

IMPROVING SHIFT HANDOVER AND MAXIMISING ITS VALUE TO THE BUSINESS

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Recent accidents at Buncefield and Texas City have illustrated how poor shift handover can contribute to major accidents. This is not a new discovery, but given the ever greater interest in human factors, it is one that is finally receiving attention.

Shift handover is a complex, high risk activity that is performed very frequently. Normally we would try to 'engineer out' high risk frequent tasks, or at least automate them to minimise the likelihood of error. However, this is not an option for shift handover.

There are two complimentary approaches that can be used to improve shift handover. The first is to improve the handover process by supporting the people involved with better systems, tools, and competencies. The second is to change perceptions by maximising the value of the information collected as part of the handover process and increasing its use. This creates additional stakeholders in the process and subsequently ensures a more effective feedback cycle regarding the quality of handover.

This paper will examine the human factors involved in shift handover. Also, it will illustrate that information about minor incidents, human errors, and reliability issues is often collected; and will demonstrate how this can be collected and disseminated effectively and efficiently.

INTRODUCTION

Continuous operation requires people to work shifts. Ensuring safety and efficiency requires critical information to be communicated between these shifts. All communication is prone to error. This makes shift handover a highly critical activity that is performed frequently with little opportunity to engineer out potential errors.

ACCIDENTS CAUSED BY POOR SHIFT HANDOVER

The role of shift handover has been highlighted in a number of recent high profile, major accidents. Following the 2005 Texas City refinery explosion, BP released their internal investigation report to the public [BP 2005]. This identified that poor shift handover was a contributor to the accident, citing the failure to communicate the failure of a hard-wired high level alarm between shifts as a contributing event. By way of an explanation the report stated that "there was no written expectations with explicit requirements for shift handover." The subsequent inquiry carried out by the Chemical Safety Board [CSB 2007] agreed with these finding, stating that "the condition of the unit – specifically, the degree

to which the unit was filled with liquid raffinate – was not clearly communicated from night shift to day shift."

In the UK, whilst at the time of writing this paper the full facts of the case were still not know, it seems clear that shift handover had a role in the 2005 explosion at the Buncefield oil storage terminal. One of the recommendations from the Buncefield Standards Task Group (BSTG) [BSTG 2006] was that "effective shift/crew handover communication arrangements must be in place to ensure the safe continuation of operations." Further details on this subject were provided in the BSTG's final report [BSTG 2007].

But this is not a new discovery. The inquiry into the 1988 Piper Alpha disaster found that prior to the accident critical information about the status of the condensate pumps was not communicated at shift handover. This meant operators started a pump that was not in an operational state. And before that, following the discharge of highly radioactive material from the nuclear processing plant at Sellafield in 1983, it was found that failures of communication between shifts created confusion regarding the contents of a particular tank that was pumped to sea.

Whilst a number of accidents have identified shift handover as a contributory cause, it seems likely that this is an under-reported issue. Put simply, because there has not been much attention paid to shift handover and relatively little information published on the subject, people have not been looking for evidence of failures with shift handover when investigating incidents and accidents.

THE PROBLEMS WITH SHIFT HANDOVER

The Health and Safety Executive's guidance document HSG48 [HSE 1999] states that reliable communication is highly critical to safety, and that shift handover falls into this category. Failures of communication occur for a number of reasons. In general either the information being communicated is incomplete or inaccurate; or the person on the receiving end misunderstands the meaning of the information they are given. There are many reasons why this can occur, with information being presented poorly being the underlying factor.

Whilst all communication is error prone, the more complex the situation the more likely errors are to occur. For shift handover, situations such as during maintenance and deviations from normal working should are considered to be 'high-risk' because errors are likely and their consequences can be significant.

IMPROVING SHIFT HANDOVER

HSG48 provides advice for improving shift handover. This includes carefully specifying information that needs to be communicated, using aids such as log books during handover, using more than one communication medium (e.g. both written and verbal), allowing sufficient time and developing communication skills and behaviours.

The advice in HSG48 is good and has been reemphasised by the final report from the Buncefield Standards Task Group. However, despite its importance and the occurrence

of numerous incidents influenced by poor shift handovers, it is quite a surprise that there is not more advice available. The reasons for this are not clear, but it is easy to surmise that it is a 'soft' and intangible subject that has probably fallen into the 'too hard' category for many years.

COMMUNICATION THEORY

In the absence of specific advice regarding shift handover, there is plenty for communication in general that should be applicable to shift handover.

One thing is clear, people tend to underestimate how complex the communication process is and consequently over estimate their ability to communicate effectively. The reality is that error is a natural and inevitable aspect of communication because language is inherently imprecise and ambiguous.

A successful communication is one where a person receiving a message achieves exactly the same understanding of that message as the person transmitting it intended. However, the following factors can interfere with this process [Lardner 1999]:

1. It is not possible to transfer meanings from one person to another directly. Rather, the receiver creates meaning in his or her mind;
2. Anything is a potential message, whether it is intended or not;
3. The message received is the only one that counts;
4. Taking the above together, unintentional meaning is likely and potential miscommunication is the norm.

Communication requires effort by both parties to avoid miscommunication. Although not infallible, face-to-face communication is generally the most reliable, not necessarily because it is a better way of transferring understanding, but because it allows immediate discussion. In contrast, written communication is generally less reliable because of this lack of immediate feedback.

BEHAVIOURAL ASPECTS

One of the reasons shift handover is a difficult topic to address is that individuals' behaviours have such a significant impact on its effectiveness. In this context the following are relevant:

- People need to be willing to say if they do not understand what they have been told;
- They need to be willing to challenge what they have been told;
- They need to be able predict what someone else needs to know;
- They need to show that they are interested in what they are being told;
- They need to make time for the handover.

No procedure or management system can address these issues directly. Whilst guidance can be provided to help people understand what is expected of them, there will be a requirement for continuous supervision and coaching to ensure bad habits are avoided and to

drive continual improvement. Given the pressures of work, it is unlikely that this will happen automatically. Shift handover practices are likely to evolve over time. Sometimes this will result in improvement, but at other times short cuts and bad practice may be the result.

THE CHALLENGES TO IMPROVING HANDOVER

As well as shift handover being a particularly complex activity, there are other reasons why making improvements are difficult. In particular, we must recognise that the individuals involved may not always have incentives to put in the effort required.

The most important person in any handover is the person finishing their shift. The quality of the information they provide and their communication skills will have the greatest influence on how well informed the person starting their shift is. However, at the end of an 8 or 12 hour shift even the most conscientious person will be interested in getting home. Also, some may have the attitude that any problems they leave are going to be dealt with by someone else (i.e. the incoming shift).

It is true that the person starting their shift can influence the quality of the handover they receive. Asking questions and being interested will tend to improve the quality of the handover. However, they are not in a particularly powerful position because they do not know what questions to ask, especially if key data has not been logged.

Finally, we must recognise that the people typically responsible for improving performance are often not present (i.e. managers) or busy themselves (i.e. supervisors) when handovers are taking place. Most handovers will be carried out unsupervised.

AN ALTERNATIVE PERSPECTIVE

Changing behaviours is always difficult, especially when the individuals may not perceive a direct benefit. Therefore, it would be useful to have an alternative approach to improving shift handover.

Having studied the handover process it is clear that a lot of information communicated at handover could have a much wider use if it could be made available in an appropriate format. If other people were to start accessing that information it would increase the number of stakeholders in the process. More people would have a vested interest in improving handovers and would be more likely to intervene if the information they need was not forthcoming. Ultimately it seems likely that a better consensus would be reached over what needs to be communicated at shift handover.

The proposal here is that the log books and handover reports used at handover could be used to record information that can then be shared. The beauty of this information being that it reflects what actually happens in practice. Face to face communication will remain the most important part of the handover, but the log books and handover reports will add structure and detail.

A STUDY OF THE INFORMATION RECORDED FOR USE AT HANDOVER

In order to determine what type of data is recorded for use at handover, a study was conducted at an offshore oil production platform [Brazier 1996]. Copies of pages from log books and handover reports from across the platform were collected covering a seven day period. This information (a stack of paper weighing 3 ½ kg) was carefully examined to determine what information had actually been recorded about events occurring during the period of interest.

Analysis of the information showed that many of the events recorded in log books and handover reports could be particularly useful for safety and reliability studies, given that they were rarely reported in other systems and this information was a largely untapped resource. The study categorised the information as being related to human error, minor incidents, routine events, and solutions to problems.

HUMAN ERRORS

There is a general consensus that human error is a significant cause of accidents and incidents. Also, that many of those errors occur frequently with minimal consequence, and only on occasions combine with other events and conditions to cause an accident. Therefore, it is particularly useful to know about the errors that occur routinely, but these are rarely reported through formal channels. The following errors were found in log books examined in this study:

- Valve 'inadvertently' closed – delayed the return of equipment to service;
- Gas leak from a newly fitted gasket – system had to be shutdown and joint remade;
- Parts missing from replacement components (two events) – delays in critical repairs because components were supplied with parts missing;
- Part missed when assembling equipment – oil leak occurred, equipment had to be shutdown, dismantled and reassembled again;
- Incomplete modification – pipework modified but control system was not. An additional task was required to rectify;
- Error in job description – diving work was delayed because instructions referred to an incorrect valve location;
- Unable to find an up to date drawing – delays whilst a drawing showing all recent modifications was found;
- Data lost from computer disk – system temporarily unavailable whilst backup data was recovered.

None of these errors had significant consequences, which explains why they were not reported through more formal channels. However, any error indicates a problem that in other circumstances could have contributed to more serious events. Having information about the errors that occur more readily available would be useful for ensuring risk assessments are accurate and for prioritising human factors activities.

MINOR INCIDENTS

Most companies now have near miss reporting systems that means all incidents should be reported no matter how minor the consequences are. In practice the effort of reporting an incident is often perceived as outweighing the benefit. This study found 15 events recorded in log books and handover reports that could be considered as incidents, in addition to the human errors described above. Examples included:

- Unplanned hydrocarbon releases (three events) – small oil slicks observed on the sea following activities and a valve found to be leaking gas;
- Equipment failures (eight events) – chemical dosing pumps failing simultaneously, generator and compressor trips, compressors failed to start and an emergency shut-down valve did not close during a test;
- Equipment found to be inoperable (four events) – pressure override switch broken, pump operating at high temperature, pig receiver door damaged and pressure gauge pipework blocked.

The fact that incidents are being recorded suggests that log books and handover reports may provide an alternative mechanism for capturing these events. The advantage is that the reporter does not have to report the same information twice whilst the information is still immediately available for shift handover. However, the study showed that information about why these incidents occurred was often missing. This suggests that effort will be required if such an approach is taken to ensure the information about why events occur is recorded to allow further investigation.

ROUTINE TASKS

It is a bit of an anomaly, but the tasks people perform most frequently are often the ones we know least about. This is because they are often not covered by procedures and, when performed successfully, there is little indication to show they occurred. Because of this it is easy to think they are not important, but this is not the case. In fact, when considering plant reliability it is particularly useful to know what routine tasks are performed, their frequency, their duration and success rate. This study showed that this information can often be extracted from log books and handover reports. Of particular interest was that operators recorded 120 different routine tasks that had been performed in the seven day period. Whereas maintenance tasks are often captured in a management or recording system, operations tasks are usually not captured anywhere else.

The study concluded that the information about routine tasks recorded in log books and handover reports is probably more accurate than other sources of information because it is a record of what actually happens (i.e. rather than a pre-defined schedule which may not always be followed). Therefore, it was potentially particularly useful for reliability studies.

SOLUTIONS TO PROBLEMS

One reason we continue to employ people on facilities, despite advances in technology, is that they are good at dealing with unforeseen events and developing ad hoc solutions to

problems. Understanding how people deal with events can give us a very useful insight into how they understand the systems they deal with. Where successful, solutions to problems can be shared so that others can use them in the future. However, it is important to know about any temporary or experimental solutions, as they may contribute to problems in the future.

This study found that solutions to problems were often recorded in log books and handover reports. For example:

- The need to release trapped pressure to reset an alarm;
- A production well that will only flow at low pressure;
- Another production well that would restart flowing if left for a while;
- The need to reduce gas pressure to start a turbine;
- Use of a 'similar' spare part where the correct one was not available;
- Manually manipulating a valve to stop it sticking;
- Using plastic sealing compound instead of a gasket to prevent a leak.

In each of these cases the operators were clearly solving the immediate problem. The successful solutions may be useful for others. In a number of cases it appears that the solution may not be fully approved, and hence it may be important in the future to know what has been done. A number of additional instances were recorded where people logged their suspicions about the cause of a problem being experienced, but where they had not been able to test them out. In these cases these assumptions may assist personnel tasked with solving the problem in the future.

USING DATA COLLECTED FROM LOG BOOKS AND HANDOVER REPORTS

The study described above identified the type of information communicated at handover. The following summarises three published papers that describe how this type of information has been used in practice.

COMPONENT RELIABILITY

A group of companies working in oil and gas production in the North Sea collaborated to collect equipment reliability data from operational experience to form a "Reliability Data Handbook" [Moss 1987]. Data was collected from maintenance and operating logbooks relating to hours of operation and stand-by, failure events and repair time. Overall, despite problems with extracting information from systems where this use was not envisaged (i.e. hand written logs etc.), the study was considered to be worthwhile and demonstrated that such an approach had potential, especially if the reliability, content and accessibility of records could be improved.

ECONOMIC OPERATION

In another study a change of operation was planned for a power station [Campbell 1987]. The company wanted to be sure that this could be achieved without increasing costs due to

plant breakdown and other reliability problems. They did this by extracting data from shift log books that would indicate the main causes of problems. An assessment of this data, backed up with discussion with engineers, allowed an economic model to be developed. Sensitivity analysis allowed the identification of the items of equipment within the plant that were most critical to system reliability. From this information it was possible to identify the most appropriate operating regime. The conclusion from this study was that the data was available and did allow an accurate and useful economic model to be developed.

RELIABILITY

In the third study a power station had experienced a number of reliability problems for some time. A fault tree model of the system was developed using site specific data obtained from logbooks covering 29 years of operation [Galyean et al. 1989]. From this the major contributors to system unreliability were identified, allowing decisions to be made about future modifications. Extracting the data was difficult because the logbooks were all hand written, but once manually transferred to a computer database it was found to be particularly useful method for storage and manipulation. Also, there were some concerns about variations in the quality of records, especially as the events of most interest were generally associated by a high level of personal stress that meant those records were not always as detailed as would have been liked. However, despite these concerns it was felt that the results had made a significant contribution to the understanding of system reliability and that the cost and effort required to collect the data was worthwhile.

IMPROVING HANDOVERS AND MAKING DATA AVAILABLE

The studies described above show that the information used at handover can have a much wider application. However, extracting that information is not usually easy because much of it is in handwritten log books. Even though computers are now being used to record events and prepare handover reports, many use word processor or spreadsheet packages, or simple databases. Whilst these make the information more legible and hence may help people carrying out handovers, they do little to improve the availability of data and so do not fundamentally increase the number of stakeholders in the process with a direct incentive to drive improvement.

A MORE SOPHISTICATED DATABASE

It is one thing to capture information. It is another to make it readily available for people to use. A database can assist in this process, but to be effective the following needs to be understood:

- To get the full picture, it is usually necessary to have input from more than one area of the business;

- It is useful to be able to consider logged information alongside the relevant 'hard' process data;
- Information may be required in different formats for different purposes.

To address these issues it becomes apparent that the current approach of having lots of individual log books and handover reports will never allow the potential of the data stored to be realised. Instead a system is required that acts as a source of information that can be used during shift handover, but has a much wider use across the business. At the same time it must be easy for the people performing the handover to use, as without this it is possible that the quality of handover is reduced in an effort to make more information available to other potential users such as engineers and managers.

PRACTICAL REQUIREMENTS

History is littered with lots of examples where technology based products have failed to achieve their potential because they were not used as intended. In this case it is no use developing a database system that people do not record information in or extract the useful data. Therefore the following are the minimum requirements:

- Logging of information must be simple;
- To be really valuable the information must not only say what has happened, but explain why;
- Information must be highly visible so that people know what is happening;
- Analysis of historical information must be possible.

It is essential that end users are actively involved in developing the system to both embed their experience into the system and to ensure they understand the objectives of the new approach. In this case operator involvement is key to ensuring information logging will be practical and efficient. However, there will be other end users who have different needs, particularly in extracting and analysing data. A consensus is required about what constitutes the optimum solution for all end users.

It is important to recognise that this is not just an exercise of transferring a current log system to computer, as the benefits of this are quite limited. Therefore, as some of the concepts will be new to the end users, it is equally important to involve people who can input information about what can be achieved with such as system.

Finally, whilst technology can assist the handover process, it can have negative consequences if not managed correctly. Robust systems must be in place that addresses the requirements for good communication at shift handover and between different job functions (most significantly between and day workers).

THE PROPOSED SOLUTION

There is no intention to replace current arrangements with something completely new. Therefore, the proposed solution builds on the existing use of shift logs and handover reports. It assists by automating the process as far as possible and provides numerous functions and

procedures that ensure handovers are as comprehensive and consistent as possible. Also, it makes information far more visible and this means there are more stakeholders with an interest in maximising the quality of shift handovers and who are more likely to intervene where these requirements are not achieved.

The old adage of 'rubbish in, rubbish out' certainly holds true in this case, especially since much of the information we are talking about is 'soft' in nature, being based on the observations of people rather than 'hard' plant data from instruments and control systems. The aim is to ensure all critical information relating to past, present, and future events are captured, will be visible and is supported by additional information including process data.

This will only be successful if the information that forms the basis of the handover is of high quality. This solution therefore encompasses the creation of operational logs and the subsequent use of that information for the benefit of managing the operation (of which handovers is a major use). In order to successfully underpin the handover process the solution must fulfil a number of key requirements:

- FACILITATE LOGGING OF INFORMATION: whatever method of capturing operational information is used, it will be, to some degree, an imposition on the operator. The proposed solution encourages quality logs by allowing most information associated with an entry to be made with a few mouse clicks. The operator is then required to type only value added information, which generally explains why an event occurred. The operator is guided through the logging process in a structured way, ensuring all essential information is captured. This has added benefits for less computer literate operators as it minimises the input required.
- PROVIDE A STRUCTURED LOGGING ENVIRONMENT: it is essential that any solution provides the flexibility to capture all the varied operational activities required in logs across the operation. At the same time, it is important to impose a level of structure on the logs to encourage consistency of input. Simply providing for free-format text entry provides flexibility but does not allow for a structured approach. The solution allows 'Event Hierarchies' to be pre-defined. Each log can have its own hierarchy tuned to the specific logging requirements. Each hierarchy point (an event that can be logged) can have its own template. This template defines the structure of the log entry and can accommodate any additional information to be captured, any rules on how the entry is shared or copied with other logs and any external documents to be attached or referenced. The level of structure imposed by the template is defined by the users. A template could in its simplest form be a simple free format text field. This template approach helps ensure that the same event logged over time will be logged in the same way and is of great benefit when reviewing and reporting on logs.
- ALLOW FOR EASY SHARING OF INFORMATION: the solution allows log entries to be very easily shared across multiple logs throughout the operation. This can be automated if required to ensure important information is highly visible to the appropriate people or issues are effectively escalated.
- ALLOW QUICK SEARCHING AND REPORTING OF LOGS: the solution allows easy access to logs, whether it is the current shift reviewing the previous shift logs,

engineers carrying out analysis of historic logs or management reporting across multiple logs. Providing the structured templates allows reports to be very easily built. This helps turn the logs from an operational record to be filed away into a live repository of valuable information. The logs become valuable assets of the business.

THE SOLUTION IN PRACTICE

The handover process can encompasses a wide range of information including the logs of past events, the current plant status, and issues for future shifts. This is true for shift handovers that occur on a daily basis and for 'trip handovers' that may occur weekly, monthly or event longer.

The solution has a number of functions specifically designed to facilitate the handover process, including; the ability to view logs across any timeframe, ability to flag important information, ability to add log entries to ToDo lists in order to action issues across shifts and the ability to create, assign and track logbook tasks across shift teams.

One of the most important aspects of the solution is the ability for each area to configure its own log structures. This is a user centred solution that achieves buy-in from the user base and subsequently leads to higher quality logs. This is much more desirable than imposing a rigid system on operators that does not meet their own individual or departmental requirements.

It must be emphasised that any computerised solution to managing shift handovers can only support (and not replace) a well thought out and well followed handover procedure. The wider considerations are those of company and operational culture and discipline. A culture of open communications, continuous learning and continuous monitoring of process quality can be underpinned by a well developed computerised system but cannot ultimately be controlled by such a system; the whole process starts and end with the organisations biggest asset – its people.

In implementing such a solution it is important to recognise that, as with any intervention in any system, there are always potential negative consequences. In this case there is the potential that making information more readily available over a computer network may mean that people talk to each other less often. Whilst it is felt the way the solution works means more people will become interested in what is going on and hence are actually more likely to ask questions and discuss events, this is something that needs to be monitored as part of its implementation. Also, it is recognised that this solution may not currently be appropriate in places where a significant proportion of the workforce either do not have access to a computer or lack the appropriate skills.

This solution has been in use with great success within several large operations with user bases in the 100s. One large site in the UK has used it for over three years. It replaced many paper based and individual computer based logs with a single, integrated solution that allows operational knowledge to be shared 24 hours a day whilst interfacing with other existing operational systems. In another case a large power generation and distribution company used the solution to develop an integrated logging system across its diverse range of sites and corporate level functions. Following a pilot project, the solution was implemented

across the company in four months. As well as practical benefits such as more consistent logs and improved availability of information, cultural improvements have been experienced including operators having a better understanding of the value of high quality logs, shift handovers are much more efficient because the high visibility of information enables the oncoming team quickly get 'up to speed' and allows them to ask insightful questions to ensure they fully understand the issues.

CONCLUSIONS

There is no doubt that shift handover is a critical activity and poor handovers have contributed to major accidents. However, it has received relatively little attention and the guidance available is rather limited.

The goal of shift handover has been defined as "the accurate, reliable communication of task-relevant information across shift changes, thereby ensuring continuity of safe and effective working." To do this oncoming personnel have to gain an accurate understanding of plant status so that they are able to make correct decisions and initial appropriate actions as required.

Improving shift handover requires systems to be in place that include procedures, training and assessment, monitoring and audit. Also, it is necessary to address the behavioural aspects, which may be something that organisations have tended to shy away from. Structured log books and handover reports can assist the face-to-face aspect of a shift handover. Also, it is important to recognise that certain circumstances such as ongoing maintenance and deviations from normal operation create higher risk and need careful consideration during handover.

This paper proposes an approach to improving shift handover that is complementary to developing and improving the communication aspects. It aims to make information recorded at handover a more valuable resource. Studies show information about all aspects of operation are often recorded in shift logs and handover reports, including information about human errors, minor incidents, routine tasks and solutions to problems. This can be used across the business to improve safety, reliability, production, and environmental performance.

To make the information more available it is suggested that a computer based database solution is required. This goes beyond simply converting log books into computer form, and instead results in a comprehensive source of management information that has many uses, as well as supporting shift handover. The advantages of this approach include:

- Important information becomes more visible;
- Better information is available when making operational and strategic decisions;
- Time is saved in logging events, meaning more value-added information can be recorded;
- Information flows much better across the organization;
- A full audit trail is provided.

A computer based approach has many potential benefits, but it must be remembered that the behaviour of users will have the greatest influence on shift handover effectiveness. Any improvement must reflect the human factors involved. However, shift handover is a critical activity and should be a high priority for any organisation working in a hazardous industry. Key issues include [IP 2006]:

- Provision of clear procedures/written guidance describing the key information to be exchanged and how this should be done (e.g. word of mouth, in writing or both);
- Providing training and having systems to ensure employees are competent to use handover procedures;
- Carrying out regular and thorough monitoring and auditing;
- Involving employees in the examination and improvement of the practices;
- Updating systems in light of information from incidents and accidents due to shift handover problems and bringing this to the attention of employees.

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