Proposed Editorial by Ludwig Benner, current draft

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Researchers undertake safety research to develop new knowledge about actions that could improve safety of systems, products and practices. Reports of many kinds of accidental occurrence investigations are among the data sources safety researchers use These investigations are undertaken to gain understanding of what happened and why it happened, identify problems disclosed, offer recommendations to remedy the problems, and report results for users. Differences among those investigations, observed during numerous investigations and report analyses, affect the content and quality of the reported information used for safety research. Safety researchers who have not conducted several investigations and prepared reports of the results are probably unaware of these differences and their influence on the data their studies use. This Editorial calls attention to those differences and their influences on safety research.

A European Commission Joint Research Center in 2011 (EUR 24757 EN – 2011) presented its analysis of the attributes of at lest 20 identifiably different accident and incident investigation methodologies and methods. At least eight more documented methods were not included in that study. Dozens more investigation "tools" and investigation software packages are in use. Investigators of fire, vehicle crash, military, environmental insults and other kinds of accidental occurrences use other methods. Each investigation methodology, method or tool differs from the others in one or more ways. The differences result in investigation reports with inconsistent objectives, scope, input data selection, input data documentation input data processing, terminology, report format, quality and utility across and within investigations. Those inconsistencies can affect safety research based on the reported investigation data.

What investigators investigate.

Essentially unanimous agreement exists in investigation research literature that an investigator's "model" of the accident phenomenon determines the methodology investigators elect to use and what investigators look for and find during investigations. The basis for any investigation methodology selection includes the perceptions and assumptions on which the investigators rely.

Perceptions

Almost all methodologies are based an accident causation models, which reflect investigators' perceptions of the accidental occurrence phenomenon. At least 6 differing perceptions of the nature of the "accident" phenomenon have been observed and reported. Those perceptions view accidental phenomenon as a simple single act of God, a (linear) chain of events, the stochastic convergence of factors, a converging event chains, a dynamic process of interactions, and an inadequate

system process control. Investigators' perception of an accidental phenomenon influences what data they will seek, document, integrate and report about an occurrence. Safety researchers' perceptions similarly affect their research when they utilize investigation data in their studies. Underlying perceptions are not stated in investigation or research reports, but can be discerned from report attributes.

Assumptions

Each perception involves assumptions about investigation goals and methods required to discover and understand what happened. One frequently observed assumption is that accidents and incidents are "caused," and that investigators' determination of "cause(s)" will provide descriptions and explanations of what happened, and a basis for recommending changes. Criteria for what safety investigators should call causes in a report, if provided at all, vary among methodologies and tools. Individual investigators or investigation teams or agencies may attribute causes or cause factors to conditions, states, people, objects, energies, emotions, designs, failures or anything else they choose in a report. Cause attribution is a subjective decision to implement the abstract construct called "cause," so the causes investigators select from among the full range of interactions required to produce the outcome(s) may or may not be valid, appropriate, comprehensive, reproducible, or consistent. Thus research based on causal or cause factor data analyses presents researchers' conclusions about investigators' conclusions rather than on specific original occurrence-generated data.

The attribution of "cause" to a limited number of relationships or factors in investigations has a subtle consequence for researchers: focusing on causes or cause factors can lead researchers to overlook other relationships or patterns in a complete accidental occurrence process scenario that might offer a problem definition, a lesson learned or intervention option.

Investigation Scope

The scope of an accidental occurrence investigation also varies with the methodology employed. A consensus about when an accidental phenomenon begins and ends, which determines the scope of what will be investigated and reported continues to elude investigation methodology developers. Investigation "start/stop rules" are variously and vaguely defined, leaving the actual scope of each investigation to the discretion of the individual or lead investigator. The scoping decision is further confused by the introduction of theoretical verbiage like latent defects, precursors, antecedents or factors "leading to accidents," as well as by the perceived nature of the phenomena. Concerns about social or organizational issues like safety cultures, resource management and safety controls further complicate an investigator's coping decisions. All this results in observable variations in the scope

of reported descriptions about what happened within and across methodologies, adversely affecting their aggregation and use for safety research purposes.

Investigation report content development

Each "safety" investigation has three basic functions: develop a description of what happened; analyze what happened to determine why it happened and what might be changed to prevent its recurrence; and report the findings. Each investigation methodology develops investigation report contents in differing ways. Those differences result in inconsistent acquisition, integration and analysis of investigation input data and in variations among investigation report contents.

Investigation input data acquisition.

Methodological differences include the ways investigation input source data are identified and selected for acquisition and processing, and how "observable" source data are transformed into the documented investigation "facts" used to reconstruct and describe what happened. Some methodologies use categories in a system operational taxonomy to drive input data acquisition. Some methodologies use forms with prescribed entries to drive investigators' input data acquisition. Some provide checklists to drive inputs. Some rely on investigators' experience or reasoning to form hypotheses to drive inputs. Some rely on investigators' interpretations of on-scene observations and investigators' judgments to drive inputs. Some rely on a search for cause(s) to drive inputs. These "drivers" are hardly ever identified in investigation reports, so the burden of identifying or inferring what drove input data selection from report contents rests on safety researchers.

The transformation of investigators' observations into documented "facts" or "building blocks" for reconstructing a description of what happened is a critical investigation task. Subsequent investigation functions and uses of the data rely on the results of this source data transformation task. Almost all methodologies and tools leave execution of this source data transformation task to the discretion of the individual investigator or team. That results in personally formulated documentation of investigation inputs such as conditions, actions, states, reactions, decisions, allegations or inferences without a consistent format, grammar, content, or perhaps even meaning. Very few methodologies provide rigidly structured and standardized source data documentation with content, grammar and syntactical specifications. Reported investigation data is thus subject to almost infinitely variable documentation.

Investigation input data integration.

Methodologies use differing investigation input data or "facts" integration methods to arrive at descriptions of what happened. Some use investigator teams to coordinate their individual analytical, experiential and reasoning skills for integrating the input data onto a description of what happened. Others used

causation logic tools to develop causal connections among selected inputs. Others use event lists or timelines for that purpose. Others use accident models to select, analyze and integrate inputs for developing descriptions of what happened. Still others use graphic matrices for this data integration. The significance of these differences for safety researches is that each methodology's integration process can result in different descriptions of what happened among occurrences, depending on the data integration method used in a particular investigation, and how rigorously it is applied.

Another subtle potential variance among methods results from the degree to which "hindsight conclusions" are introduced during the data integration process. Such conclusions, intended to explain why something happened, are based on the application of today's behavioral constructs and context to yesterday's context, actions and outcomes. Researchers must recognize whether conclusions so determined are being reported, and if so whether the explanations are valid. ?

Terminology in reports.

Words and terms used in investigation reports also differ among the methodologies. Descriptions of what happened depend on the survival and recoverability of source data generated by actions sustaining the course of interactions during the accidental occurrence and how it is documented. The investigators, inadvertently or deliberately, uses terms that obscure the specific behavioral interactions needed to fully describe objective reality and understand what actually happened. This can occur because words and terms used in reports are at relatively high levels of abstraction, rather than at the lowest, concrete level. The similar obscuring of specificity results from using plural nouns, pronouns, speculations, "did nots" unsubstantiated or under-substantiated conclusions or conjectures, pejorative allegations, or characterizations rather than specific descriptors for actions or states. Use of passive voice in descriptions usually masks incomplete data or understanding about actions or words that specifically define interactions that really happened. Allegations about behaviors based on "hindsight" analyses may be invalid when reported as part of an occurrence description. In each case, such terminology poses problems for the safety researcher trying to ascertain the reported data specificity needed to achieve valid and actionable research results.

Investigation work products.

Investigation methodologies generally produce investigation work products in one of four forms: narrative reports, occurrence reporting forms, graphic representations, or a combination of forms. Narrative reports present descriptions of what happened using natural language, which is a linear recitation of states, events and factors. Natural language reports are often supplemented with photos, quotations, tables, charts, transcripts or appendices to help users understand what happened. The actual form and content of supplemental materials varies

significantly among methodologies. As used, natural language impedes the economical concatenation of individual actions or states in reports.

Almost all methodologies lack requirements for explicit reporting of uncertainties in reported descriptions. Most also lack a convenient *listing* for easy perusal of problems disclosed or lessons to be learned from an investigation by users. This means safety researchers and other users need to generate that information from what is presented, complicating their determination of the data's potential relevance to the needs.

Accident reporting forms contain blank spaces for investigators to insert entries that reflect the designers' opinion about information about what users might need. Reporting forms thus drive the information investigators try to acquire. Form designers face the challenge of selecting data entries that will accommodate various kinds of occurrences, and defining each entry to ensure consistency and user utility. This compels investigators' to recast investigation source input data, raw or integrated, into characterizations, abstractions, condensations or interpretations that fit the designers' causation model. To illustrate this data corrupting requirement, accidents occur over time, yet there is an almost universal requirement to enter "Time of accident" on forms. That entry precludes reporting of the duration of the occurrence or time between specific individual "facts" and compels investigators to pick a number that misrepresents reality.

Form designers usually provide glossaries to explain the intended content and form of required entries to increase consistency of entries, yet when a form provides a blank space for entering a narrative description of what happened, the description's structure, content and syntax are left to the investigators' discretion, resulting in predictable quality variations.

Some forms require the reporting of "contributing factors" compelling investigators to judge which elements of an accident process to report as a factor, and how to define them. That discourages discovery of the full spectrum of problem relationships that the investigation might expose, and minimizes the number of potential intervention options that an unabbreviated description of the occurrence might offer safety researchers.

Investigation quality assurance.

Almost every accidental occurrence investigation methodology lacks formal, objective quality assurance and verification procedures or criteria to demonstrate that an investigators' report presents complete, consistent and validated description of what happened. Instead, substitutes for an objective quality assurance process are used. Such substitutes include team or group consensus approaches, peer reviews, check lists and post hoc critiques. Each substitute employs subjective personal judgments about the completeness, accuracy, consistency and logical

validity of the occurrence description, compounding uncertainties introduced by differing source data documentation and integration practices.

This lack of objective quality assurance criteria leads to investigation reports with insufficient specificity to enable replication of the reported description by an alternative methodology, and analytical content that may be incomplete, unfaithful to objective reality or invalid.

Report utility

The ultimate value of reported accidental occurrence investigation data for safety researchers lies in their utility. Because of the effects of the observed differences described, use of reported episodic and aggregated investigation data may undermine research findings if the variations are not addressed during the research process.

Until the investigation community reconciles the cited differences, safety researchers are confronted with the burden of examining reported investigation data scrupulously for the influences described and using reported accidental occurrence investigation data cautiously.

End.