On the Possibilities of Transferring Technology to the Part Time Investigator[1]

JOHN LEWKO, SCOTT DIXON and BILL NARASNEK
Industrial Safety and Productivity Group
Laurentian University
Ramsey Lake Road
Sudbury, Ontario P3E 2C6

DON HINE
University of New England
Armidale, New South Wales
Australia, 2351

A majority of investigations in industrial settings are conducted by 'Part Time Investigators" (PTI's) as one of several formal responsibilities. The role of human factors in accident causation is now widely acknowledged, yet investigative practices to identify such factors remain largely within the domain of the professional full-time investigator. We report on two studies conducted with PTI's and identify ways in which technology transfer could improve the investigation for human factors. Specific strategies are identified in three areas: the Adapted Mind Man software; the TSB Model; Naturalistic Decision Making techniques.

1. Introduction

Occurrences (accidents and incidents) and their subsequent investigations place a great burden on modern industrial organizations. Investigations into the causes of occurrences are costly both in terms of time and money. Whether or not organizations recognize the intrinsic value of investigations for improving safety, they are required to investigate occurrences at some minimum level by today's legislation. The majority of these investigations will be carried out by the so-called 'Part Time Investigator' (PTI) (Lewko, 1998). Part time investigators are distinguished from professional investigators in a number of ways. Unlike the professional [full time] investigator who typically operates under the auspices of an independent body such as the Transportation Board of Canada (TSB), the PTI is usually an employee of the company within which the occurrence took place. For these individuals, investigation and analysis (I&A) of occurrences is one of several facets of their job description. One has only to consult a report issued by professional investigators to appreciate that comprehensive I&A requires a multitude of skills and knowledge, both practical and scientific. Ideally, we would like all part time investigators to be able to complete formal investigations and analysis with as much skill as the professionals. Towards this end, we have explored the possibilities of integrating various technologies into the arsenal of the PTI in their I&A of occurrences.

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2. The Part Time Investigator

The PTI faces many challenges when trying to identify the root causes of occurrences. While part time investigators are expected to complete their traditional (full-time) duties in an efficient and expedient manner, when dealing with occurrences these same individuals are expected to proceed in a thoughtful and logical fashion. The decisiveness that is valued as a supervisor of traditional tasks can impede a good I&A and would be expected to increase the probability of committing the fundamental attribution error.

Today, it is understood that the majority of occurrences can be attributed to 'human error' at the sharp end and 'latent organizational failures' at the blunt end (Reason, 1997). Unfortunately, the average PTI is not likely to have a great deal of exposure to the information processing and management sciences, much to the detriment of their I&A activities. We would predict that the PTI will be the most effective in performing I&A into occurrences that have a genesis rooted in their area of specialty. For example, imagine the maintenance department supervisor who is also responsible for investigations. When tasked with identifying why all of the dump truck engines within the last week had failed, he would likely have no problem determining that a new mechanic had rebuilt all the fuel pumps with the wrong type of lubricant. However, questions that linger outside his domain of expertise, such as why the new mechanic did not have the proper training, would likely remain untouched.

We have identified 2 'short circuits' that could adversely affect the determination of underlying causes and prevent the flow of useful information to those who can act on it (management).

The first short circuit is related to the situation in which the PTI finds themselves. Not only are they part of the system that is involved in an occurrence, they themselves are directly responsible for supervision of the individual(s) affected. Consider a military officer who issues orders to his platoon to assault an enemy held hill, before making the necessary reconnaissance. If the assault fails he will no doubt be thoroughly questioned as to the reasons behind the failure of the attack. How likely is it that he would admit erring in his planning process when his status [job] may be at risk? In all likelihood excuses would be sought elsewhere. This is a simplistic example, however it illustrates the conflict of interest that arises when one individual is expected to both make decisions, and then question them at a later date.

The second short-circuit is more complex, and is a prediction that is based on the assumption that many organizations separate production from safety and, in various ways, communicate that production is valued over safety. The economic realities faced by various organizations today make this assumption rather robust. We have already mentioned that abundant time resources have a special place in the hearts of investigators, however the application of time resources is in turn dictated by the nature of the system under study. Within any system, certain components will be more amenable to detailed examination than others. Specifically, redundant components can be examined in greater detail than components lacking redundancy. Consider an electrical power generating system. While the individuals who monitor the turbine can be trained in large enough numbers to permit immediate replacement, it is unlikely that a duplicate of the turbine itself is kept around, ready to go in case of emergency. Assume a worst case scenario where a PTI is called in to investigate why the turbine is off line. Needless to say, the management will be concerned with getting the turbine back on line (i.e. it loses money with the turbine offline). As the turbine exists in

a non redundant state, it is unlikely that management would tolerate a month long investigation involving the a complete overhaul of the turbine apparatus, whose results may be inconclusive. However, redundant components such as the operators working under the supervisor / PTI at the time of the occurrence can be taken out of service and thoroughly examined (interviewed) without stopping production. In this way time resources are preferentially channeled into the individuals who work under the command of the supervisor/PTI because these components of the system are the easiest (cheapest) to investigate.

3. Our Data

Two studies have been carried by the ISPG into the nature of part time investigation, the results that they yield within a large organizational setting, and the potential impact of technology on this process.

In the first study, a sample (n = 31) of active PTI's (front line supervisors) from an industrial setting were asked to analyze to basic causes a sample accident case (a train derailment) that was presented to them. The first group of the subjects (n = 10) completed the analysis in accordance with their traditional I&A practices. A second group (n = 16) analyzed the identical case, but their traditional I&A practices were augmented with the addition of a software program (Mind Man) that was selected to enhance their ability to organize and display data as trains of thought. A third group (n = 5) completed their analysis with the aid of the software much like the second group, but further benefiting from a brief training session that introduced specific TSB I&A methodologies.

A near unanimous interest in performing I&A task was noted (perhaps this is an interesting break from normal routine?). The outputs revealed that the subjects were using three distinct modes of analysis. A 'clustering' mode was evident, with subjects simply trying to organize pieces of data under one heading, but not necessarily analyzing the data. A 'top-down' processing mode was observed where some fact would be pinpointed as a causative agent first, and then data would be listed in support of this assertion. Finally, a 'bottom-up' processing mode was characterized by thought processes that started with the identification of a key event followed by the logical consideration of potential underlying (latent) factors leading up to that event. Top down and bottom up processing was equally prevalent with the clustering mode being rather rare. In most cases all subjects were observed to employ at minimum two of these modes of thought in their analysis. Many observations were made that will have bearing on the question of how to improve PTI in the future with the assistance of technology (See 'Helping the Part Time Investigator').

The second study involved a retrospective analysis of reports (n = 74) that were produced over the course of a year in one industrial setting. Within the reports there was no evidence that part time investigators were performing thorough and systematic I&A. An equally conspicuous result was the lack of attention that was paid to human factors, management, and organizational issues when attempting to identify basic causes. Not one of the investigative reports submitted by a PTI recognized problems with, or recommended changes in, operational procedures on a systemic organization wide basis. In essence, the 'sharp end' remained the focus of the investigation and ultimate cause attribution and recommendation processes.

In post-task interviews conducted with the active PTI's, the participants (who were front line supervisors) repeatedly noted that their duties as part time investigators are severely compromised by time limitations imposed by the regular duties. If time is not allocated within normal working

hours for I&A, it must therefore be completed on the individuals personal time. The results of this pressure were reflected in the second study. This is not the ideal situation for promoting I&A to the depth required for organizational learning, which is a necessary condition for achieving significant and sustained improvements in safety (Blanco, Lewko & Gillingham, 1996).

4. Helping the Part Time Investigator

Traditionally, technology is pictured as taking the form of computers, automobiles and other such objects making everyday life easier or more enjoyable. However, technology can also be conceived of as any product or process that is derived from scientific investigation. In this way, we can view technology transfer within the PTI context that involves not only traditional mediums such as computer software, but also investigative models and psychological technologies designed to the optimize. Three such transfer opportunities are considered: implementation of the adapted Mind Man software tool; application of key elements of the TSB model; and naturalistic decision making strategies.

4.1 *Adapted Mind Man*

By it's very nature, the structure of the software that was employed as an analysis aid requires the A/I analyst to record and display his/her logical thought process. I&A activities are very much about organizing the data you collect and considering numerous interpretations of the data. Both experimenters and subjects noted that, when used, the adapted Mind Man software enabled the individuals to display their thought process and to note where logical inconsistencies developed and where analysis was terminated prematurely. Furthermore, the electronic manner in which the analyses are generated and stored is well suited to rapid dissemination and analysis by superiors and colleagues. We (investigators and participants) could envision a time where I&A results are recorded in electronic form with this software and then instantaneously transmitted to the proper authority who could readily verify the consistency and completeness of any report, pointing out were further information needs to be gathered.

A second speculative application of this technology would be for group I&A activities. When combined with an overhead projector our software would allow for the construction of event chains, the organization of information and the analysis of that data in a group setting. Several of the participants in our first experimental series pointed out that if they were able to discus their findings with others the final results would be much improved. In this manner our software could serve as a convergence point between multiple individuals, functioning as an 'electronic whiteboard'.

One final application noted by the investigators was the potential for computer software to impact the training of part time investigators. The adapted software package would be ideal for stepping a novice PTI through the basics of constructing an events chain, and of ensuring the logical accuracy and completeness of ones analysis. Furthermore, past occurrences could be re-analyzed rapidly, with the new results compared to the old. The obvious benefits of an electronic tutorial include the freedom it provides both the organization and the PTI to pursue the training at a time and pace that is individually desirable.

4.2 TSB model

While the software technology could theoretically stand alone as an I&A aid, it's value would be increased exponentially when combined with instructional methods that emphasize strong I&A techniques. Distilled to its core, the TSB model provides a number of best practices for I&A activities, focused on systematic and thorough collection, consideration, and dissemination of data. The construction of a logical chain of events is emphasized along with the concurrent examination of each event separately using a multiple why technique.

4.3 *Naturalistic decision making*

The emerging field of naturalistic decision making provides numerous strategies and cognitive models that are relevant to the PTI. Klein's work (1998) in particular, outlines several principals that are relevant to the training of part time investigators. While he stresses that analytical decision making training is of little use, as people do not employ this strategy to solve problems he concedes that analytical methods may be helpful for those who lack experience. Decision training courses may be valuable as aids for novices or for complex cases with many different stakeholders...they have been helpful for setting out different factors and helping everyone achieve a shared perspective. He goes on to point out that the key to effective decision making is to build up expertise, (and) one temptation is to develop training to teach people to think like experts. But in most setting, this can be too time-consuming and expensive. However, if we cannot teach people to think like experts, perhaps we can teach them to learn like experts. Klein lists four ways in which experts in different fields learn. These points will be equally applicable to the full and part time investigator.

1) They engage in deliberate practice, so that each opportunity for practice has a goal and evaluation criterion.
2) They compile an extensive experience bank.
3) They obtain feedback that is accurate, diagnostic, and reasonably timely.
4) They enrich their experiences by reviewing prior experiences to derive new insights and lessons from mistakes.

We believe that the software mentioned above would be particularly well suited to assisting the PTI to learn like an expert in the 4 ways outlined by Klein.

5. References

Blanco, J., Lewko, J.H., and Gillingham, D., 1996, Fallible decisions in management: learning from errors, *Disaster Prevention and Management: An international Journal*, 5, no.2, 5-11.

Lewko, J., 1998, Human Factors and Accident Investigation: The Trend for the 21st Century, *Proceedings of the 30th Annual Conference*, Mississauga, Ontario.

Reason, J. *Managing the Risks of Organizational Accidents*. Aldershot: Ashgate, 1997.

Klein, G., *Sources of Power, How People Make Decisions*. Cambridge: The MIT Press, 1998.