessment;
- Focus on safety culture.

However, it must be borne in mind that simple comparisons between initiatives in different sectors need be interpreted cautiously. The targets and programmes are similar, but the nature and scale of the risks differ and, although many of the elements of the two initiatives had similar objectives, the detail of their implementation was tailored to the priorities and circumstances in their respective sectors.

### **4.5.2 Step change results**

The rate of fatal and major injury in the off-shore sector appears to have increased for the first 18 months or so, reducing again to about the same level at the end of the third year as it was at the outset of the initiative. The all injury rate was about 25% lower at the end of year three than at the outset, but the 50% overall reduction target was not achieved.

At the three year point, PABIAC therefore appears to be comparable with the effectiveness of the Step Change Initiative. The ~26% fall in the major injury rate in the paper industry is greater than that achieved at the same stage in the offshore initiative, although the 5% fall in 3 day injuries in the paper industry is lower than the ~25% fall in the offshore all injury rate.

Figures are also available from the fourth year of the Step Change programme. It is interesting to note that there were marked improvements in safety performance in year four, perhaps as the improvements initiated fed through into accident statistics. As of March 2001 (almost four years into the initiative) there had been a 43% improvement in the all injury rate and a 26% improvement in fatal and major injury rate compared to 1997.

As with the PABIAC equivalent, a target of a 50% reduction over three years seems to have proved to be too ambitious. The most sustained and sharp decline in the all injury rate in the off-shore sector occurred in year four.

#### **4.6 TRANSFERABILITY OF INITIATIVE TO OTHER SECTORS**

PABIAC partners believe that the feasibility of carrying out a similar initiative in other industries depends on the make-up and size of other industries. It is thought that a similar initiative would be facilitated by a relatively small and homogenous industry within which active trade and union organisations provide an effective vehicle for networking. In the case of larger sectors, these should be sub-divided into smaller units.

#### **4.7 COMMENTS ON RESULTS & BENCHMARK**

Although almost half the mills disagree with the proposition that the Initiative has to date delivered a reduction in accident costs, the standards of safety culture and safety management have improved markedly and over 80% believe it has motivated senior management - a vital intermediate step.

The survey results were on the whole positive. The vast majority of responding mills agree that the benefits arising from the PABIAC Initiative justify the costs and more than half the mills regarded nearly all of the elements of the PABIAC as effective or very effective.

The survey results are therefore consistent with the conclusions from the case study and injury rate analysis. That is, that the Initiative has been effective at stimulating management action, and the development of safety culture and safety management on site, but that these improvements have not yet fed through into accident statistics.

One might conclude that the three-year term of the Initiative target was with hindsight too short to achieve the size of reductions being sought. Comparison with the off-shore industry's Step Change programme supports the view that, given that much of the first year of such initiatives inevitably focuses on awareness raising, more significant improvements in injury rates might be expected from year four onwards - *provided* of course that the changes have acquired the momentum to become self-sustaining.

## 5 ANALYSIS OF INDUSTRY COSTS AND AVERTED LOSSES

### 5.1 BACKGROUND

The final part of our study provides an assessment of the quantifiable costs and benefits of the PABIAC Initiative based on industry level data on costs and benefits in terms of accidents avoided. Given the limited amount and quality of information available on the costs and benefits, this study can only provide an initial opinion on the balance of costs and benefits rather than a precise assessment, but it is an important aspect of the overall assessment of the Initiative. We have attempted to validate and cross-check the data where we could.

The assessment relies on the self-reported cost estimates provided by mills and PABIAC partners. This augments the assessment of self-reported judgements of value for money, the statistical assessment of injury rates and safety culture and safety management audits.

Ideally, a cost-benefit assessment compares the full cost of an intervention with the total benefits of an intervention. Such benefits would include the value of averted accidents and incidental benefits such as improved productivity. Also, ideally, the costs and benefits would be clearly linked to and arise from the intervention. In this instance the following points limit the assessment.

- Mills did not consistently record costs.
- Whilst the PABIAC Initiative was launched in 1998, many mills only made progress in implementing changes in the year 2000. Thus, there is a limited period for benefits to materialise.
- It is reasonable to assume that many of the actions associated with the PABIAC Initiative have incurred a significant one-off cost. However, the benefits will continue over a much longer period. Currently available data does not provide a sound basis to predict future benefits or separate out one-off and recurring costs.
- Mills did not keep records that would allow them to readily provide information on any quantifiable on-going incidental benefits such as improved productivity.

We have therefore estimated and compared the costs of PABIAC over the duration of the Initiative with the value of the reduced number of injuries during the same period, recognising that the above limitations might result in an under-estimate of the benefits. We have also had to bear in mind that, whilst the number of injuries has fallen during the period of the PABIAC Initiative and feedback from mills does suggest that the PABIAC Initiative has led to safety improvements, the attribution of this trend to PABIAC is not certain. In an attempt to check the validity of the subjective evaluations and cost estimates, we have therefore also:

- Compared the findings of the self-reported evaluations from mills against our own comparison of costs and benefits, and;
- Compared the reported PABIAC-related costs against those reported by firms in other sectors.

The aim of these checks is to provide an opinion on the “face validity” of the self-reported costs and the balance of costs and benefits. This face validity check should be viewed in the context of the observations of changes in safety management and safety culture noted in the earlier sections of this report. These changes also provide a check on the self-reported evaluation, in that they provide examples of changes to support the view that the Initiative prompted significant changes and expenditures by mills.

## **5.2 ANALYSIS OF COSTS**

### **5.2.1 Cost data**

In the absence of contemporary cost records, this assessment relies on retrospective judgements of the costs arising from the PABIAC Initiative.

Two part questionnaires were issued to each mill and other stakeholders (HSE, trade unions and trade associations). The first part asked for judgements of the cost-effectiveness of the initiative and each aspect of the initiative as reported in the previous section. The second part of the questionnaire asked for estimates of the costs incurred for the PABIAC Initiative. The questionnaires were completed by mill safety managers (sometimes in collaboration with other mill managers) and by PABIAC representatives from the HSE, trade unions and trade associations. In all, we had responses from 37 mills (42%), and questionnaires issued to PABIAC partners.

Mills have not consistently segregated and recorded the costs related to the PABIAC Initiative, and the data may not have been readily available to the person filling in the questionnaire. The accuracy of estimates provided in the questionnaire responses would therefore be likely to vary so the questionnaire attempted to 'unpack' some of the major cost components. Costs were identified by:

- Asking mills, HSE, trade unions and trade associations to self-report staff time (including time spent in meetings, training and safety representative activity) and other costs;
- Assigning nominal costs to staff. The average time per site was multiplied by an average daily employment cost (costs for time are based on a day cost of £108 reported by a mill).

The questionnaire asked for equipment costs for equipment modifications and repairs. We have excluded guarding costs (of about £62,500 per mill) from the comparison of costs and benefits as these occurred late on in the period and would not have impacted the accident figures in these years.

It was noted that a significant proportion of the costs incurred by mills related to machinery modifications and safety management actions required to comply with extant regulations. Thus, it was judged that many mills have incurred significant costs in a relatively short period of time to achieve legal compliance. Such costs may otherwise have been spread over a longer period of time and would not be attributed to a special initiative. The implication of this point is that it is uncertain whether all of the costs arising from improvements prompted by the PABIAC Initiative should be attributed to the Initiative.

### **5.2.2 Cost analysis results**

The results of the survey and cost conversions are set out in Table 19 below. The three-year cost per mill averages £235k, or a little over £78k per annum. With 88 mills, this corresponds to a total cost for the three-year period of £20.7m.



Trade unions report that their costs amounted to about 20 to 25% of one person per year, plus days spent training safety representatives and miscellaneous costs. The main HSE cost comprised about 1.5 person-years per year of inspectors' time, plus £138,000 research and a few days on Ministerial briefings. Taken together, the costs incurred by these and other stakeholders in total account for perhaps £0.9m. The total three-year cost of the Initiative on this basis would therefore be about £21.6m.

**Table 19: Average PABIAC related mill costs (for 3 years per reporting mill)**

	<i>Self-report</i>	<i>Average days</i>	<i>Total cost</i>
<b><i>Time</i></b>			
General management time	4.1	90	9 720
Safety manager time	3.6	69	7 452
Supervisors time	3.5	65	£7 020
Staff training time	3.3	450	£48 600
Safety representatives	2.4	135	£14 580
Other staff time	2.8	395	£42 660
<b>Sub-total</b>			<b>£130 032</b>
<b><i>Consultancy &amp; training</i></b>			
Consultancy	1.6		£15 500
Training £	2.3		£28 750
Software	1.3		£10 500
Other consultancy & training	0.3		£1 500
<b>Sub-total</b>			<b>£56 250</b>
<b><i>Equipment expenses</i></b>			
Equipment repairs	1.7		£10 250
New equipment	2.0		£17 500
New PPE	1.9		£20 750
<b>Sub-total</b>			<b>£48 500</b>
<b>Total time &amp; expenses per mill</b>			<b>£235 000</b>

### 5.2.3 Cost benchmarking

The self-reported time and costs of mills have been compared in Table 20 with the health and safety costs per employee reported by other companies<sup>4</sup>.

The costs quoted for other firms probably cover all health and safety related costs rather than costs associated with any one initiative. The paper industry costs relate in theory just to the PABIAC Initiative, but mills did report that it was difficult to separate out PABIAC related costs from other health and safety expenditure though it was probably the dominant component. The figures in Table 20 therefore probably do provide a crude but valid benchmark.

The estimated paper industry average cost of £364 per employee per year is below that reported by two of the chemicals firms, about the same as the mining firm, and 30% higher than the manufacturer. Not surprisingly, it is well above the costs in low risk firms such as telecommunications and finance. The industry's self-reported costs are therefore ranked where one might expect them to be, which suggests that they are reasonable.

**Table 20: Cost benchmarks**

<i>Sector</i>	<i>Company</i>	<i>Benchmarks</i>
Chemicals	Shell	£6,250
Chemicals	ICI	£1,214
	<b>Paper Industry</b>	<b>£364</b>
Mining	Billington	£355
Chemicals	Astrazeneca	£272
Manufacture	BAT	£247
Energy	National grid	£138
Telecoms	Cable & wireless	£104
Telecoms	BT	£80
Bank	HSBC	£58.50
Telecoms	Kingston communications	£53
Hotels	Hilton	£28
Finance	Sun life	£8

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<sup>4</sup> Health and Safety Management in FTSE 100 Companies. Karen Pearson. 2000, GEE Publishing. ISBN 1 86089 897 1.

## 5.3 ANALYSIS OF BENEFITS

### 5.3.1 Methodology

The quantifiable “benefit” is limited to the estimated number of averted injuries taken from the statistical analysis of accident trends in this report. There is no information on the impact of the PABIAC Initiative on cases of occupational ill-health and so these benefits cannot be claimed in this assessment.

The questionnaire probed for additional benefits but, although one might expect to see spin-offs in time, there is little extra that can be attributed to the Initiative in this analysis. A few respondents noted incidental productivity benefits - for example, the need to install guarding is reported to have prompted a mill to resolve intermittent equipment problems in order to avoid the anticipated delays associated with accessing machinery for the purpose of repairs. However, no data was available on the impact of safety improvements on production.

The averted injuries are expressed in sterling. We used the Department of Transport value of life figure as a starting point for estimating the value of averted injuries. The DOT provides a value for three grades of injury, namely fatal, major and minor that we have assumed to correspond to fatal, major and over three day injuries. However, examination of the DOT value, which was derived for road traffic accidents, indicates that the costs reflect the damage incurred in road traffic accidents rather than in manufacturing accidents. Therefore, information was sought on the costs to the employer of accidents.

An industry report on the cost of accidents in a paper mill has been acquired and used to estimate the cost of each grade of injury (fatal, major and minor) in the paper industry. This revised employer cost has been added to the ‘willingness to pay’, NHS and ‘loss of societal output’ components of the DOT value. These are all increased to allow for inflation. We then multiplied the cost per injury type (fatal, major and over 3 day) by the number of estimated averted injuries to get a total value of averted injuries.

### 5.3.1 Benefits analysis results

The derived nominal value per grade of injury is shown in Table 21. There is a range of values for fatal injuries. This reflects the fact that the cost of a fatal injury to an employer can vary significantly depending on the extent of business interruption.

**Table 21:** Value per injury (adjusted for inflation, to nearest £1k)

<i>Component</i>	<i>Fatal</i>	<i>Major</i>	<i>Minor</i>
Loss of welfare & suffering	£751k	£106k	£9k
Medical and ambulance	£5k	£10k	£1k
Loss of societal output	£385k	£17k	£2k
Insurance admin	<<£1k	<<£1k	<<£1k
Employer costs	£199k - £662k	£13k	£1k
Total	£1.3m - £1.8m	£147k	£13k

For this assessment we estimated the number of averted incidents by applying the results of the statistical analysis of injury rates. The analysis indicated that injury rates have fallen by about 277 per 100,000 employees per year, on average. Analysis of the number of accidents indicates that the ratio of averted fatal to major and a minor injury is 1 to 50 majors and 49 minors. This gives 174 fewer injuries over 3 years, when allowance is made for falling employment numbers.

The number of averted injuries is multiplied by the value per injury to give the value of averted injuries over the three-year period. The results are shown (rounded) below in Table 22.

**Table 22:** Nominal value of averted injuries

	<i>Number of averted injuries</i>	<i>Value per averted injury</i>	<i>Value of averted injuries</i>
Fatal	2	£1.8m	£3.1m
Major	87	£150k	£13m
Minor	86	£13k	£1.1m
Total	174		£17.1m

Data from one paper mill indicates that there are about 7.5 non-injury incidents per RIDDOR reportable injury incident, with an average cost of about £1,500 per non-injury accident. If it were assumed that non-injury accidents have fallen in line with injury incidents this would give 1,300 fewer non-injury incidents over the three years at a value of about £2m.

#### **5.4 BENEFIT / COST RATIO**

The three-year costs for the Initiative were estimated above at £21.6m. The corresponding benefits in terms of averted injuries and other losses are estimated at £19.1m. The ratio of quantifiable costs to the value of reduced injuries is therefore approximately 1.1 to 1 for the three years to date, if allowance is made for a fall in non-injury accidents.

Given the potential level of error in the data and the potential for a reduction in cases of ill health and additional but unquantifiable future safety and commercial benefits, it is probably safe to conclude that the costs and benefits to date of the PABIAC Initiative are about equal.

## 5.5 LEARNING POINTS FOR FUTURE COST-BENEFIT ASSESSMENTS

The learning points for future cost-benefit evaluations include the following.

- As firms do not track costs and benefits as a matter of routine, it is important to provide a mechanism for tracking them during the Initiative.
- It would be useful to complete a pilot study of the costs and benefits prior to a full scale assessment, to enable the research method to identify and separate out one off costs from recurring costs.
- Thought needs to be given to the question of how to estimate the benefit associated with changes (such as machinery guarding) that may only influence low frequency serious incidents. These are difficult to monitor using accident statistics for short periods such as 1 to 5 years of data.
- A method needs to be derived to assess the impact of interventions on the frequency of ill health, allowing for the long latency of ill health. Similarly, a method or “rule” is required to provide a basis on which to project current accident trends into the future, to allow for future benefits arising from current interventions.
- As firms do not assess the impact of health and safety changes on productivity, a method needs to be developed to take these benefits – if there are any – into account.
- The evaluation of costs and benefits needs to take place when enough time has passed for benefits to work their way through into performance statistics.

## **6. CONCLUSIONS AND RECOMMENDATIONS**

### **6.1 OVERVIEW**

Comparison with the off-shore industry's Step Change programme supports the view that, given that much of the first year of such initiatives inevitably focuses on awareness raising, more significant improvements in injury rates might be expected from year four onwards provided that the changes have acquired the momentum to become self-sustaining. One might conclude that the three-year term of the Initiative target was with hindsight too short to achieve the size of reductions being sought.

Major and fatal injury rates have reduced by about a quarter across the entire industry. This has, however, not yet been matched by other performance measures. The statistics are consistent with a pattern of improving performance, but in themselves they do not provide conclusive evidence of a sustainable major improvement. What gives us confidence is the very strong improvement in understanding of - and commitment to - safety culture and safety management found at the case study mills, and the initiatives they are now implementing.

There is still a long way to go, but standards are rising and the feedback from all involved is that much of this is due to the PABIAC Initiative. Furthermore, the Initiative is recognised as being broadly appropriate and cost-effective and the consensus seems to be that it should be continued, albeit with more flexibility to keep it relevant to mills at all stages of development.

### **6.2 SPECIFIC ISSUES**

The research originally sought to answer the following questions:

1. Did standards of safety culture and safety management increase, and can the improvement be linked to the PABIAC Initiative?
2. Did health and safety performance improve, and can the change be attributed to the PABIAC Initiative?
3. How effective was the PABIAC Initiative?
4. Was the PABIAC Initiative effective in cost-benefit terms?
5. Are the changes sustainable? Will the industry's performance deteriorate without the Initiative?
6. What actions can PABIAC take to ensure the continued improvement across the industry?
7. Taking into account the nature of the paper industry and the PABIAC Initiative is the Initiative transferable to other industries?

Each of these are addressed in turn below.

***Did standards of safety culture and safety management increase, and can the improvement be linked to the PABIAC Initiative?***

This question was primarily addressed through the eight case study mills, and in particular the four that were revisited. Our conclusions are that:

- Standards of safety culture have improved, in particular senior management commitment, understanding of safety responsibilities and improved management of the production/safety trade-off.
- Standards of safety management have also improved, in particular in the areas of ‘measure’, ‘audit’ and ‘review’.
- There is still variability in the standards of safety management and safety culture.
- The measures of safety culture, safety management and technological risk form an injury rate prediction model that fairly reliably predicts injury rates.
- The injury rate prediction model predicts a 15% reduction in injury rate based on the improvements in scores for these 8 mills.
- PABIAC aimed to improve standards of safety culture and safety management, and the model suggests that not only have these improved but that these are responsible for improvements in injury rates. This outcome is reinforced by the recognition from all stakeholders that performance has improved as a direct result of the PABIAC Initiative.

*Conclusion 1: Standards of safety culture and safety management have improved since the original study. No change was identified in technological risk scores.*

*Conclusion 2: The PABIAC Initiative was a useful framework for improving standards of safety management and safety culture across the paper industry.*

***Did health and safety performance improve, and can the change be attributed to the PABIAC Initiative?***

Section three reports on the changes identified during the Initiative in injury rate, which is the main direct measure of health and safety improvement. Our conclusions are as follows.

- Major and fatal injury rates have reduced by about a quarter across the entire industry. This has, however, not yet been matched by other performance measures.
- The reduction in accidents is genuine and statistical analysis reveals an underlying pattern of gradual reduction.
- The industry has undergone significant change over recent years, including increased production, demanning, closed factories etc. The pattern of reduction in injury rates holds when these factors are considered.

The stakeholder consultation and the case studies revealed that all those involved link the improvements in accident performance to actions carried out as a result of the Initiative. Furthermore, the evaluation considered other possible causes for the reduction in injury rates and could not identify any other factors that would account for the change.

*Conclusion 3: Injury rates have reduced across the paper industry. The major injury rate has reduced by 26%; other measures are expected to follow.*

*Conclusion 4: The PABIAC Initiative would appear to have a major role in this reduction in injury rates.*

### **Indicators of performance**

This research indicates that there are a number of limitations with the use of injury rate data for target-setting including the following.

- The rate of over three day injuries may be susceptible to reporting trends.
- The number of major and fatal injuries provides a reasonable measure for gauging the progress of the industry as a whole and is less susceptible to influence by reporting practice. However they are too few to provide a measure of performance for individual mills from one year to the next.
- Injury rates do not necessarily provide a measure of occupational health performance.
- Injury rates when calculated as a number per 100,000 employees fail to take account of changes in production levels.
- Injury rate measures lag behind changes in safety management.

It is recommended that the following measures be used to gauge the performance of the industry as whole .

- Fatal and major injury rates calculated per 100,000 employees and per volume of production.
- Working days lost due to work related ill health and injury (i.e. absence), as a per cent of total working days.

At an individual mill level, it is suggested that PABIAC give consideration to the use of two alternative types of performance indicators, namely “incident” and “management” based indicators.

Incident based indicators could include:

- Working days lost due to work related ill-health and injury (i.e. absence);
- The number of cases of reportable occupational ill-health;
- The number of non-injury accidents (and their costs). These could be graded by severity.

Management based indicators could include the following.

- Progress against specific qualitative goals, such as “all sites to have effective workforce involvement in health and safety” and “all mills to have effective safety review and root cause analysis of accidents”.



- The proportion of completed actions noted in action plans could be used as a measure of progress.
- Measures of safety culture and safety management. For example, mills could apply the HSE safety climate questionnaire at set intervals to gauge progress in safety culture improvement. Similarly, mills could apply a safety management-rating scheme, such as the one applied in this study, and gauge progress using the rating.

If all mills applied safety climate and safety management rating schemes, the scores could be collated (anonymously) to give a “leading” measure of progress for the industry as a whole.

*Conclusion 5: An injury rate target at a mill level does not provide a good measure of progress.*

Recommendation 1: PABIAC should consider promoting other performance measures to gauge progress in health and safety.

### ***How effective was the PABIAC Initiative?***

This part of the research programme comprised a review of qualitative feedback from 37 mills and other stakeholders obtained via a postal questionnaire. The objective was to gain an understanding of how the industry viewed the effectiveness of the PABIAC Initiative, and whether there was any consensus as to whether it should be continued in its current form. Pertinent findings include the following.

- Stakeholders and industry do not perceive sufficient improvement and progress to have been made across the industry yet (the 50% reduction in injuries has not been achieved). The Initiative appears to have been effective at stimulating management action and the development of safety culture and safety management on site, but these improvements have not yet fed through into accident statistics.
- The vast majority of responding mills agree that the benefits arising from the PABIAC Initiative justify the cost and more than half the mills regarded nearly all of the elements of the PABIAC as effective or very effective. Elements of the Initiative recognised as important and cited as being particularly effective were:
  - Senior management recognition of the importance of improving safety across the industry, and their commitment to improving standards across industry;
  - Cooperation, networking and collaboration increased across the industry, and provided opportunities for benchmarking on injury rates;
  - Partnerships improved, and resulted in better relationships between trade unions and employers;
  - Consistency of approach by HSE inspectors.

Comparison with the off-shore industry's Step Change programme supports the view that, given that much of the first year of such initiatives inevitably focuses on awareness raising, more significant improvements in injury rates might be expected from year four onwards - *provided* that the changes have acquired the momentum to become self-sustaining.

Recommendation 2:	The Initiative should be modified to consolidate on its successes.
Recommendation 3:	The next phase of the Initiative should have a 'brand name' to ensure continued buy-in.
Recommendation 4:	The notion of continuous improvement should remain a key element of the Initiative, perhaps through the use of accident reduction rolling targets, e.g. 10% reduction per year.
Recommendation 5:	HSE should continue to exert influence on CEOs.
Recommendation 6:	The elements of tripartite collaboration and partnership should be continued.

### ***Was the PABIAC Initiative effective in cost-benefit terms?***

A quantitative evaluation of the Initiative was undertaken to establish the balance of costs and benefits. The three-year costs for the Initiative were estimated above at £21.6m. The corresponding benefits in terms of averted injuries and other losses are estimated at £19.1m. The ratio of quantifiable costs to the value of reduced injuries is therefore approximately 1.1 to 1 for the three years to date, if allowance is made for a fall in non-injury accidents.

Stakeholders noted that much of the investment required for the PABIAC Initiative had now been made, but the benefits - including reduced accident costs - would be spread over a much longer period. Given the potential level of error in the data, and the potential for a reduction in cases of ill health and additional but unquantifiable future safety and commercial benefits, it is probably safe to conclude that the costs and benefits to date of the PABIAC Initiative are about equal.

*Conclusion 6: The PABIAC Initiative was cost neutral.*

*Conclusion 7: The evaluation was carried out very soon after the three-year point. This was too early to be able to evaluate quantitative impact on injury rates. However it did provide a good qualitative picture of the effectiveness of the Initiative, and it was carried out at the right time to feed into consideration of the Initiative's future direction.*

### ***Should the initiative be continued?***

Based on the conclusions of our analysis and feedback from mills and other stakeholders, the answer is yes, the PABIAC Initiative should be continued.

Those elements of PABIAC that should be maintained are:

- The encouragement of workforce involvement in health and safety, including involvement in the development of action plans;
- CEO briefings;
- The tri-partite nature of the Initiative;
- Action plans;

- The provision of advice by HSE inspectors to mills.

Those elements of the Initiative that could be extended include networking between mills and the sharing of best practice. In particular, it is recommended that examples of best practice are identified and presented to other mills, including best practice in the following:

- Action plans (including the role of workforce involvement);
- Safety management review and root cause analysis;
- Risk assessment;
- The application of training and S/NVQ in the workplace.

Those elements of the Initiative that need to be reviewed and improved include:

- The level of emphasis placed on safety management review and root cause analysis of incidents;
- The manner in which training and S/NVQ are applied in the workplace;
- The standard of risk assessment;
- Support for mills considering implementing behavioural safety schemes, including advice on timing and establishing the necessary pre-conditions;
- The presentation and understanding of the role of HSE enforcement in the paper industry.

<p>Recommendation 7: The PABIAC Initiative should be continued.</p>
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***Are the changes sustainable? Will the industry’s performance deteriorate without the Initiative?***

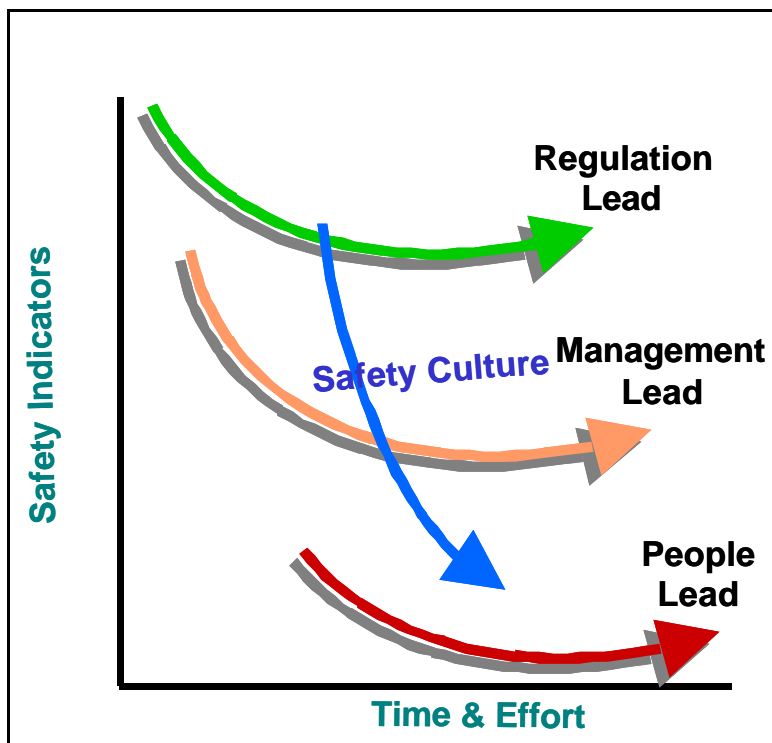
When the PABIAC Initiative was originally devised, an industry wide single target was proposed to improve the standards of health and safety across the industry, and the aims and objectives were shared across the industry. However performance across the industry varies and, although the gap between firms has reduced, further improvements are still required by the poorer performers. In particular:

- Action plans were viewed as an effective method by most mills, although initially many mills had difficulty developing and implementing them;
- Injury rate targets provided a shared goal for the entire industry, although some found the target challenging, unachievable and ultimately de-motivating;
- Mills’ progress in implementing action plans was affected by the quality of safety management and safety culture. Mills with better cultures and better standards of safety management were more effective at implementing action plans compared to poorer performers.

Poorer mills typically require greater levels of support. They ought to be able to improve standards fairly easily by putting effort into, and being more effective at, controlling risks and managing safety. Significant reductions in injury rates and continued reduction in variability of safety management and injury rates might be expected to follow. One could argue that to improve performance, the priority should be continued emphasis on the core elements from the Initiative.

By contrast, mills that already have reasonable standards of safety management and well-developed systems for the management and control of risks have already significantly reduced their potential for accidents. Therefore, these mills would find the 50% target more challenging. They need something different to help them develop further, to maintain the rigorous applications of safety management systems whilst at the same time continuing the transformation from a 'management-led' to a 'people-led' approach to safety that emphasises involvement. The Initiative's core elements are still important, but they will have been internalised. These mills need to be encouraged and to be made aware that effort still needs to be continually put into safety improvements, even though there may appear to be diminishing returns for the effort expended.

Figure 41 below illustrates these distinctions graphically, showing that to maintain an improving safety culture there must be a progression from regulation-led to management-led, to a people-led approach. Each will reduce accidents, but experience shows that injury rates will then tend to plateau, and further effort and an evolving approach are needed. Although performance is converging, there are mills at all levels and a more differentiated Initiative is required.

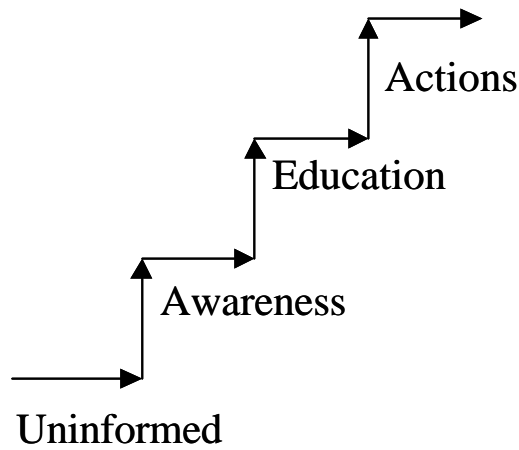


**Figure 41:** Injury rate reduction curves

Our view is that progress may already be sustainable in some mills, but even these would benefit from on-going support. For the industry as a whole, our impression is that the Initiative has to be continued to maintain progress and that the current core elements are still important. We would recommend tailoring the Initiative to give it the flexibility to meet the different requirements of mills with different levels and styles of safety management.

The Initiative therefore now needs to include different elements in that:

- Reward efforts, irrespective of injury rates. Evidence from this study suggests that time delays affect the achievement of injury rate reduction targets;
- Recognise that improving health and safety involves a series of steps, moving from ‘uninformed’, through awareness, education to action. This becomes an iterative process as mills become aware of where their weaknesses lie, and through a process of education implement actions. As awareness improves, mills will move through this cycle and continuously improve, particularly as their management standards improve and they develop robust review systems that provide a link between their performance and required standards. This is depicted below in Figure 42:



**Figure 42:** Progressions from ignorance through to actions

*Conclusion 8: Safety improvements in the paper industry are still required to bring it in line with UK Manufacturing.*

*Conclusion 9: Progress may already be sustainable in some mills, but for the industry as a whole the Initiative has to be continued to maintain it.*

*Conclusion 10: The Initiative needs to be more targeted and flexible to meet the needs of individual mills.*

<p><b>Recommendation 8:</b> The elements of the Initiative should be reviewed and enhanced so that they can be applied flexibly to suit the maturity of individual mills in terms of safety management.</p>
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***Taking into account the nature of the paper industry and the PABIAC Initiative is the Initiative transferable to other industries?***

One of the supplementary objectives of this research was to consider whether the PABIAC Initiative could be tailored for use in other industries.

We have concluded that the PABIAC Initiative was effective, however we believe that this is a consequence of a number of quite specific factors, including:

- The industry is relatively clearly defined and self-contained;
- It is a small industry - there are less than 100 paper mills across the UK;
- Mills tend to be very similar in terms of technology;
- Two trade unions, and one trade association represent the majority of the industry;
- There was a willingness both within the industry and amongst other stakeholders to co-operate and allow trust to develop, and a feeling that all mills were in the same boat as the poor performers.

Each of these factors contributed to the success of the Initiative. Therefore if it were to be successfully applied to another industrial sector without modification, that sector would need to share some, or perhaps all, of them. This is hardly surprising, since the Initiative was carefully devised to fit the particular circumstances of the paper industry, compensating for its weaknesses and drawing on its strengths. However we believe that individual elements developed as part of PABIAC would be more generally transferable, including:

- Benchmarks;
- Targets;
- Partnership;
- Action plans;
- The role of the HSE in getting CEO leadership buy-in;
- The development of CEO and other peer networks.

In other contexts, use could be made of networks, clubs etc to create smaller constituencies where accident improvement targets and competition would work successfully. Many companies already take part in benchmarking exercises, so the concept is widely accepted. The CIA's 'Responsible Care' programme offers another model, where interaction is also encouraged through local 'cells'.

***Conclusion 11: The PABIAC Initiative succeeded because of a number of features that are specific to the paper industry, but that with care similar approaches could be adopted in other industries.***

***Conclusion 12: If an analogous Initiative were to be implemented in another, larger, sector, there might be a need to break it down into smaller 'homogenous units with a common identity and representation e.g. regional agricultural groups.***

### ***Comments on the current study***

The current evaluation has been carried out to identify how successful the PABIAC Initiative was in achieving its aims and objectives. Our conclusions are set out above. However we have also been asked for our observations on the appropriateness the timing of the evaluation and the methodology employed.

- The evaluation was carried out a little too early, which meant that the benefits have not as yet all materialised or are not yet explicit enough;
- We included a cost-benefit analysis, but in interpreting its conclusions we have had to bear in mind that retrospective cost data will be subjective and prone to dispute;
- We have included comments where we think accident reporting effects may be significant, but the impact is unquantified;
- We considered the possible effect of the Initiative on productivity and other potential spin-off benefits. However data is not generally available and retrospective estimates would have had little validity.

Ideally, the requirements of evaluation ought to be agreed at the outset and appropriate data collection methods built into the programme. Certainly, if future PABIAC evaluations are contemplated, measures to allow the necessary information to be tracked and collected should be included within the Initiative. There are particular challenges in cost/benefit modelling.

- As firms do not, as a rule, track costs and benefits as a matter of routine it is important to provide a mechanism for tracking such costs and benefits during the Initiative;
- It would be useful to complete a pilot study of the costs and benefits prior to a full scale assessment, to enable the research method to identify and separate out one off costs from recurring costs;
- An approach needs to be agreed to estimating the benefit associated with changes (such as machinery guarding) that may only influence low frequency serious incidents, because accident statistics covering periods of only 1 to 5 years do not provide a meaningful measure;
- A method needs to be derived to assess the impact of interventions on the frequency of ill health, allowing for the long latency of ill health. Similarly, a method or agreed approach is required to provide a basis on which to project current accident trends into the future, to allow for future benefits arising from current interventions;
- As firms do not assess the impact of health and safety changes on productivity, a method needs to be developed to assess this issue further;
- The evaluation of costs and benefits needs to be timed to allow the lagging benefits to become apparent.

Our observations concerning the attribution of injury rate reduction to initiatives are as follows.

- Measures (such as safety culture scores) should be developed that are sensitive to those elements of health and safety targeted by the Initiative. The regression analyses undertaken as part of this study to determine the proportion of variation in injury rates that can be explained by changes in these measures should form part of any evaluation.
- Verified data needs to be collected and analysed for the 3 to 5 years preceding the Initiative if an accurate “before” and “after” analysis is to be completed.
- The availability of data on matters such as levels of production, profitability and organisational change, should be ascertained at the outset of the Initiative. In the event that such data is not available, consideration needs to be given to prompting its collection to support a regression analysis of injury rates against these “incidental” factors.
- Ideally, the HSE would fund a stand-alone research study that explored the feasibility and value of alternative methods of assessing cost-effectiveness and the attribution of improvements to interventions. This would have the advantage of not making the outcome of a “real” evaluation dependent on the success of previously untried methods of evaluation.

Recommendation 9: Prior to commencing an initiative, the evaluation methods and criteria need to be designed and built into the Initiative.

Recommendation 10: Research needs to be carried out to explore the feasibility and value of determining cost effectiveness.

### 6.3 SUMMARY OF CONCLUSIONS

1. Standards of safety culture and safety management have improved since the original study. No change was identified in technological risk scores.
2. The PABIAC Initiative was a useful framework for improving standards of safety management and safety culture across the paper industry.
3. Injury rates have reduced across the paper industry. The major injury rate has reduced by 26%; other measures are expected to follow.
4. The PABIAC Initiative would appear to have a major role in this reduction in injury rates.
5. An injury rate target at a mill level does not provide a good measure of progress.
6. The PABIAC Initiative was cost neutral.
7. The evaluation was carried out very soon after the three-year point. This was too early to be able to evaluate quantitative impact on injury rates. However it did provide a good qualitative picture of the effectiveness of the Initiative, and it was carried out at the right time to feed into consideration of the Initiative's future direction.
8. Safety improvements in the paper industry are still required to bring it in line with UK Manufacturing.



9. Progress may already be sustainable in some mills, but for the industry as a whole the Initiative has to be continued to maintain it.
10. The Initiative needs to be more targeted and flexible to meet the needs of individual mills.
11. The PABIAC Initiative succeeded because of a number of features that are specific to the paper industry, but that with care similar approaches could be adopted in other industries.
12. If an analogous Initiative were to be implemented in another, larger, sector, there might be a need to break it down into smaller 'homogenous units with a common identity and representation e.g. regional agricultural groups.

#### **6.4 SUMMARY OF RECOMMENDATIONS**

1. PABIAC should consider promoting other performance measures to gauge progress in health and safety.
2. The initiative should be modified to consolidate on its successes.
3. The next phase of the Initiative should have a 'brand name' to ensure continued buy-in.
4. The notion of continuous improvement should remain a key element of the Initiative, perhaps through the use of accident reduction rolling targets, e.g. 10% reduction per year.
5. HSE should continue to exert influence on CEOs.
6. The elements of tripartite collaboration and partnership should be continued.
7. The elements of the Initiative should be reviewed and enhanced so that they can be applied flexibly to suit the maturity of individual mills in terms of safety management.
8. Prior to commencing an initiative, the evaluation methods and criteria need to be designed and built into the Initiative.
9. Research needs to be carried out to explore the feasibility and value of determining cost effectiveness.

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# APPENDIX 1 CASE STUDY SCALES

## 1 SAFETY CULTURE

### Element

- Relationship to Head Office
- Commitment to safety by Mill Manager
- Visibility of Managing Director
- Visibility of Line Management
- Resources to health and safety
- Resources to training
- Production/safety
- Claims
- Organisational learning
- Financial health
- Competence
- Stress
- Blame
- Safety focus of organisation
- Clarity of health and safety objectives
- Allocation and acceptance of responsibilities
- Workforce involvement
- Participation of workforce
- Communication
- Feedback
- Trust between management and workforce
- Morale
- Labour relations
- Quality of supervision
- Quality of housekeeping
- Adherence to safety procedures on basis of site tour
- Individual safety awareness

## 2 SAFETY MANAGEMENT SYSTEMS

### Element

#### Policy

- Is there a current statement of OH&S Policy?
- Has the OH&S Policy been authorised by senior management?
- Does the OH&S Policy include a description of organisational health and safety objectives?
- Is the OH&S Policy appropriate to the nature and scale of the organisation's risks?
- Does the OH&S Policy include a commitment to compliance with legislation / industry standards?
- Is the OH&S Policy communicated to all employees?
- Is the OH&S Policy reviewed periodically?

#### Planning

- Are there procedures for:
  - hazard identification
  - risk assessment
  - risk control
- Are risk assessments conducted?
- Are risk assessments documented?
- Has a risk assessment methodology been defined?
- What's done with the information, e.g. devise risk control measures, safe systems of work, permits, PPE, training etc.
- Why are risk assessments carried out? What's their purpose?

#### Implementation & Operation

- Are SSOW and PTW in place where appropriate?
- Have personnel received training? What sort of training? How is competence to do their job safely ensured?
- Are employees aware of their OH&S roles and responsibilities?
- Are communication systems in place?
- Are employees involved, represented and consulted on OH&S matters?

#### Checking & Corrective Action

- Does the organisation employ both qualitative and quantitative performance measures?
- Does monitoring take place to verify that OH&S objectives are being addressed / met?
- Are there both proactive and reactive measures of performance to monitor accidents, incidents etc?
- Do procedures exist for accident, incident and near miss reporting and investigation?
- Is there an audit programme?

#### Management Review

- Does senior management review the SMS periodically?
- Are actions instigated where appropriate?
- Injury rate
- Numbers of accidents over last 5 years
  - fatal
  - major
  - over three day
- Employment figures for equivalent years

### **3 TECHNOLOGICAL RISK**

#### **Element**

- Output of Mill
- Machine downtime
- Number of paper breaks per 24 hours
- Number of paper grades, changes to set-up of the machine
- Number of employees - take into account the degree of contracterisation
- Input materials - index of complexity of the process
- Speed of machine - miles/hour
- Complexity of process
- Absenteeism
- Turnover of staff
- Is overtime worked?
- Number of shift teams
- Type of shift pattern
- Age of machines - last major rebuild?
- Maintenance

## APPENDIX 2 PABIAC IMPLEMENTATION QUESTION SET

<i><b>PABIAC Implementation</b></i>	<i><b>Detail</b></i>
<b>Defined aims and goals</b>	<ul style="list-style-type: none"> <li>• Did you know your starting performance?</li> <li>• Were you confident the data was reliable?</li> <li>• Was the target right for you?</li> <li>• Was the aim to improve safety performance or to satisfy PABIAC?</li> <li>• Did you feel the need for the target?</li> <li>• Was the goal realistic?</li> </ul>
<b>Development of Action Plan</b>	<ul style="list-style-type: none"> <li>• Consultation about how the goal can be achieved</li> <li>• Status quo – where you are now?</li> <li>• Risk assessments (ie, what needs controlling, defining objectives of the plan)</li> <li>• Consultation with stakeholders</li> <li>• Is it measurable – take into account the finance, business, operational requirements etc – was the OHS Action Plan ‘SMART’?</li> </ul>
<b>Implementation of Action Plan</b>	<ul style="list-style-type: none"> <li>• Who is responsible for each element of the Action Plan?</li> <li>• Management / monitor / review</li> <li>• Implementation</li> <li>• Were all personnel informed of the PABIAC initiative / Action Plan?</li> <li>• Training identified and carried out?</li> <li>• Employees involved in development / implementation of Action Plan?</li> <li>• Action Plan and supporting documentation / systems documented and accessible to all?</li> <li>• Procedures and work instructions concerning risk control and achievement of objectives (PTW, SSOW etc)</li> </ul>
<b>Has the plan been implemented?</b>	<ul style="list-style-type: none"> <li>• How do you know if:               <ul style="list-style-type: none"> <li>- the Plan is implemented?</li> <li>- performance is changing?</li> </ul> </li> <li>• Frequency of investigations to ascertain root causes of:               <ul style="list-style-type: none"> <li>- accidents</li> <li>- incidents</li> <li>- near misses</li> </ul> </li> <li>• Physical conditions</li> </ul>
<b>Has the Action Plan worked?</b>	<ul style="list-style-type: none"> <li>• Has the Plan worked?</li> <li>• Is it right?</li> <li>• Does it need tailoring</li> <li>• Anything missed?</li> </ul>

## APPENDIX 3 STATISTICAL ANALYSIS OF CASE STUDY MILLS

This small sample of mills lends itself to a limited range of statistical analyses. The number of mills means that statistical power is limited. Only in the case of very strong relationships between variables or very distinct differences between groups are we able to reject statistical null hypotheses. For correlational analyses, Spearman's rho ( $\rho$ ) is generally used in preference to Pearson's  $r$ , as the latter can be greatly influenced by one outlier in a sample of this size. These disclaimers aside, there are some patterns in the data that we believe are helpful in the interpretation of the injury rate data.

### 1 MEASURES OF SAFETY

Table 1 shows there are positive correlations between all three 'safety' measures (obtained in 2001). These are the same measures obtained in the original study of 12 mills, and the following assumes that they should be interpreted in the same way (i.e. 'direction') as they were at that time. For these 8 mills there is a weak correlation between the safety culture and safety management systems scores. The moderate correlation between safety culture score and the technological risk score indicates a tendency for mills with *greater* technological risk to have a *better* safety culture.

The near perfect correlation between the safety management systems score and the technological risk score indicates that mills with the greatest technological risk are those with the best safety management systems. The extremity of the correlation between these two measures means that it is extremely difficult to disentangle their *independent* relationship to other factors (e.g. injury rates). Note that the relationship between technological risk and the other two 'safety' measures is the reverse of that noted in the original study. Some thought could be given to whether this is an important change.

**Table 1:** Correlation between 'safety' measures obtained in 2001 (Spearman's rho)

	<i>Safety management score</i>	<i>Technological risk score</i>
Safety culture score	0.313	0.479
Safety management score		0.946***

\*\*\*  $p < 0.001$

## 2 RELATIONSHIP BETWEEN SAFETY MEASURES AND INJURY RATE

The weighted injury rate has been used in this analysis. This combines minor accidents, major accidents and fatalities into a single injury rate with progressively greater weight being given to more serious accidents.

The relationships observed in the original report were that injury rates were negatively related to both safety culture and safety management systems, but positively related to technological risk. Presumably these relationships would be expected to be the same in 2001.

**Table 2:** Correlation of safety measures with mean annual weighted injury rates

	<i>Last 3 years</i> <i>1998-2001</i>	<i>Last 2 years</i> <i>1999-2001</i>	<i>Last year</i> <i>2000/01</i>
Safety culture	-0.216	-0.006	-0.575
Safety management	-0.898**	-0.759*	-0.587
Technological risk	-0.810*	-0.635	-0.564

\* p < 0.05      \*\* p < 0.01

Table 2 indicates that the relationships with injury rates are as expected for safety culture and safety management systems, but contrary to expectation for technological risk. In other words, *lower* (better) injury rates are observed in mills with *greater* technological risk. However, as noted above, in a correlational analysis such as this, the technological risk score is essentially indistinguishable from the safety management systems score (which also negatively correlated with injury rate to a similar extent).

It is tempting to suggest that technological risk may be subordinate to safety management systems. In other words, if the extent or quality of safety management systems is ‘in proportion to’ technological risk, then we might expect injury rates to be negatively related to the safety management system score irrespective of the technological risk score. (In other words, to attribute the negative correlation between technological risk and injury rates in Table 2 to the influence of safety management systems, which happen to be closely allied to the technological risk.) The pattern of results above is consistent with this – though the sample is far too small for us to draw this as an inference from this statistical analysis.

## 3 MILL-BY-MILL ANALYSIS AND PREDICTIVE MODEL

Section 7 of the original report to the HSE dealt with the explanation and prediction of injury rates as a function of safety culture (SC), safety management systems (SMS) and technological risk (TR). This was explored using multiple linear regression, and this approach is adopted here. The intent is to determine whether the relationship observed in 1996/97 holds in 2001. The approach is to predict injury rates in 2001 using a linear rule derived from data from 1996/97. Safety measures obtained in 2001 are then substituted into the linear prediction rule to obtain *expected injury rates* for 2001. The match between *expected* and *actual* injury rates can then be examined. This match can be examined in two ways:



- Correlation – are mills with higher expected injury rates also those with higher expected injury rates?
- Difference – is there a small difference between expected and actual injury rates?

We would argue there are two important implications of a ‘good match’:

- It provides validation of the relationships observed and of the predictive rule derived in 1996/97. (I don’t think this is at all contentious).
- It could be argued that changes in injury rates can be attributed (causally?) to changes in safety culture, safety management systems and technological risk. (This may be a more contentious claim). However, we would argue that the claim is strengthened under the following conditions:
  - i. Prediction is good for an independent (new) sample of mills
  - ii. Prediction is good for a repeated (old) sample of mills where there have been clear changes in the safety measure scores
  - iii. The match between predicted and actual 2001 injury rates is better than that between actual 1996/97 injury rates and actual 2000/01 injury rates
  - iv. The assessment of safety culture, safety management systems and technological risk in individual mills is *not biased* (influenced) by knowledge of the injury rate for those mills.

**The predictive linear rule:** Consistent with the method described in Section 7 the original report to the HSE, linear regression was used to model the relationship between the three safety measures and the annual weighted injury rate. The mean annual weighted injury rate from the two years prior to the HSE intervention was used as the dependent variable in this analysis. The following linear rule was derived:

$$\text{Expected injury rate} = 9244 - 88(\text{SC}) - 16(\text{SMS}) + 25(\text{TR})$$

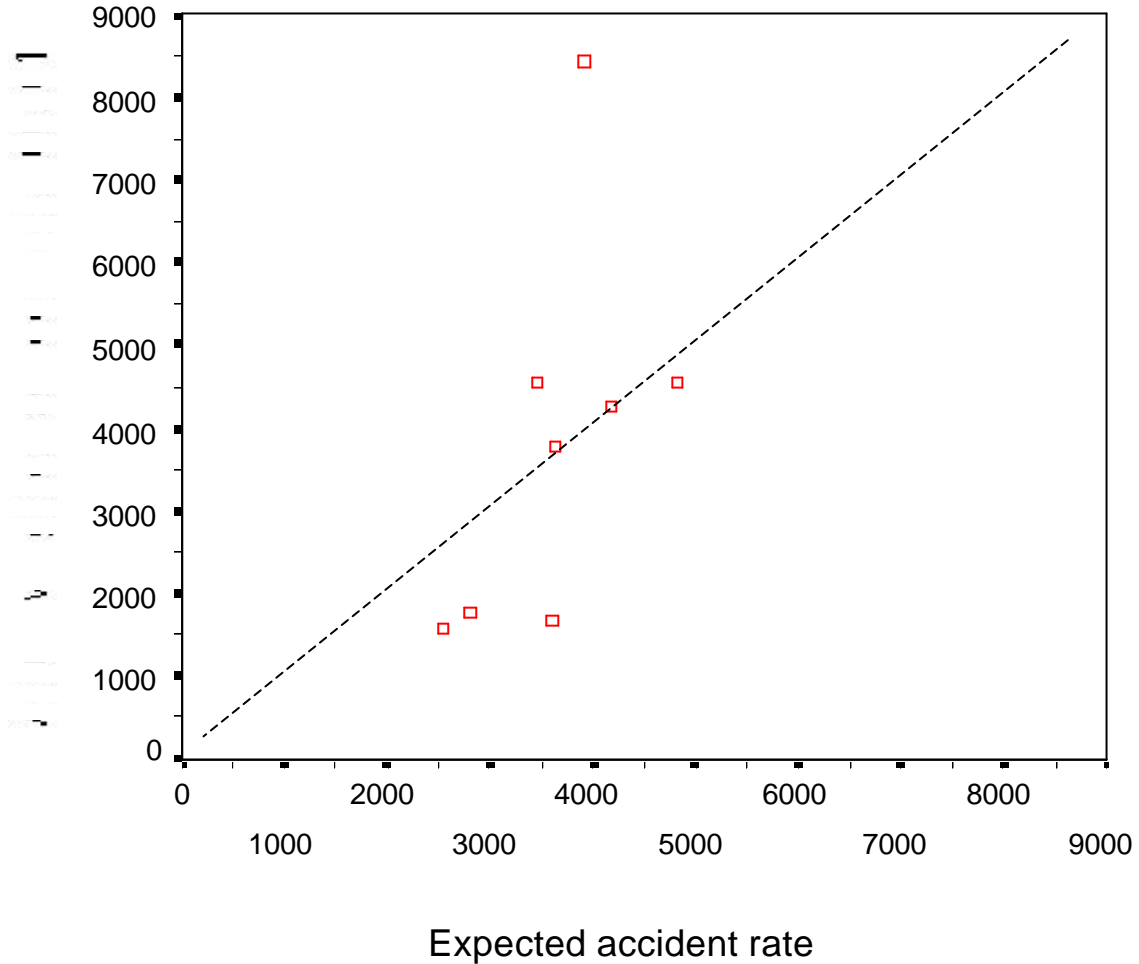
This rule accounts for 56% of the variance in the annual injury rate (adjusted  $R^2 = 0.561$ ). No variable is independently significant in the equation, however, the overall relationship is statistically significant,  $F(3,8) = 5.685$ ,  $p = 0.022$ . The equation can be interpreted as follows: “Holding other variables constant we expect fewer accidents the greater the safety culture score, the greater the safety management score, and the lower the technological risk score. The ‘impact’ of each unit change in safety culture score is about 5 times greater than each unit change in the safety management systems score, and about 4 times greater than each unit change in the technological risk score.”

Table 3 overleaf shows the results of applying this regression equation to each mill (using the safety measure scores obtained in 2001).

**Table 3** Safety measures and predicted and actual injury rates by mill

	<i>Revisit</i>	<i>SC</i> <i>(Prev.)</i>	<i>SMS</i> <i>(Prev.)</i>	<i>TR</i> <i>(Prev.)</i>	<i>Mean Ann.</i> <i>Wt. Acc. Rate</i> <i>1996-98</i>	<i>Exp. Annual</i> <i>Wt. Acc. Rate</i>	<i>Actual Wt.</i> <i>Acc. Rate</i> <i>2000/01</i>
Mill A	No	82	68	65	3968	2565	1587
Mill B	Yes	54 (82)	64 (73)	55 (45)	1739	4843	4565
Mill C	Yes	68 (66)	76 (47)	63 (68)	3305	3619	1695
Mill D	Yes	68 (66)	79 (62)	66 (49)	4286	3646	3810
Mill E	No	64	57	49	3257	3925	8429
Mill F	No	77	61	53	3869	2817	1786
Mill G	Yes	60 (40)	58 (38)	46 (58)	4669	4186	4280
Mill H	No	70	64	56	286	3460	4571
<b>Mean of these 8</b>		<b>68</b>	<b>66</b>	<b>57</b>	<b>3172</b>	<b>3633</b>	<b>3840</b>
<b>Mean of original 12</b>		<b>61</b>	<b>53</b>	<b>59</b>			
<b>Range of these 8</b>		<b>54-82</b>	<b>57-79</b>	<b>46-66</b>			
<b>Range of original 12</b>		<b>25-90</b>	<b>23-73</b>	<b>44-86</b>			

Figure 1 below shows the relationship between the expected annual weighted injury rate and the actual weighted injury rate for 2000/01. This is a moderate, or moderate-to-strong positive linear relationship: Spearman's rho = 0.595, Pearson's r = 0.558 (31% of variance accounted for), and indicates reasonable validation of the linear equation on the 'correlation criterion'.



**Figure 1:** Scatterplot of predicted and expected annual weighted injury rate (The broken line indicates 'perfect prediction')

The 'difference criterion' can be assessed by examining the deviation of actual injury rates from the 'perfect prediction' line on Figure 1. This ('vertical distance') would seem to be relatively small for 6 out of 8 cases, moderate for one case, and large for one case. From Table 3 it can be seen that the expected mean weighted injury rate for these 8 mills (3633) differs from the actual mean weighted accident (2000/01) for these 8 mills (3840) by only 5.4%.

Note also that the linear rule (on the basis of the three safety measures) predicts a *higher* mean annual injury rate for this subset of mills than was observed in 1996-98. In other words, for these 8 mills, the linear rule has made a prediction *against the trend* of the industry as a whole – yet this prediction seems to be borne out. More specifically, comparing annual weighted injury rates in 1996-98 with expected annual injury rates, the rule predicts an *increase* in injury rates for 4 mills and a *decrease* in injury rates for 4 mills. The direction of this predicted change is correct for 7 out of 8 mills, though this might also be predicted by ‘regression to the mean’.

The predictive linear rule seems to perform reasonably well according to the ‘correlation and difference criteria’. Included in the cases under which the linear rule was tested were 4 mills that were not included of the original study, suggesting the rule does generalise beyond the original 12 mills investigated. Also examined were 4 mills that were included in the original study. Injury rates and safety measures at these mills had changed somewhat over time, *suggesting* that the rule is doing more than just capitalising upon consistency in performance over time.

To further examine this possibility, the relationship between annual injury rates in 1996-98 and the present day were examined. This allows us to consider better whether changes in SC, SMS and TR explain variation in injury rates across time over and above the observation that there is some consistency in which mills have high (or low) injury rates from year to year. The correlation between the mean annual injury rate in 1996-98 and the annual injury rate in 2000/01 was negative (Spearman’s  $\rho = -0.52$ , Pearson’s  $r = -0.24$ ). Therefore, in this particular sample there was no consistency in injury rates across time to which the apparent success of the linear rule might be spuriously attributed.

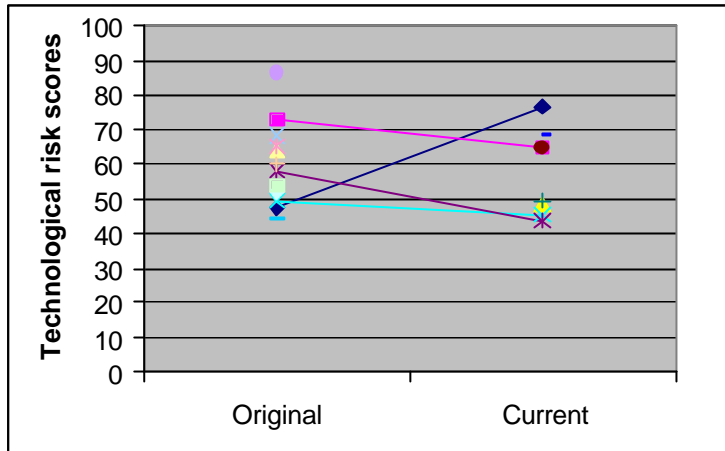
It would seem that the general form of the relationship of SC, SMS and TR with injury rates observed in the original study remains valid. And this seems satisfactory with respect to the three ‘challenges to statistical validity’ outlined in section 3 of this Appendix. The fourth challenge to validity listed [(iv)] is methodological rather than statistical, so cannot be addressed here.

Whilst perhaps not provable from small samples, it does seem reasonable to attribute an important portion of the variation in injury rates between mills and across time to differences and changes in safety culture, safety management systems and technological risk. In the context of evaluating the HSE initiative this would seem to prompt two important questions. What changes over time have there been in safety culture, safety management systems and technological risk? Can these changes be attributed to the HSE intervention?

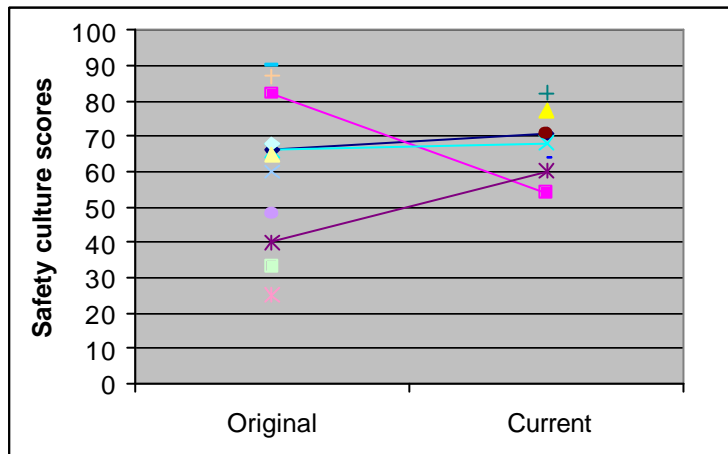
#### **4 CHANGES OVER TIME**

Figure 2 below compares the SC, SMS and TR measures obtained in 1996/97 and 2001. Comparing each measure over time, there would appear to be a distinct overall improvement in the SMS scores, but little discernable improvement in the other scores (with the possible reduction of the ‘lower tail’ of the SC scores). Without knowing how ‘typical’ or ‘representative’ of the industry as a whole these two samples of mills are, it is difficult to say whether the reduction in injury rates observed in the industry as a whole can be attributed to general improvements in safety management systems.

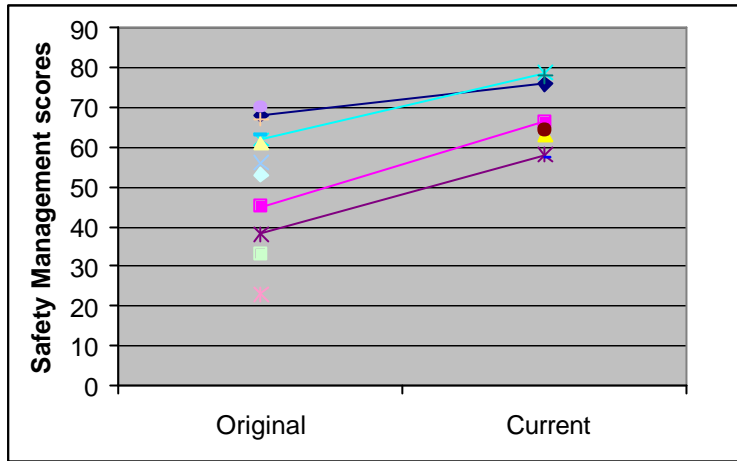
However, improvements of the order seen here (e.g. 5 points on the SC scale and 15 points on the SMS scale) would be expected to result in about a 15% reduction in the annual weighted injury rate (per 100 000). This is consistent with the changes in injury rates observed after the introduction of the HSE initiative.



**Figure 2:** Technological risk scores



**Figure 3:** Safety culture scores



**Figure 4:** Safety management scores

## APPENDIX 4 INDUSTRY INJURY RATES 1996 – 2001

### 1 INTRODUCTION

This Appendix comprises a statistical analysis of accident statistics for the industry as a whole and then on a mill-by-mill basis.

Analysis of industry wide figures

- Accidents per 100 000 employees
- Accidents per 100 000 tonnes production

Analysis mill by mill

- For 'weak' and 'strong' performers
- By size of mill (by number of employees and by output)
- By output
- By product
- Multivariable analysis

Some overall conclusions are drawn in section 4.

### 2 ANALYSIS OF INDUSTRY WIDE FIGURES

#### 2.1 Injury rate per 100 000 employees

Based on industry-wide employment figures of 23 000 in 1996 and 18 800 in 2000, a comparison of injury rates per 100 000 employees in 1996/97 and 2000/01 shows little change in the overall injury rate (-2.0%) and the minor injury rate (+3.3%), but a marked decrease in the major (including fatal) injury rate (-26.6%). In other words, the decrease in the total number of accidents (consisting mainly of minor accidents) is roughly in proportion to the decrease in the number of employees during this time period across the industry as a whole. However, the decrease in the number of major accidents exceeds the decrease in the size of the workforce.

**Table 1** UK paper industry: Injury rate per 100 000 employees

	<i>Major (include. Fatal)</i>	<i>Minor</i>	<i>All accidents</i>
1996/97	434.8	1987.0	2421.7
2000/01	319.1	2053.2	2372.3

## 2.2 Injury rate per 100 000 tonnes production

Despite a decreasing workforce, the production of the industry has increased (from 6 224 600 tonnes in 1996 to 6 605 300 tonnes in 2000). This represents an increase in the output per operative from 270.6 tonnes to 351.3 tonnes (+29.8%).

Based on these industry-wide production figures, a comparison of injury rates per 100 000 tonnes produced in 1996/97 and 2000/01 shows marked improvement in the overall injury rate (-24.5%), the minor injury rate (-20.4%), and in the major (including fatal) injury rate (-43.5%).

**Table 2** UK paper industry: injury rate per 100 000 tonnes production

	<i>Major (inc. Fatal)</i>	<i>Minor</i>	<i>All accidents</i>
1996/97	1.607	7.342	8.948
2000/01	0.908	5.844	6.752

Overall minor injury rates have changed little and major injury rates have fallen by about one quarter over a period of time when industry efficiency has increased by about one quarter. This suggests a number of open questions that cannot be addressed from this data. These relate to how the increase in output per operative has been achieved over these five years.

- Are individuals working longer hours?
- Is existing machinery being run differently?
- Has new technology been introduced?

## 3 ANALYSIS MILL BY MILL

The intention of this analysis is to use injury rates (per 100 000 employees) for each mill to track changes in injury rates before and after the start of the HSE intervention (March 1998). In order to 'smooth' fluctuations in injury rates from year to year, rates for the two pre-intervention years were averaged, as were rates for the three post-intervention years.

Data was available for 109 mills that operated in the time period 1 April 1996 to 31 March 2001. However, this included 10 mills that appeared under two names (where ownership had changed in this period) - these were 'matched' to reflect the ongoing production on these single sites. 7 mills closed and 1 opened during this period - these were excluded from analysis as production was not ongoing throughout the period in question. A further 3 mills with fewer than 25 employees were excluded as rates based on such numbers were deemed insufficiently reliable for this analysis. The remaining 88 mills were analysed.

Four different injury rates per 100 000 employees were analysed: minor injury rate, major injury rate, overall (unweighted) injury rate, and a weighted injury rate (weighting: minor = 1, major = 3, fatal = 10). Rates were calculated on the basis of 2001 employment figures (prior figures not available). Mill closures (less one mill opening) account for only 640 out of 4200 job losses in the industry. Presumably the remaining 3560 job losses were sustained by mills that remained open. On the assumption of constant rates job-loss across this period, relative changes in injury rates are best judged by decreasing the pre-intervention injury rates by 10%. These will be given as 'corrected' figures.



The weighted injury rate correlates highly with both the minor injury rate (mean  $r = 0.87$ ) and with the major injury rate (mean  $r = 0.80$ ). The overall (unweighted) injury rate correlates very highly with the minor injury rate (mean  $r = 0.97$ ) and correlates moderately with the major injury rate (mean  $r = 0.61$ ). This could be interpreted as: the weighted injury rate reflects both the major and minor injury rates reasonably well, whilst the overall (unweighted) injury rate is little more than a restatement of the minor injury rate (because most accidents are minor accidents).

### 3.1 Changes in rate

Pre/post-intervention changes in the mill-by-mill injury rates mirror the industry wide figures with a small change in the mean minor injury rate (-5%, corrected change +5%) and the mean overall injury rate (-10%, no change when corrected), and a clear reduction in the mean major injury rate (-33%, corrected change -26%) and in the mean weighted injury rate (-18%, corrected change -9%).

**Table 3** Mean (SD) annual mill injury rate per 100 000 employees [all based on 2001 employment figures]

	<i>Minor</i>	<i>Major</i>	<i>Overall</i>	<i>Weighted</i>
Pre-intervention 1996-1998	2005(1543)	448(506)	2453(1814)	3431(2701)
Post-intervention 1998-2001	1902(1161)	298(276)	2201(1302)	2814(1696)

(Uncorrected) injury rate reductions were statistically significant for major accidents ( $t(87) = 2.65$ ,  $p = 0.010$ ) and for the weighted injury rate ( $t(87) = 2.34$ ,  $p = 0.22$ ), but not for other measures.

Standard deviations in Table 3 indicate reduced variation in injury rates over time (though this may, in part, reflect greater 'smoothing' from averaging 3 years figures as against 2 years to generate these measures). The pattern of change can be seen more clearly in Tables 4 to 7 below.

**Table 4** Distribution of (uncorrected) annual minor injury rates

	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>
Pre-intervention1996-1998	0	971	1539	2937	7000
Post-intervention1998-2001	0	996	1798	2576	5333
Change(Corrected change)	-	+3%(+14%)	+17%(+30%)	-12%(-3%)	-24%(-15%)

**Table 5** Distribution of (uncorrected) annual major injury rates

	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>
Pre-intervention1996-1998	0	0	350	698	2419
Post-intervention1998-2001	0	0	265	453	1111
Change(Corrected change)	-	-	-24%(-16%)	-35%(-25%)	-54%(-44%)

**Table 6** Distribution of (uncorrected) annual overall injury rates

	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>
Pre-intervention1996-1998	0	1263	1977	3333	8000
Post-intervention1998-2001	0	1205	2030	2958	6000
Change(Corrected change)	-	-5%(+6%)	+3%(+14%)	-11%(-1%)	-25%(-17%)

**Table 7** Distribution of (uncorrected) annual weighted injury rates

	<i>Minimum</i>	<i>Q1</i>	<i>Median</i>	<i>Q3</i>	<i>Maximum</i>
Pre-intervention 1996-1998	0	1380	3128	4947	11750
Post-intervention 1998-2001	0	1742	2643	3783	7333
Change (Corrected change)	-	+26% (+40%)	-15% (-6%)	-23% (-15%)	-37% (-31%)

Where improvement has occurred, it appears to be predominantly among the ‘weaker’ mills – coming closer to the median performance (which changed little). In other words, fewer mills have very high injury rates, whilst the injury rate of the ‘typical’ mill has changed little since the intervention. Note that there was little/no room for improvement among the ‘best’ mills.

### 3.2 Changes in injury rates for ‘weak’ and ‘strong’ performers

Another way to examine this is to split mills into two cohorts by pre-initiative weighted injury rates. These ‘weak’ and ‘strong’ performers can then be compared to see how improvement subsequent to the start of the initiative might be dependent upon performance prior to its inception.

There are important difficulties associated with interpreting this type of analysis. Even if there were no overall change in injury rates we would expect, on average, the best performers to get worse, and the worst performers to get better. This is the statistical phenomenon of ‘regression to the mean’. If some of the fluctuation in injury rates is due to chance, then we would expect that some mills in the ‘top half’ in a given year would be in the ‘bottom half’ the following year. Similarly, we would expect that some mills in the ‘bottom half’ in a given year would be in the ‘top half’ the following year. We are really looking for changes over and above those that can be attributed to chance fluctuation.

**Table 8** Mean (SD) annual mill injury rate per 100 000 employees, by pre-intervention performance (‘best’ half vs ‘worst’ half) [based on 2001 employment figures]

	<i>‘best’ half</i>	<i>‘worst’ half</i>	<i>‘best’ half</i>	<i>‘worst’ half</i>
Pre intervention 1996-1998	1044(731)	2965(1547)	96(172)	799(486)
Post-intervention 1998-2001	1357(1016)	2448(1043)	232(259)	364(278)
Change -	+313	-517	+136	-435

**Table 9** Mean (SD) annual mill injury rate per 100 000 employees, by pre-intervention performance ('best' half vs 'worst' half) [based on 2001 employment figures]

	<i>'best' half</i>	<i>'worst' half</i>	<i>'best' half</i>	<i>'worst' half</i>
Pre-intervention 1996-1998	1140(740)	3765(1609)	1333(866)	5528(2238)
Post-intervention 1998-2001	1589(1117)	2812(1192)	2069(1472)	3561(1585)
Change	+449	-953	+736	-1967

Two things are worthy of note:

- The better mills prior to the HSE initiative tend to be the better mills after the initiative. In other words there is some consistency over time in which mills have better injury rates. The pre/post-initiative correlation coefficients for the four accidents are: 0.40 (minor), 0.19 (major), 0.46 (overall) and 0.44 (weighted).
- Although the 'best get worse and the worse get better' (as would be anticipated with this type of analysis), the improvement of the 'worst' half always exceeds the deterioration of the 'best' half. This is the case whether we examine the magnitude of change or the 'reliability' of changes (using t-tests). This further suggests that we can characterise some of the changes over time as an improvement in accident (major) rates by those mills with initially high injury rates (as opposed to an across-the-board improvement).

### 3.3 Changes in injury rate by size of mill

#### ***Changes in injury rate by number of employees***

The mills were split into quartiles by number of employees, leaving 22 mills in each group.

1st quartile	0 – 115 employees
2nd quartile	116 – 119 employees
3rd quartile	200 – 399 employees
4th quartile	400+ employees

Pre- and post-Initiative accident data is shown in the tables overleaf for each quartile.

**Table 10** Mean (SD) annual mill minor injury rate per 100 000 employees by number of employees [based on 2001 employment figures]

	<i>1st quartile</i>	<i>2nd quartile</i>	<i>3rd quartile</i>	<i>4th quartile</i>
Pre-intervention1996-1998	1767(1838)	2299(1628)	2208(1507)	1745(1136)
Post-intervention1998-2001	1893(1307)	2254(2259)	1660(1138)	1803(1144)

**Table 11** Mean (SD) annual mill major injury rate per 100 000 employees by number of employees [based on 2001 employment figures]

	<i>1st quartile</i>	<i>2nd quartile</i>	<i>3rd quartile</i>	<i>4th quartile</i>
Pre-intervention1996-1998	575(784)	464(489)	428(228)	324(246)
Post-intervention1998-2001	166(239)	426(360)	283(232)	318(197)

**Table 12** Mean (SD) annual mill overall injury rate per 100 000 employees by number of employees [based on 2001 employment figures]

	<i>1st quartile</i>	<i>2nd quartile</i>	<i>3rd quartile</i>	<i>4th quartile</i>
Pre-intervention1996-1998	2342(2158)	2763(2017)	2636(1735)	2070(1265)
Post-intervention1998-2001	2059(1413)	2680(1162)	1942(1303)	2122(1282)

**Table 13** Mean (SD) annual mill weighted injury rate per 100 000 employees by number of employees [based on 2001 employment figures]

	<i>1st quartile</i>	<i>2nd quartile</i>	<i>3rd quartile</i>	<i>4th quartile</i>
Pre-intervention1996-1998	3492(3302)	3916(3094)	3570(2528)	2744(1610)
Post-intervention1998-2001	2390(1705)	3532(1641)	2547(1685)	2785(1638)

Injury rates for mills employing differing numbers of employees were quite similar (both before and after the initiation of the HSE initiative). One-way ANOVA was used to examine differences between the four quartiles for the four injury rates both before and after the HSE intervention. Only one of these analyses was statistically significant – that for the major injury rate after the HSE intervention,  $F(3,84) = 3.63$ ,  $p = 0.016$ . Post hoc tests indicated that the major injury rate for mills in the first quartile was significantly lower than that for the second quartile. This highlights perhaps the most noteworthy shift in the figures above - the marked improvement in the major injury rate at the smallest mills.

### ***Changes in injury rate by output level***

Mills employing greater numbers of employees will, of course, tend to produce more paper. Therefore this analysis would be expected to overlap considerably with that reported in the previous section. For this analysis, mills were grouped into the following output categories. Pre- and post-initiative accident data is shown in the tables below for each group.

<i>Output (tonnes)</i>	<i>&lt;10K</i>	<i>10-25K</i>	<i>25-50K</i>	<i>50-100K</i>	<i>100-250K</i>	<i>&gt;250K</i>
Number of mills	12	19	18	18	12	6

**Table 14** Mean (SD) annual mill minor injury rate per 100 000 employees by mill output [based on 2001 employment figures]

	<i>&lt;10K</i>	<i>10-25K</i>	<i>25-50K</i>	<i>50-100K</i>	<i>100-250K</i>	<i>&gt;250K</i>
Pre-intervention 1996-1998	2595(1995)	1602(1207)	1816(1532)	2157(1486)	2217(963)	2989(2189)
Post-intervention 1998-2001	2087(1390)	1627(1076)	1702(1068)	2046(1337)	2404(942)	1996(1176)

**Table 15** Mean (SD) annual mill major injury rate per 100 000 employees by mill output [based on 2001 employment figures]

	<i>&lt;10K</i>	<i>10-25K</i>	<i>25-50K</i>	<i>50-100K</i>	<i>100-250K</i>	<i>&gt;250K</i>
Pre-intervention 1996-1998	646(771)	452(510)	371(448)	487(532)	420(301)	428(361)
Post-intervention 1998-2001	150(218)	226(249)	294(250)	393(328)	435(261)	359(277)

**Table 16** Mean (SD) annual mill overall injury rate per 100 000 employees by mill output [based on 2001 employment figures]

	<i>&lt;10K</i>	<i>10-25K</i>	<i>25-50K</i>	<i>50-100K</i>	<i>100-250K</i>	<i>&gt;250K</i>
Pre-intervention 1996-1998	3141(2052)	2054(1433)	2187(1854)	2644(1947)	2637(1151)	3417(2489)
Post-intervention 1998-2001	2237(1446)	1853(1244)	1997(1127)	2439(1494)	2839(1146)	2355(1419)

**Table 17** Mean (SD) annual mill weighted injury rate per 100 000 employees by mill output [based on 2001 employment figures]

	<i>&lt;10K</i>	<i>10-25K</i>	<i>25-50K</i>	<i>50-100K</i>	<i>100-250K</i>	<i>&gt;250K</i>
Pre-intervention 1996-1998	4433(2871)	3061(2518)	2930(2613)	3618(2942)	3725(1706)	4665(3731)
Post-intervention 1998-2001	2537(1640)	2305(1644)	2586(1380)	3304(1960)	3708(1604)	3071(1933)

Injury rates were again reasonably similar, and there were no statistically significant differences between this admittedly large number of groups. There is some suggestion of higher injury rates among mills with very high or very low output levels prior to the HSE intervention. Subsequent to the HSE intervention, injury rates at these mills are much more in line with those with intermediate levels of production.

### 3.4 Changes in injury rate by type of production

Product type information was available for 85 of the 88 mills being analysed. The breakdown of mills by product type was as follows:

Product	Graphics	Newsprint	Packaging	Tissue	Other
Number of mills	27	3	23	14	18

**Table 18** Mean (SD) annual mill minor injury rate per 100 000 employees by product type [based on 2001 employment figures]

	<i>Graphics</i>	<i>Newsprint</i>	<i>Packaging</i>	<i>Tissue</i>	<i>Other</i>
Pre-intervention 1996-1998	1735(1102)	2427(1377)	2252(1741)	1926(1486)	2419(1833)
Post-intervention 1998-2001	1785(930)	2048(1261)	2052(1325)	2144(1403)	1816(1158)

**Table 19** Mean (SD) annual mill major injury rate per 100 000 employees by product type [based on 2001 employment figures]

	<i>Graphics</i>	<i>Newsprint</i>	<i>Packaging</i>	<i>Tissue</i>	<i>Other</i>
Pre-intervention 1996-1998	298(291)	313(172)	525(668)	655(559)	510(491)
Post-intervention 1998-2001	314(295)	352(100)	218(283)	361(205)	345(304)

**Table 20** Mean (SD) annual mill overall injury rate per 100 000 employees by product type [based on 2001 employment figures]

	<i>Graphics</i>	<i>Newsprint</i>	<i>Packaging</i>	<i>Tissue</i>	<i>Other</i>
Pre-intervention 1996-1998	2033(1320)	2739(1439)	2777(2134)	2581(1704)	2929(2017)
Post-intervention 1998-2001	2099(1121)	2400(1358)	2271(1510)	2505(1521)	2161(1225)



**Table 21** Mean (SD) annual mill weighted injury rate per 100 000 employees by product type [based on 2001 employment figures]

	<i>Graphics</i>	<i>Newsprint</i>	<i>Packaging</i>	<i>Tissue</i>	<i>Other</i>
Pre-intervention 1996-1998	2629(1819)	356391524)	4033(3378)	3891(2484)	4057(2889)
Post-intervention 1998-2001	2749(1638)	3103(1553)	2745(1952)	3227(1806)	2852(1541)

Minor accidents rates were, and are very similar for all types of mill. Prior to the HSE initiative, major injury rates were somewhat higher in mills producing packaging, tissue or 'other' products. These subsequently fell to levels close to those for the graphics and newsprint sectors. Fairly large falls in the weighted injury rates are apparent for the packaging and 'other' sectors of the industry. Differences in injury rates by product (pre- and post-intervention) were examined using one-way ANOVA. None of the differences were statistically significant.

One difficulty with this analysis is that only 3 mills produce newsprint. If there is a principled way to group newsprint with another sector, perhaps on technological considerations, this analysis could be repeated in a more satisfactory fashion.

### **3.5 Multivariable analysis of changes in injury rates**

Some changes in injury rates over time have been noted for certain sectors of the industry in the analysis above. Although some of these changes would seem to be of a reasonable order, it should be noted that differences between sectors of the industry are rarely statistically significant (reflecting the wide variability of injury rates within the industry and within its different sectors). We should therefore exercise caution not to over-interpret these changes.

However, to re-summarise the above sections there seems to be a *tendency* for small mills to have achieved some improvement in their injury rates; and for mills producing packaging, 'other' and (to some extent) tissue products to have achieved some improvement in their injury rates. These sectors of the industry previously had higher major injury rates, but now seem much more in line with other sectors. These results are not independent findings, as packaging, tissue and 'other' products are more likely to be produced at smaller mills than graphics paper and newsprint (see table 22 below). It is therefore very difficult to guess which, if any, of these factors might be dominant in the tendencies for change described above.

**Table 22** Number of mills by number of employees and product type

<i>Sectors</i>	<i>Number of Employees</i>			
	<i>0 – 115</i>	<i>116 – 199</i>	<i>200 – 399</i>	<i>400+</i>
Graphics	2	7	7	11
Newsprint	-	-	-	3
Packaging	8	6	6	3
Tissue	4	2	4	4
Other	5	7	5	1

**Table 23** Mean change (post-intervention – pre-intervention) in weighted injury rate by number of employees and product type [based on 2001 employment figs.]

	<i>Number of Employees</i>			
	<i>0 – 115</i>	<i>116 – 199</i>	<i>200 – 399</i>	<i>400+</i>
Graphics	+1014	+889	-915	+127
Newsprint	-	-	-	-460
Packaging	-1697	-821	-1544	-613
Tissue	-1092	-2913	-508	733
Other	-2546	-559	-964	-222

Discerning whether one factor may be more important than the other is unfortunately not clarified by tabulating changes by size and product type, as might be hoped (see table 23). Any pattern is similarly difficult to determine if mill size is assessed by production levels (table 24).

**Table 24** Number of mills by number of employees and product type

	<i>Annual production levels (tonnes)</i>		
	<i>&lt; 25K</i>	<i>25K – 100K</i>	<i>&gt;100K</i>
Graphics	7	15	5
Newsprint	-	-	3
Packaging	5	10	8
Tissue	4	9	1
Other	15	2	1

**Table 25** Mean change (post-intervention – pre-intervention) in weighted injury rate by number of employees and product type [based on 2001 employment figs.]

	<i>Annual production levels (tonnes)</i>		
	<i>&lt; 25K</i>	<i>25K – 100K</i>	<i>&gt;100K</i>
Graphics	-323	+461	-280
Newsprint	-	-	-460
Packaging	-1347	-1324	-1204
Tissue	-844	-977	+2874
Other	-1650	+1642	-222

We have performed some more complex factorial ANOVAs using these variables but they do not add significantly to the more straightforward analyses described above, and so they have not been reported here.

#### **4 SOME CONCLUSIONS**

If injury rates are calculated by output the picture is rather more ‘successful’ than if injury rates are calculated by number of employees. It may be that the ‘story’ behind the industry’s marked improvement in output efficiency may be important in understanding the relatively small changes in the number of accidents across the industry as a whole.

It would appear that safety has been improved at those mills that previously had the (major) highest injury rates. It is unclear how significant it is that these mills tended to be smaller mills producing packaging, tissue or ‘other’ products. This is perhaps a qualitative question.

If future monitoring is desired, there are two figures that it would be useful if every operating mill returned to their industry bodies on an annual basis:

- The number of employees (perhaps at some mid-year enumeration date such as 1st Oct).
- The annual output of the mill (perhaps to the nearest 1000 tonnes)

## APPENDIX 5 THE 12 MILLS IN THE ORIGINAL ANALYSIS

Accident data from the current investigation was combined with the original 1996 HSE investigation of 12 paper mills. Specifically, employment figures (for 1996) and measures of safety culture (SC), safety management (SM) and technological risk (TR) obtained in the original study were added to the current data. Weighted injury rates were chosen as the measure to compare injury rates at these 12 mills in 1996/7 and 2000/01. The weighted injury rate was recalculated for 1996/97, using the appropriate employment figures.

### 1 CHANGES IN EMPLOYMENT

Between 1996 and 2000, total employment at the 12 mills rose from 3711 to 3834 employees. This increase of 3.3% is slightly against industry trends in falling employment, though one of 12 mills closed in 2001 (with the loss of 100 employees), at the very end of the 5-year period of investigation.

### 2 CHANGES IN THE WEIGHTED INJURY RATE

Changes in injury rate matched the pattern noted for the industry as a whole (Table 1). The fall in the mean weighted injury rate of 22% looks to be largely attributable to considerable improvements made at the mills with high injury rates in 1996/97. A moderate correlation was observed between the two injury rates ( $r = 0.47$ ,  $p = 0.124$ ), indicating a (non-significant) tendency for the mills with the lowest injury rates in 1996/97 to be those with the lowest injury rates in 2000/01.

**Table 1:** Weighted Injury rates per 100000 employees

	<i>Mean</i>	<i>Std. Dev.</i>	<i>Minimum</i>	<i>Maximum</i>
1996/97	4355	3102	704	12500
2000/01	3411	1424	1667	6200

### 3 IMPACT OF ORGANISATIONAL FACTORS

As noted in the original 1996 investigation, there appears to be a very strong relationship between the injury rate (1996) and safety culture, a moderately strong relationship between the injury rate (1996) and safety management (1996), and a moderate relationship between the injury rate (1996) and technological risk (1996) - see Table 2. The SC, SM and TR scores in 1996 are largely unresponsive of injury rates in 2000/01.

**Table 2:** The correlation between weighted injury rates and organisational factors

	<i>SC score (96)</i>	<i>SM score (96)</i>	<i>TR score (96)</i>
(1) Weighted injury rate 1996/97	-0.83**	-0.62*	0.36
(2) Weighted injury rate 2000/01	-0.28	0.16	0.27
Five-year change [(2) - (1)]	0.79**	0.79**	-0.26

\*\* p < 0.01      \* p < 0.05

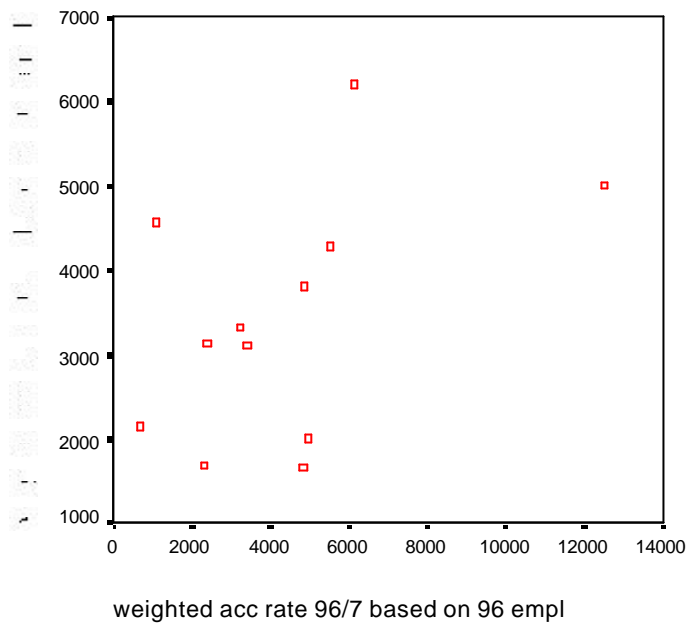
It would be very interesting to have SC, SM and TR scores for the present day - if these have changed, it might account for the lack of correlation between SC/SM scores in 1996 and current injury rates. Interestingly there is a very clear relationship between the SC and SM scores in 1996 and the size of change in injury rates over time. Mills with the lowest (poorest) SC and SM scores in 1996 have seen the greatest decrease (improvement) in injury rates in the last five years. Keeping in mind that we might expect some 'regression to the mean' for injury rates, the relationship is, nevertheless, very clear.

This would account for the way that the correlation between SC/SM measures from 1996 and injury rates has changed considerably over time. Conversely the relationship between TR and injury rates has changed only slightly with time.

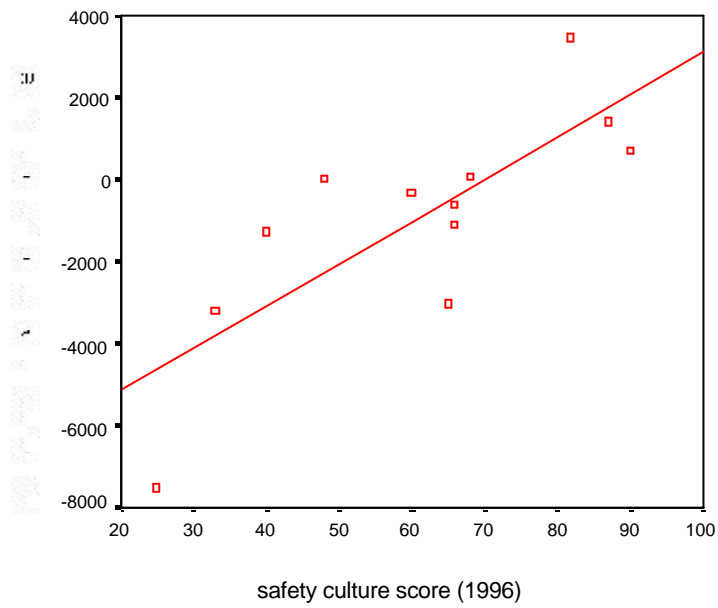
With such a small data set, firm conclusions are difficult. However, the following hypothesis is, we believe, consistent with the above (and preceding) results - though many alternatives are possible. It would be very interesting if this could be examined further.

The pattern observed would be expected if:

- Safety culture scores and safety management scores have improved at the mills where these scores were previously low (e.g. below 50), but were largely unchanged at those mills with better scores in 1996.
- Technological risk scores were largely unchanged across all mills.



**Figure 1** Scatter-plot showing weighted injury rates in 1996/97 and 2000/01



**Figure 2** Scatter-plots showing changes in injury rate as a function of SC in 1996



**Figure 3** Scatter-plots showing changes in injury rate as a function of SM in 1996









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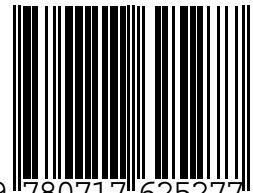
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