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Discussion: Investigation of dam incidents and failures

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1. Contribution by G. S. Shrivastava

I wish to propose an alternative way of classifying the generic causes of dam incidents and failures noted by Warren (2011) order to make it easier to take corrective action during the education and training of engineers for preventing or mitigating dam incidents and failures in the future. The alternative classification is based on two philosophical viewpoints – the concept of three worlds outlined by Popper (1978) and the three types of human error described by Fonseka (1996).

From an engineering perspective, the three worlds proposed by Popper (1978) can be interpreted as:

(*a*) the natural world (planet Earth and the universe)
(*b*) the world of the mind (skills of analysis and synthesis, science and technology)
(*c*) the engineered world (product of the natural world and the world of the mind).

It can be argued that these three worlds interact and there is a common intersecting zone symbolising all that is uncertain in the three worlds. Furthermore, it can be said that human errors primarily arise from this zone of uncertainty and have a specific characteristic in each of the three worlds. For example:

(*a*) knowledge-based errors arise due to our incomplete understanding of the natural world
(*b*) skill-based errors arise due to imperfections of the world of the mind
(*c*) rule-based errors arise due to neglect of professional rules in the engineered world.

Through a number of real-life case studies from the field of medicine, Fonseka (1996) provides a good analogy for illustrating these human errors:

(*a*) a physician may make a wrong diagnosis due to lack of knowledge (knowledge-based error)
(*b*) a surgeon, although not lacking knowledge, may put a patient at risk due to poor surgical skills (skill-based error)
(*c*) a surgeon, not lacking either knowledge or skill, may cause complications in a patient by not ensuring proper procedures are followed (e.g. rules regarding sterilisation of surgical instruments or post-operative monitoring and care) (rule-based error).

From this perspective of human errors, the six generic causes outlined by Warren (2011) may be reclassified as shown in Table 1. It may be noted that knowledge-based errors primarily relate to shortcomings in academic curricula, whereas skill-based and rule-based errors generally reflect weaknesses in the process of training chartered/professional/registered engineers (Shrivastava, 2004). Classifying errors as

Generic cause	Knowledge-based error	Skill-based error	Rule-based error
Project planning	•		
Site investigation			•
Design errors	•		
Construction errors		•	•
Material deficiencies		•	
Operational errors			•

Table 3. Classification of errors

knowledge, skill or rule based can thus make it easier to identify where corrective action needs to be taken.

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