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Designing a Safer Built Environment

A complete guide to the management of design risk

John Carpenter

Foreword

I am honoured to provide a foreword to this book. The author, John Carpenter, has been a friend and colleague for years and we share a strong commitment to aiding our profession in its pursuit of construction safety. None of us involved in construction can be content when tragedies occur, lives and careers are blighted, workers' health suffers and vast resources are squandered. Readers only have to keep abreast with current news and events in their own business sector to reveal examples. John's theme is that the cause of such events is normally inadequate management of inherent risk since for sure all construction is a risky business. John's focus is that a proper appreciation and management of risk at the time of design will yield significant benefits. Yet despite this being a legal and moral duty, the feedback of actual practice is disappointing.

As John writes, the underlying causes of tragedy are rarely ones of unforeseen technical ignorance. Rather, they are usually exacerbated by human failings which ought to be controllable. I've had a long design career and in reading this book I see many echoes of events that I have witnessed, or of mistakes I myself have made.

That last comment on personal mistakes is one made not so much as a confession but a recognition that ours is a vast and complex industry with so much to learn that I wonder how any of us can hope to acquire the requisite skill set within one career's lifespan. After our initial engineering education, we all start out with a mindset that if only we apply mathematics, all will be well. Alas, the task of engineers is to deal with uncertainty on a huge scale. We start out assuming our more senior colleagues know what they are doing. But as we progress, we learn that just isn't always true and, as John emphasises, 'People', their quirks and fallibilities, are a root cause of many problems.

If ever we needed a reminder not to be complacent, we should have regard to the (2017) Grenfell Tower fire, which this book rightly highlights. We may ask ourselves: how can we have ended up with such a tragedy? What went so wrong? More aptly, what went wrong with the whole design and project management process that terminated in this awful incident? John mentions many other cases, though he doesn't refer to the Boeing 737 Max affair. Readers may recall there were two plane crashes (in 2018 and 2019) which revealed serious faults in the plane's design, not just technically but in the whole process of handling and

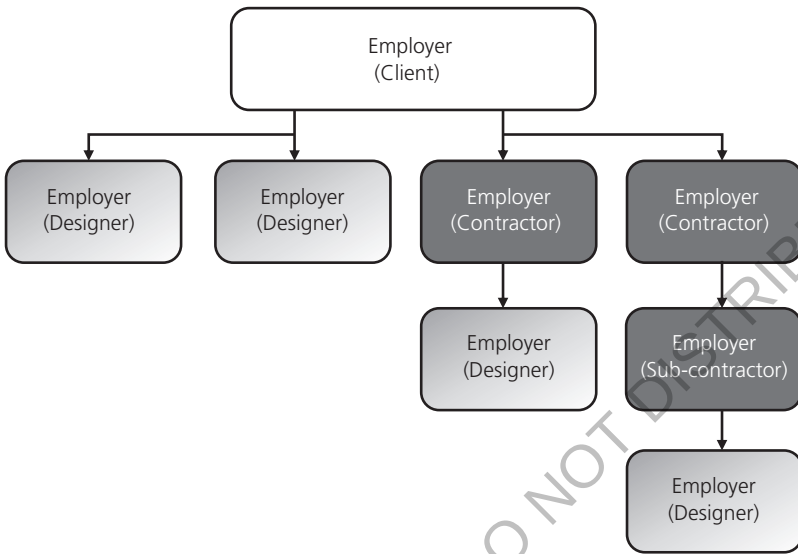
regulating the design's evolution. The net result was a collapse in confidence, worldwide groundings, a dramatic drop in Boeing's market value and huge order cancellations. Those who wish to learn would do well to read the 2020 report commissioned by the US House Committee on Transportation and Infrastructure. It is a damning indictment of the engineering and the whole design process. Many parallels will be found with comments in this book which centre on another of John's key messages: watch the 'Processes'.

Readers may feel that the world of Grenfell and Boeing is somewhat remote from their daily workings. Do not fall into that trap. There are significant dangers on 'High Street projects'. Not long ago, a multimillion-pound Chelsea house collapsed during extension works. Lessons of what goes wrong in all these projects can be traced back to a lack of design risk management across the spectrum of design and construction and generic lessons are the same for a small domestic project just as for the mighty task of bringing a major plane upgrade to market.

John's text does not make for a comfortable read. As designers, we have contractual and moral obligations to actively consider and manage risks but for a myriad of reasons this task is not being performed to the standard required: we must do better and John's aim is to help us all. His text offers some practical explanation and guidance on how we can do better and all of this is gleaned from his vast experience. It is not easy, not least for those starting out. The only solution is to be patient but commit to observe and learn continually. We learn from each other and we learn by studying what has gone wrong elsewhere and why, and we learn from others who have given the problem much thought: this text has some strong pointers. Finally, John offers firm advice: do not look upon a proper risk assessment as a legal chore. Powerful benefits to self-preservation and good business accrue when carrying out proper designer risk assessments. If you want to stay motivated, stay successful and make a profit, by far the best thing you can do is avoid a catastrophe.

Allan Mann BSc, PhD, CEng, FIStructE, FREng

Figure 3.1 Typical contractual arrangements and pathways



Thus, there is no direct contractual link between many of those producing the design (and appointed by the Client) and those constructing it. As noted previously, there is also a time issue in that some designers may have left the project before the work is implemented, and will have done in the case of operating, repair or maintenance tasks. However, those designers appointed by contractors (as illustrated in Table 3.4 or Figure 3.1) do have the necessary direct linkage with those who are going to construct the design output, which is what is sought.

This mismatch, whereby the Designer has no integrated contact with those who have to assemble, maintain or repair the product (either to plan the process or to oversee its implementation) is a poor business model. No other high-risk industry operates in this manner and it has other detrimental aspects outside the scope of this book. Those projects where there are strong integrated teams will generally fare much better. However, as is shown later (see s5.9), teamwork, while an essential element for communication, coordination and cooperation (all legal requirements and essential business attributes), does not itself produce design decisions on specific risks.

The difficulties are resolved, in practice even if not entirely in law, by designers being appointed by contractors, as this provides the contractual control set out in Table 3.1 and Figure 3.1. In these circumstances, close working allows the design to be progressed in a manner which will suit the Contractor's method of working, and thus when eventually on site, nothing should arise which gives rise to unnecessary or unexpected risk. Should it do so, there is still the opportunity to resolve the concern.

However, on those projects where the parties are assembled in a contractual framework which has more to do with saving short-term money than managing risk in an intelligent manner, and there is, as a consequence, little opportunity for integrated working, this avenue for identifying

6.3. Designer's role

Paraphrasing Regulation 9 of CDM, it is the Designer's role to

(*a*) In respect of risks

(*i*) **Eliminate risk**, or, if not reasonably practicable to do so
(*ii*) **Reduce risk,** so far as is reasonably practicable.

(*b*) In respect of communication

(*i*) To pass on information, on significant residual risks, to others who have a need to know.

The above is in relation to persons 'carrying out or liable to be affected by construction work; maintaining or cleaning a structure; or using a structure designed as a workplace'. Note that 'construction work' can be building, repairing and demolishing/decommissioning.

Risk is defined as a 'situation that could be dangerous or have an undesirable outcome'. By definition, it is uncertain. CDM is concerned with outcomes that adversely affect people, but, as we have seen, the engineer is concerned overall with a far greater range of risk (see Figure 1.1).

The first requirement (a) has, over the time in which CDM has been in place, caused uncertainty as to how it should be implemented. Clearly not all risk can be reduced, still less eliminated. Construction is, after all, a 'risky business'.

Regulation 9 also requires designers, if it is not possible to reduce risks, to control them through the subsequent design process. It is not altogether clear what the latter action means (this is illustrated later in s6.15).

The requirement to take action on risks '*as far as is reasonably practicable*' (SFARP) often causes difficulties for designers in respect of many risks because this obligation is not defined in any meaningful manner (Chapter 3 explained this in more detail). The aim of this chapter is to provide useful guidance on how Regulation 9 may be applied, in a compliant manner, without getting 'bogged-down' with the (often unworkable) legal definition of SFARP.

This regulation lies at the heart of the design process. Although the legal obligation here relates to safety and health risk, the general process (eliminate, reduce, communicate) can be applied to all risk and was discussed in Chapter 4.

If the project involves a building which is a workplace, then additional regulations come into play. These are the Workplace (Health, Safety and Welfare) Regulations (HMG, 1992). For most civil engineers these will not impinge on the design as the requirements will tend to fall to other disciplines in the team, or other legislation (i.e. Building Regulations). However, exceptionally, or for those working for an industrial client, they may become more relevant and require attention, for example regarding access, traffic routes, lighting or doors and gates. Designers should check specifically against the regulations, and their brief, if they are involved in a workplace.

9.3. Permanent Works Designers

Section 8.20 introduced the Permanent Works Designer (PWD) with regard to temporary works. It was not a particularly complimentary text and emphasised the need for Permanent Works Designers to improve their approach and performance.

As we have seen in earlier chapters, PWDs may be engaged by the Client, by contractors or other designers, and their work may arise at any time within the project timeline. In discharging their obligations, it will be necessary to consider constructability and this may necessitate consideration of temporary works issues. The TWf has written on this aspect (TWf, 2020). PWDs must establish that there is at least one feasible (and economic) way to construct the structure. Unless trivial, or obvious to a competent contractor, this should be communicated to the Contractor, even if in outline. Similarly, unless temporary works requirements result in 'standard work tasks' (see s6.12), these too should be outlined to show a feasible method.[4]

There will be many instances when there is no required involvement: an experienced contractor will be able to manage the process without further input. However, even on some common structures (e.g. multistorey in-situ flat slab or domestic-scale structures), thought and guidance may be required on, for example, access, striking times, early strength requirements, slab capacities for temporary loading during back-propping and the like (Carpenter, 2011). A particular concern is lightly loaded thin slabs required to carry the weight of subsequent construction at higher level.[5]

On more complex structures, or refurbishment projects, the stability of the permanent works may be critically related to the temporary works, in terms of sequence, space, movement limits or strength. In these cases, the Permanent Works Designer will have a key role to play in eliminating unnecessary hazards, reducing risk and finally ensuring that key information is conveyed to contractors.

A specific example relates to site investigation data. Most projects will involve some form of site investigation but this is usually set up to furnish the PWD with data for the permanent works design. It would take little effort or cost to expand this to encompass the likely factual soils data needed by the, yet to be appointed, Temporary Works Designer (TWD).[6] This would be a small difference but with significant advantage. How often is this considered?

The foreseeable need for lateral restraint of falsework systems, and the ability of the permanent works to provide for this, should always be considered. For example

- on columns to restrain falsework decking
- on structures to restrain a foreseeable tower crane
- on facades to restrain foreseeable scaffolding.

[4] This is not to tie the Contractor down. Other methods can be used; it is just to identify a starting point.
[5] This was raised as a concern in the TWf survey mentioned in s8.20.
[6] This would be base data. The interpretation would still lie with the TWD so as to keep contractual responsibility clear.