Leveson and Dekker on Reason: How the Critics Got the Swiss Cheese Model Wrong

Written for the Festschrift* for Jim Reason

Andrew Hopkins

Australian National University

(andrew.hopkins@anu.edu.au)

September 2023
(with typo corrections December 2023)

*A Festschrift is volume of writings collected in honour of a scholar.

One way to identify great theorists is by the extent to which their work has influenced their discipline. No doubt many who contribute to this festschrift will talk about Reason's influence. I myself could write at length about the way his work has shaped my own.[1]

But there are other less direct and, in some respects, more interesting ways to demonstrate this influence. Writers who seek to make their own names as theorists often begin by identifying the supposed deficiencies of great theorists who have come before them. They then go on to demonstrate how their own theorising supposedly overcomes these deficiencies. Accordingly, another way in which we can identify great theorists is by the extent to which later writers have sought to expose these supposed failings. By this second criterion as well, Jim Reason is one of the great theorists of safety science[2]. In this essay I shall examine two theorists who have rejected Reason's work and I shall show that their arguments have little merit. The two I have chosen are Nancy Leveson and Sidney Dekker. Both are now influential in the field, claiming to have established new paradigms for safety practitioners and researchers. Both have developed their paradigms in part by repudiating Reason's work, in particular his Swiss Cheese Model of accident causation.

Nancy Leveson has developed what she calls a systems approach to explaining accidents, one which explains accidents as a failure of controls[3] . She calls her approach STAMP[4]. There is nothing wrong with Leveson's approach; indeed, it is very similar to Reason's. However, she seeks to differentiate her work from his by criticising it harshly, and in the process, she gets many things wrong, as I shall show in some detail in this essay.

Sidney Dekker advances his theory, "Safety Differently", in a book of that name[5]. The book is a wide-ranging critique of what he calls the Cartesian-Newtonian approach to safety. At many places in the book, he refers to the Swiss Cheese Model, which he treats as the paradigm case of the Cartesian-Newtonian approach to accident analysis. Dekker's rejection of the Swiss Cheese Model is therefore part of his broader rejection of the Cartesian-Newtonian world view, as applied to safety, which paves the way for his doing "safety differently". However, like Leveson, he gets many things wrong, and the Swiss Cheese Model survives its encounter with Dekker, unscathed.

---

[1] See eg *Disastrous Decisions: The Human and Organisational Causes of the Gulf of Mexico Blowout* (CCH: Sydney, 2012), chapter 1.

[2] The expression "safety science" is problematic but it is useful shorthand in the present circumstances.

[3] See Leveson N, 2011. *Engineering a Safer Word: Systems Thinking Applied to Safety,* MIT Press, pp115ff. Kindle edition.

[4] STAMP (Systems-Theoretic Accident Model and Processes),

[5] Dekker, S (2015) *Safety Differently :Human Factors for a New Era,* Taylor and Francis

Heinrich and the domino theory

I begin with Leveson, but to fully understand her errors we must go back to one of the first theorists of accidents, H.W. Heinrich, and his book, *Industrial Accident Prevention: A Scientific Approach*[6]. In this book, Heinrich developed his curious domino theory of the causes of industrial accidents. This theory is now almost universally viewed as being of historic interest only, with little or no value when it comes to understanding accident causation. Leveson, however, asserts that Reason's Swiss Cheese Model is a re-invention of the domino model. Here is what she says.

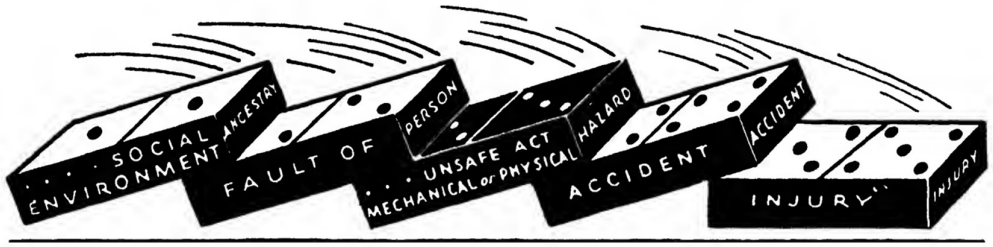
> "Reason reinvented the domino model in what he called the Swiss Cheese model, but with layers of Swiss cheese substituted for dominos and the layers or dominos labeled as layers of defence that have failed".[7]

In so saying she is effectively claiming that the Swiss Cheese Model is as irrelevant to the understanding of accident causation as is Heinrich's domino model.

So what precisely was Heinrich's model? Here are his words

> The occurrence of a preventable injury is the natural culmination of a series of events or circumstances, which invariably occur in a fixed and logical order. One is dependent on another and one follows because of another, thus constituting a chain that may be compared with a row of dominoes placed on end and in such alignment in relation to one another that *the fall of the first domino precipitates the fall of the entire row*. An accident is merely one link in the chain. (emphasis added)[8]

This passage is accompanied by the following diagram and caption, reprinted here exactly as it occurs in his text.



The injury is caused by the action of preceding factors.

Figure 1 Heinrich's domino illustration

Heinrich's claim that "the fall of the first domino precipitates the fall of the entire row" is clearly true for a row of dominos arranged in this way, but does he really intend us to understand accident causation in this way?

---

[6] First published in 1931. Page references here are to second edition, H.W. Heinrich (1941) *Industrial Accident Prevention: A Scientific Approach*, second edition, Mc-Graw-Hill Book Company.

[7] Op cit p41

[8] Op cit 14

To answer this question, look a little more closely at the labels on the five dominos in the above figure. They are:

1 Social environment and ancestry
2 Fault of person
3 Unsafe act and mechanical or physical hazard
4 Accident
5 Injury

These are the basic elements of his theory of accidents, as elaborated in the table below, taken straight from his book[9].

Accident Factors	Explanation of Factors
1. Ancestry and social environment.	Recklessness, stubbornness, avariciousness, and other undesirable traits of character may be passed along through inheritance. Environment may develop undesirable traits of character or may interfere with education. Both inheritance and environment cause faults of person.
2. Fault of person.	Inherited or acquired faults of person; such as recklessness, violent temper, nervousness, excitability, inconsiderateness, ignorance of safe practice, etc., constitute proximate reasons for committing unsafe acts or for the existence of mechanical or physical hazards.
3. Unsafe act and/or mechanical or physical hazard.	Unsafe performance of persons, such as standing under suspended loads, starting machinery without warning, horseplay, and removal of safeguards; and mechanical or physical hazards, such as unguarded gears, unguarded point of operation, absence of rail guards, and insufficient light, result directly in accidents.
4. Accident.	Events such as falls of persons, striking of persons by flying objects, etc., are typical accidents that cause injury.
5. Injury.	Fractures, lacerations, etc., are injuries that result directly from accidents.

Figure 2 Heinrich's theory, in words

[9] ibid

To a modern audience, reading down the column "explanation of factors" suggests an extraordinarily limited and one-sided understanding of accident causation and an archaic understanding of the social forces that shape human beings. But let us pass over this issue and focus on a second, which is more important in the present context. That is: there is no direct or automatic causal transmission from any one of these accident factors to the next. Even assuming we could identify the type of ancestry or environment that tends to generate "fault" in a person, it is inconceivable that all people with these characteristics will necessarily exhibit the kinds of fault which Henrich describes in his second factor. In other words, the fall of the first domino does *not* necessarily result in the fall of the second. Nor do people who exhibit the personal faults identified in the second domino necessarily commit unsafe acts. Nor do unsafe acts necessarily result in accidents, and finally, not all accidents result in injury. In short Heinrich's actual theory of accident causation does not conform *at all* to the domino model in which "the fall of the first domino precipitates the fall of the entire row". This is a massive contradiction.

Heinrich is well aware of this contraction. Here again are his words:

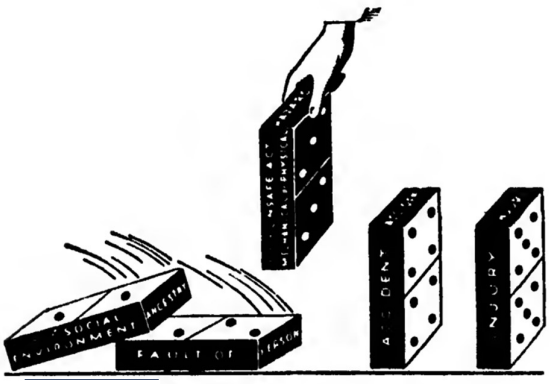
> Happily, the first event or circumstance in the list of factors does not always result in establishing the series that produces an injury. Many things may occur to break the chain. A person having inherited or acquired faults may not act unsafely or may not permit a mechanical hazard to exist. If he does violate a safe-practice rule it is possible that an accident may not occur. Even when a person falls or is involved in some other kind of an accident, there may be no resulting injury[10].

In this passage Heinrich unashamedly admits that his own theory does not conform to the logic of the domino model. However, he is unperturbed by this contradiction because the domino chain he describes is not central to his work, which is the prevention of accidents. It is a metaphorical introduction to his book which he rapidly leaves behind. As he says

> [The work of] the accident-prevention engineer should centre upon the factors immediately preceding the accident itself; these being the unsafe act and/or the mechanical hazard, and the proximate reasons why these exist[11].

He makes this point using his domino model in the following diagram.

[10] Op cit p16
[11] ibid



The removal of the central factor makes the action of preceding factors ineffective.

F*igure 3 Heinrich's illustration of the work of accident prevention engineers*

But many others have made this same point without recourse to domino images. The domino metaphor adds nothing. Apart from one instance, Heinrich makes no further reference to this model in his book.

Heinrich's domino model is no more than a thought bubble, to use a modern-day expression, and would have gone the way of all bubbles, except that Leveson has resurrected it as a way of criticising Reason's model of accident causation.

The Swiss Cheese Model

The Swiss Cheese Model went through many iterations, from when it was first conceived in about 1987 until the image stabilised in Reason's 1997 book[12]. In fact there are two versions of the model in that book, presented below – an elaborated version and a streamlined version.

[12] Reason J (1997) *Managing the Risks of Organisational Accidents,* Ashgate: Aldershot;
J. Reason, E. Hollnagel, J Paries, *Revisiting The « Swiss Cheese » Model Of Accidents,* Eurocontrol, Brussels, 2006.
Justin Larouzee, Jean-Christophe Le Coze, "Good and bad reasons: The Swiss cheese model and its critics", *Safety Science* 126 (2020) 104660

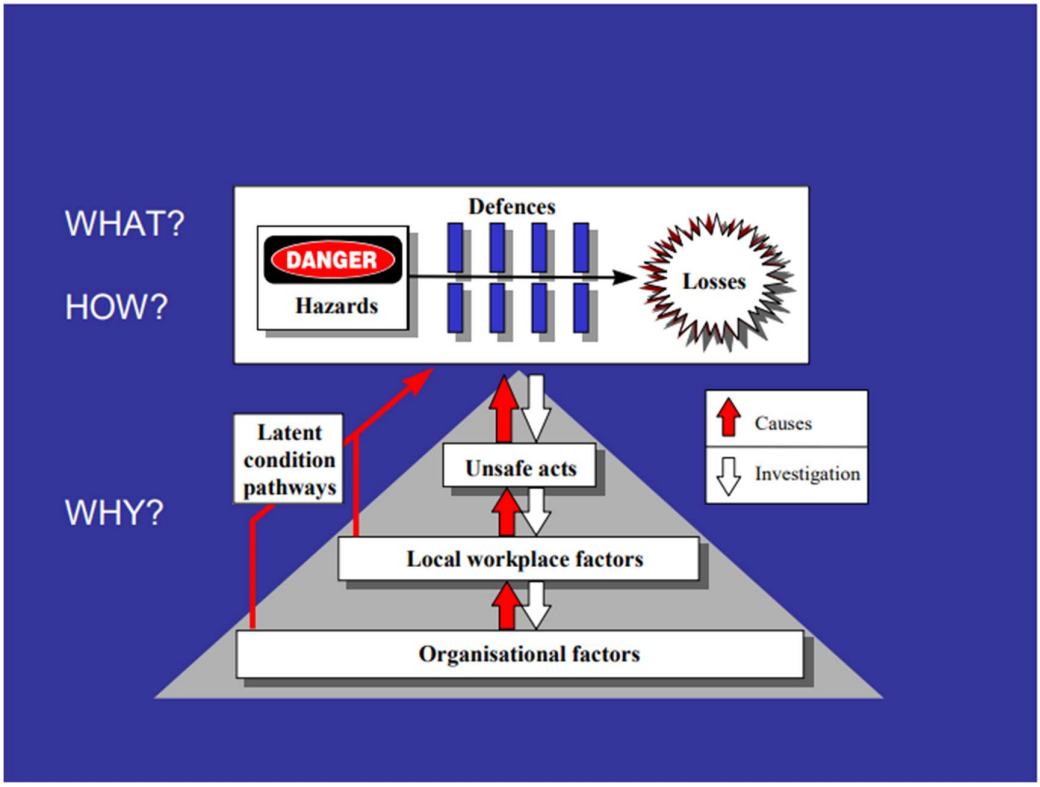


Figure 4 The elaborated version of the Swiss Cheese Model. Source: Reason 1997:17.

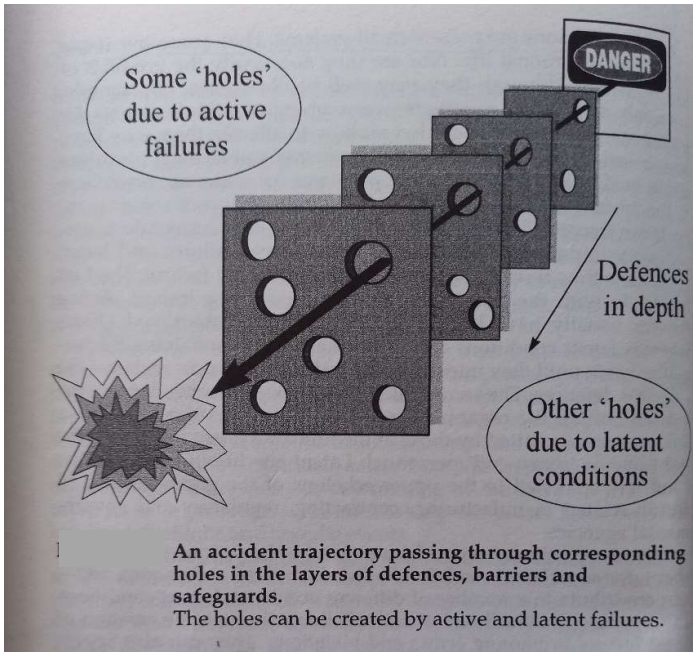


Figure 5 The streamlined version of the Swiss Cheese model –Source Reason 1997:12

The elaborated version, figure 4, appears on page 17 of the 1997 book; it also appears on the front cover. I use it, therefore, as a starting point. There are four failing barriers (defences, safeguards, controls etc) in the top panel of Figure 4. These can fail because of unsafe acts by front line personnel which themselves stem from latent conditions located in the local workplace or in organisational arrangements, located in the triangle below. They may also fail because of latent condition pathways that are quite independent of frontline operators. Both space shuttle accidents (Challenger and Columbia) exemplify this second possibility: no unsafe acts by shuttle crews contributed to these accidents; both resulted from management decisions made prior to launch. Latent conditions may be present, and lying dormant for years, before they give rise to an accident.

Figure 5 is a streamlined version of figure 4. This version is better known, probably because it more closely resembles a series of slices of Swiss cheese. Note that some of the holes are due to active failures, another term for unsafe acts[13], while other holes are due to latent conditions. The streamlined version provides no indication of the source of these latent conditions or unsafe acts and in that respect is less helpful than the elaborated version.

Back to Leveson

Unfortunately, summarising the Swiss Cheese Model as in figure 5, facilitates Leveson's misrepresentation of it as a domino model. She identifies the following features of Reason's model (page references are to her published book):

- It assumes "chains of failures, each directly causing or leading to the next one in the chain". (p41)
- It assumes "a single or root cause" (p41)
- It involves an emphasis on human error in identifying accident causes (pp41,49)
- It discounts systemic factors (p21)
- It fails to recognize that the foundation for the accident may have been laid years before. (p49)

I deal with these claims in turn below; not one of them is true. First, and most fundamentally, to characterise the Reason model as a domino model or an event chain is a serious error. As noted above, in any coherent domino model, as each domino falls, it causes the next to fall in a deterministic fashion. That is very far from Reason's conception. There is no assumption in his model that the failure of the first barrier will cause or lead the second barrier to fail, and hence the third, and so on. On the contrary, if the first barrier should fail, the assumption is that the second will normally *not* fail, and any potential accident sequence will therefore be interrupted at that point. In the theoretically unlikely event that the first *and* second barriers should fail simultaneously, the third barrier will interrupt the sequence, and so on. Ideally, if the barriers are independent of each other, and every barrier has a small probability of failure, the probability that all will fail simultaneously will be exceedingly small[14]. In reality, the reason major accidents occur is not because an extremely improbable event has occurred, but because

[13] See Reason 1997:10

[14] In fact the barriers are often not fully independent of each other, but this is not the fault of the model. Sometimes the barriers are entirely inter-dependent and the collapse of one does indeed cause the collapse of the rest. For an example of this see Hopkins, 2012, op cit, chapter 4

the barriers, that were supposed to be in place, were not. Moreover, understanding why this was so, leads inevitably to organisational causes, possibly a small number of such causes[15].

Leveson's second point above is that the model assumes a single or root cause. That is evidently far from the case. Reason's elaborated model clearly allows for multiple latent failures operating at the organisational level.

Her third point is that the Reason model emphasises human error. In fact, the model insists on tracing all human errors back to organisational failures, as is explicitly done in the elaborated version. Moreover, the model also explicitly recognizes that latent errors may have their effect independently of any error by front line employees.

Fourth, Leveson claims that the model discounts systemic factors. But organisational factors are systemic factors. This fourth claim is therefore wrong.

Finally, Leveson claims that the model fails to recognize that the foundation for the accident may have been laid years before. But the concept of latent factors explicitly recognizes this possibility. This final claim is therefore wrong as well.

It is hard to understand how someone reading Reason's 1997 book, as Leveson has done, could get his theory so entirely wrong. But doing so has an important consequence. It allows her to argue that her theory of control failure is much superior to the theory implied in the Swiss Cheese Model.

There is a fundamental difference between the Swiss Cheese Model and a domino model of accident causation that is worth pointing out. It concerns the meaning of "cause". There are two diametrically opposed ways of thinking about the cause or causes of a particular event - sufficient cause and necessary cause[16]. A sufficient cause is one that inevitably leads to the outcome. This is assuming other relevant factors remain unchanged. Given a row of dominos arranged as Heinrich does, the fall of the first is sufficient to cause the fall of the last, if other relevant factors remain unchanged. Of course, there are many things that might change after the first domino falls that would interrupt the causal chain, and in more complex situations things are forever changing. But there are many simple situations, like the domino chain, where it is reasonable to assume that during a very short time interval of concern, other relevant factors are unchanged. In such a situation it is reasonable to talk of a particular causal factor as being sufficient to give rise to the outcome. In other words, in these simple situations we can predict the future with some confidence. In most situations of interest, however, it is impossible to be sure of what all the relevant factors are, even less to ensure that they will remain

[15] For a good account of this see Hudson, P.T.W & Hudson, T.G.L. (2015) "Integrating cultural and regulatory factors in the bowtie: Moving from handwaving to rigor". In V. Ibrahimapour & S. Yacout (Eds) *Ontology Modelling in Physical Asset Integrity,* Springer, Berlin.

[16] There is another meaning of cause that Leveson touches on (pp43-44) that can be called statistical cause. It is relevant to causal statements of the type "smoking causes lung cancer". It refers to an association between two variables that survives attempts to control for confounding influences and that includes a plausible theory of why there should be such an association. All of that is true for the statement "smoking causes lung cancer". But the truth of the statement does not depend on whether or not, in a particular case, a smoker contracts lung cancer. Establishing causation in a statistical sense enable us to make probabilistic predications about the future, but not deterministic ones. (see further my book, *Organising for Safety: How Structure Creates Culture* Chapter 9)

unchanged during the time interval between cause and ultimate consequence, so it is impossible to predict the future with any confidence.

But accident prevention does not require that we predict the future; it requires that we learn from the past about how an accident might have been prevented, and that we set about making these changes to reduce the likelihood of future accidents. This is precisely what the Swiss Cheese Model does. It does so by relying on the contrasting concept of cause – necessary cause. Each barrier *failure* is necessary for the accident to have occurred, but none is sufficient, by itself, to give rise to the accident. Each barrier failure can be thought of as a "but-for" cause: but for this failure (were it not for this failure), the accident would not have occurred. Had any one of the barriers worked as intended, the accident would not have occurred. That, by the way, is why major accidents in well-defended systems are relatively rare[17].

There is actually an infinite set of such but-for causes of any particular incident or injury. For example, if a worker who suffers an injury had not been at work that day, s/he would not have been injured. But it is of little practical use to identify such a but-for cause. It makes far more sense to focus on but-for causes that are within the capacity of someone to control. That is exactly what the Swiss cheese model does, and that is why it is so useful.

Leveson seems confused about this fundamental difference between sufficient and necessary causes. The Swiss cheese model identifies various *necessary* causes; a domino model identifies a precipitating event that is *sufficient* to cause the outcome[18]. To describe the Swiss cheese model as a domino model misses this crucial distinction.

Leveson herself is highly critical of theorists who mispresent the arguments of those they disagree with. In an article in which she criticizes another contemporary theorist, Erik Hollnagel, she accuses him of strawman arguments. She provides the following definition.

> Strawman arguments. Because Prof. Hollnagel uses the strawman fallacy so much in these books, indeed it is the basis for the entire argument in his 2014 book, it is useful to review this type of logical fallacy. A straw man is a form of argument and an informal fallacy based on giving the impression of refuting an opponent's argument, while actually refuting an argument that was not presented by that opponent. One who engages in this fallacy is said to be "attacking a straw man". The basic form of such an argument is to start with a misrepresentation of someone's argument to make it easier to attack and make your own position seem more reasonable.[19]

One would have to say that Leveson is guilty of this very same fallacy in her critique of Jim Reason and his Swiss Cheese Model.

---

[17] The concept of but-for cause is used in a legal context with a slightly more restricted meaning than is used here. See HLA Hart and T Honore, *Causation in the Law*, 2nd Ed, 1985, Clarendon Press, Oxford Chapter 5

[18] For a further discussion, Hart and Honore, op cit, and D Fischer "Insufficient causes", *Kentucky Law Journal,* Vol 94,(2005-2006), pp67-107

[19] Leveson N, "Safety III: A Systems Approach to Safety and Resilience", MIT Engineering Systems Lab, 7/1/2020, p5

Sidney Dekker

Sidney Dekker is my second example of a theorist who has misrepresented Reason, perhaps without realising it, in the process of advancing his own theoretical position. It is relatively easy to see how Leveson misrepresents Reason, but it is more difficult to see how Dekker does, because his arguments are deeply embedded in a more general critique of what he calls the Cartesian-Newtonian world view. According to Dekker, this world view, though helpful in the past, now stands in the way of better understandings of safety. Reason's model is an expression of this world view - the old view as opposed to the new view that Dekker is advocating. It is part of the problem, rather than the solution. As he says, the Swiss Cheese Model "reifies centuries-old Cartesian-Newtonian ideas about cause and effect relationships, linearity, and closed systems."[20] Dekker is quite confused, indeed wrong about this, as I hope to show in what follows.

It may help the reader if I first present the logic of my argument in a nutshell, as follows:

- The Cartesian-Newtonian world view is a well-recognised philosophical view, stemming from the work of two 17th century thinkers - the philosopher Rene Descartes and the physicist/mathematician, Isaac Newton – both long preceding the industrial revolution.
- Dekker himself elaborates this world view to deal with the causes of accidents, in particular, socio-technical accidents, about which Descartes and Newton themselves could have had nothing to say.
- Dekker argues that this Cartesian-Newtonian view of accident causation, as he himself has elaborated it, is significantly flawed.
- He further argues that the Swiss Cheese Model is an instance of this flawed Cartesian-Newtonian view of accident causation.
- He concludes that the Swiss Cheese Model itself must be significantly flawed.
- However, in fact it is not flawed in the ways that Dekker claims it to be.
- It is therefore Dekker's argument that is flawed.

So let me now flesh this out. According to Dekker, Newton's

> "third law of motion … lies at the basis of our presumptions about cause and effect, and the causes of accidents: For each action there is an equal and opposite reaction. In other words for every cause there is an equal effect, or rather for each effect there must be an equal cause. Such a law … is misguiding and disorienting when applied to sociotechnical failures, where small banalities and subtleties of normal work done by normal people in normal organisations can slowly degenerate into enormous disasters… The cause-consequence equivalence dictated by Newton's third law of motion is quite inappropriate as a model for organisational accidents."[21]

[20] Dekker op cit, p25
[21] op cit p 43

Let us consider this paragraph carefully. It is true that Newton's third law of motion holds that for every action there is an equal and opposite reaction. One of the clearest illustrations of this is the principle of rocket propulsion, in which gases are expelled at very high speed from the rear of the rocket, which propels the rocket forwards, in an equal and opposite reaction. But notwithstanding Dekker's claim, Newtons third law is *not* the equivalent of saying for every effect there must be an equal cause. If someone pulls the trigger of a gun, which causes the explosive release of a bullet that kills someone else, there is no equivalence between the force on the trigger and the fatality, even though, most would agree, one is the cause of the other. Nor does Newton's law imply any equivalence. All it says is that when the finger applies a force to the trigger, the finger will experience an equal and opposite force, which has nothing to do with the catastrophic outcome that follows the pulling of the trigger. So while it is true, as Dekker says, that a catastrophic accident may have one or more banal or subtle causes, this is in no way inconsistent with Newton's third law of motion. There is nothing in the Newtonian paradigm that requires a catastrophic accident to have cataclysmic causes. Dekker's attempt to extend Newton's physics to cover accident analysis in this way is just wrong. It cannot therefore be used to discredit the Swiss Cheese Model.

Here is another example of the way in which Dekker misuses his discussion of the Cartesian-Newtonian world view to dismiss the Swiss Cheese Model. He notes that Newton's system is deterministic, that is, if we knew enough about the system in its current state we could predict its state in the next moment. By implication we could predict the future[22] . Complete knowledge of the current state of a system also enables us to deduce what must have been. There is thus a symmetry between past and future. However, he says, in the everyday world of work, we can never know everything needed to predict the future. We can never hope to identify a sufficient cause or set of causes that will determine the occurrence of a future event.

So far so good. But the next step in his argument is this.

> "Best practice" social analysis challenges the usefulness and validity of retrospective analysis, such as used in accident investigation. This is because the future cannot be entirely determined by the past… [23]

This is a rejection of the Swiss Cheese Model, as well as all other attempts to identify the causes accidents.

Dekker does not name these "best practice" analysts, but given their reasoning stated above, they are simply wrong. They are wrong because they fail to take account of the distinction introduced earlier between cause as a sufficient condition or set of conditions, and cause as a necessary condition - but-for cause. Accident investigators using the Swiss cheese model are not seeking to identify a cause, or set of causes, that can be used to predict the future; they are seeking to identify but-for causes, that is, events or conditions which, had they been otherwise, would have prevented an accident from occurring. Identifying such causes enables

[22] Op cit p46
[23] Op cit p 175

investigators to make recommendations that, if followed, could be expected to reduce the likelihood of similar accidents in the future[24].

There is another reason why analysts like Dekker are critical of retrospective analysis, namely, it involves hindsight bias (and/or outcome bias, which is a form of hindsight bias). This is a commonly made criticism that deserves a response. The validity of the criticism depends crucially on the way in which the retrospective analysis is used. If it is used to allocate blame, then indeed this can result in hindsight bias. This is the context that Dekker has in mind when he talks of hindsight bias[25]. The problem of hindsight bias is most acute in legal proceedings where allegations of negligence are to be determined. After the event, it is often concluded that the reasonable person would not have behaved as did the people involved in the accident. Such a conclusion can easily be contaminated with hindsight bias, with far-reaching negative consequences for the people concerned. But where the purpose of the retrospective analysis is to draw lessons for accident prevention, we can rightly speak of the "wisdom of hindsight", precisely because it enables us to see things that were not known or understood to the participants at the time. We can begin to understand why people behaved as they did and therefore what needs to be done to change this behaviour (eg, better training, different incentives, etc). Hindsight in this context is an aid to understanding, not a source of bias. Where the purpose of the analysis is to make recommendations for the prevention of future accidents, as is the case with of the Swiss Cheese Model, hindsight is a virtue, not a vice[26].

Dekker draws primarily on the Newtonian aspect of the Cartesian-Newtonian world view in his critique of the Swiss Cheese Model. The Cartesian aspect is not in focus. It comes into greater focus in his discussion of error. He notes that Descartes proposed a sharp distinction between mind and matter, and that "mental and physical phenomena cannot be understood by reference to each other. …The notion of the separate mental and material worlds became known as dualism…."[27]

Then comes a remarkable intellectual leap.

> "The choice between human error and mechanical failure is such a dualist choice: According to Cartesian logic, human error cannot be derived from material things"[28]

In circumstances where there is no mechanical failure, we are left with human error as the only explanation for an accident. Moreover, in the logic of Cartesian dualism, human error needs no further explanation. It "is accepted as a satisfactory explanation", says Dekker. Were it not for the human error the accident would not have happened; "end of story"[29].

---

[24] For a more detailed discussion see Hopkins A (2014)"Issues in Safety Science", *Safety Science,* Vol 67 August, Pages 6-14, section 4

[25] Op cit pp46, 54,64,67, 120

[26] Barry Turner was well aware of this point. His PhD thesis was all about turning hindsight into foresight

[27] Op cit p42

[28] ibid

[29] Op cit p60

Since the Swiss Cheese Model is said to be an expression of Cartesian dualism (as well as Newtonian determinism), it follows from Dekker's discussion that the Swiss Cheese Model will treat human error as an ultimate explanation.

That conclusion is patently wrong. The Swiss Cheese Model involves an explicit search for the causes of human error, starting with local workplace factors. If for instance the error involved the misreading of a dial that was poorly lit or difficult to see for some other reason, the Swiss Cheese Model would be very comfortable identifying such a material factor as a cause of the error. In fact, the Swiss Cheese Model displays none of the characteristics which Dekker attributes to Cartesian dualism.

Dekker draws one other remarkable inference from his discussion of Cartesian dualism as applied to accident investigation. If the accident cannot be attributed to a faulty or broken component of the engineering system, then Cartesian thinking leads to the conclusion that "the fault must lie with the people operating the system"[30]. In this way, he says "moral tags (unsafe acts, violations, complacency, deficiency) "have insidiously become part of this model"[31]

Again, we must read this as a claim about the Swiss Cheese Model. And again, it is patently wrong. The Swiss Cheese Model is very careful to avoid blaming those who make the errors, instead seeking to understand the "error-enforcing" features of the system.[32]

I conclude that Dekker's attempt to locate the Swiss Cheese Model as part of the Cartesian-Newtonian world view is problematic in two respects. First, his elaboration of this world view to cover accident causation is dubious. Second, the inference that the Swiss Cheese Model exhibits the faults of Dekker's elaborated Cartesian-Newtonian world view is wrong. This is important because Dekker's discussion will inevitably lead readers unfamiliar with the Swiss Cheese Model to conclude that it is part of an old and faulty world view that needs to be discarded in favour of the new view that Dekker advocates.

Finally, by way of disclaimer, I have restricted myself in this essay to those parts of Dekker's book that refer specifically to the Swiss Cheese Model. The book is in fact much broader in scope. A more comprehensive discussion can be found in Jean Christophe Le Coze, "The 'new view' of human error. Origins, ambiguities, successes and critiques"[33]

Conclusion

Jim Reason's Swiss Cheese Model is one of the best known and most useful innovations in the field of safety science, used by practitioners and academics alike, as many other contributors to this volume will no doubt attest. Moreover, it generalises easily to bowtie analysis now widely used for dealing with major accident risk[34].

[30] Op cit p175
[31] ibid
[32] Reason 1997: 134-6
[33] *Safety Science*, Vol 154, October 2022, 105853
[34] See my book *Disastrous Decision*, chapter 4

I have argued here that aspiring theorists sometimes feel a need to kill off the giants in their field, or at least highlight their failings, as part of the process of establishing their own credentials. We can therefore infer the status of established theorists by the vigour with which later theorists criticise them. Unfortunately, vigorous criticism in this context runs the risk of misrepresenting the work of the established theorist. Jim Reason has been subject to more than his fair share of this and, by this criterion alone, is one of giants of our field.