**Phased mission system reliability with imprecise mission timing**

D. Krpelik*1,2\*; X. Huang3, L.J.M Aslett1, F.P.A. Coolen1*

*1Department of Mathematical Sciences, Durham University, Durham, UK, \*Primary author contact details:* *daniel.krpelik@durham.ac.uk*

*2Department of Applied Mathematics, VŠB - Technical University of Ostrava, Ostrava-Poruba, Czech Republic.*

*3School of Mechanical Engineering and Automation, Northeastern University, Shenyang City, China.*

1. **Introduction**

A Phased Mission System (PMS) performs multiple functions or tasks in sequence, where each part of the mission may involve different components in the system. For example, a space mission may involve launch, orbital and re-entry phases, each of which involves very different subsystems, components and stresses on the system.



Figure 1: Toy example of how a reliability block diagram may
vary across mission phases.

As such, designing highly reliable PMSs can be challenging since every phase must achieve a high level of reliability. This calls for an effective reliability assessment that accounts for as many uncertainties in the system as possible.

1. **Reliability assessment**

There has been work on reliability and component importance assessment for PMSs [1]. In that work, the survival signature [2] was generalised to the PMS setting, enabling the natural separation of system structure and component lifetimes afforded by the survival signature to be extended to this more complex setting. As such, uncertainty in component reliability could be assessed across changing system functions and design.

A limitation of the analysis in [1] is that the duration of all phases in the mission is assumed to be precisely known apriori. Therefore, we contribute a crucial extension to [1], whereby uncertainty in the duration of mission phases is robustly accounted for within the framework of imprecise probability. This enables full reliability assessment of PMSs under the more realistic constraint that phase duration is highly uncertain: as such, we only require upper and lower bounds on phase duration, with both component and duration uncertainty then propagated through the analysis to give reliability bounds for any chosen mission time of interest, or bounds on the whole survival curve of the PMS.

1. **References**

[1] Huang, X., Aslett, L.J.M and Coolen, F.P.A. Reliability and reliability importance analysis of phased mission systems using survival signatures. Preprint, 2018.

[2] Coolen, F.P.A. and Coolen-Maturi, T. Generalizing the signature to systems with multiple types of components. In *Complex Systems and Dependability.* Springer, 2013, pp 115 — 130.