Why Engineering Safety Fails to See Commissioning

A Short Conceptual Paper

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Keywords: Commissioning; Engineering safety; System integration; Lifecycle risk; Early-life failures; Socio-technical systems; Reliability engineering; Operational readiness

Abstract

Engineering safety research traditionally frames the project lifecycle as a sequence of design, construction, and operations. This framing omits commissioning—the phase where system assumptions first meet system behaviour. Commissioning is the activation point for latent design, integration, and interface risks that remain invisible during earlier stages. Yet it is almost absent from safety science, risk modelling, and organisational reliability research. This paper argues that commissioning should be treated as a distinct, study-worthy phase with its own risk profile, behavioural dynamics, and lifecycle implications. Recognising commissioning as a socio-technical environment, rather than a technical milestone, is essential for improving system readiness, reducing early-life failures, and strengthening lifecycle reliability.

1. Commissioning as the Missing Phase in Engineering Safety

Engineering safety research has long treated the project lifecycle as if it operates in three phases: design, construction, and operations. There is a fourth phase—commissioning—at the exact point where system assumptions meet system behaviour. Commissioning is the moment when a project stops living on drawings and must finally work in the real world. It is the phase that exposes hidden dependencies, undocumented workarounds, integration failures, and design gaps that "should have been caught months ago" [1,2].

Despite this, commissioning is almost absent from safety science, risk modelling, and organisational reliability research. It barely appears in the bodies of knowledge that claim to study how and why systems fail. This omission is no longer tenable. Commissioning is the missing link in engineering safety, and ignoring it has tangible consequences for system readiness, early-life failures, and lifecycle reliability [3].

2. Commissioning Activates Risk, It Doesn't Just Observe It

Safety frameworks tend to treat hazards as arising either during construction or later, once a system settles into steady-state operation. In practice, many of the most serious failures do not appear in either phase. They surface the moment a system is switched on, energised, loaded, and constrained by real operating conditions.

Commissioning is where design assumptions meet physical reality, where tidy logic written months earlier no longer behaves as expected, and where missing interfaces, unclear communication, and improvised fixes finally come to light. It is also the point at which behaviour diverges from simulation, and the gap between design intent and what has actually been built becomes visible.

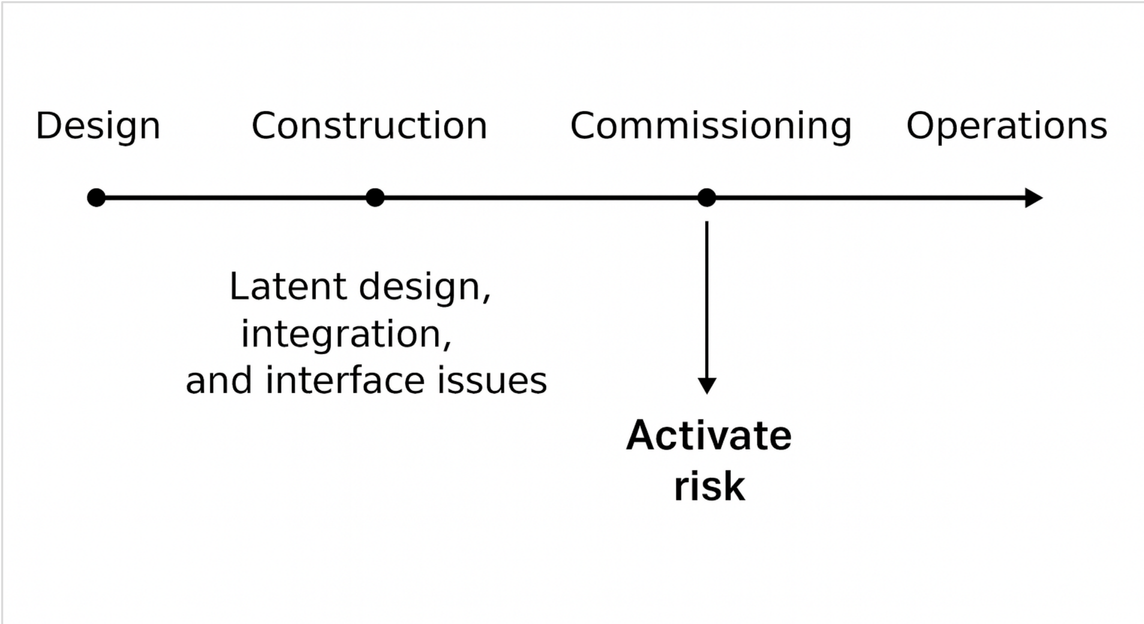

Figure 1 conceptualises commissioning as the lifecycle activation point—where latent risks surface and system behaviour diverges from design assumptions.

3. Why Commissioning Requires Distinct Treatment in Safety Science

This framing highlights why commissioning deserves distinct treatment, rather than being folded into construction or operations. Even so, commissioning barely appears in most safety management systems, resilience frameworks, or organisational governance models. A few standards now mention testing and commissioning as part of the lifecycle, such as AS 7474:2020 [4], but the research base has not caught up. Most analytical tools still treat the phase as a technical check, rather than recognising it as a messy, high-pressure socio-technical environment shaped by uncertainty, shifting timelines, and complicated handovers.

Commissioning teams carry responsibility that extends well beyond what is usually acknowledged. They must verify design integrity, integrate contractor work, confirm safety functions, and coordinate start-up while everything around them is in flux—often dealing with the consequences of upstream decisions they had no part in. They routinely operate in the most ambiguous and consequential phase of the entire lifecycle. Yet, their work remains poorly understood, rarely studied, and largely absent from the models that shape organisational decision-making.

Early-life instability—often labelled “normal bedding-in”—is frequently the result of issues missed or unmanaged during commissioning: unverified interfaces, temporary controls persisting into operations, undocumented vendor assumptions, or logic not tested under real conditions [5]. These are not unavoidable teething issues; they are preventable lifecycle failures.

4. Towards a Research Agenda for Commissioning

To correct this gap, engineering safety research should treat commissioning as a distinct, study-worthy phase with its own risk profile, failure modes, behavioural dynamics, and lifecycle interactions. It deserves the same analytical sophistication that safety science applies to design, construction, and operations.

Foregrounding commissioning as a critical component of system safety will help shape a more complete understanding of lifecycle risk and improve the reliability of complex engineered systems. The field cannot continue treating commissioning as an administrative milestone when it is the phase where systems first reveal what they truly are.

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