For the purpose of structural longevity assessment, an estimate of future operating conditions is required. If possible, the loading history from hull monitoring and operational records are used to make that forecast. With a structural health monitoring system, the actual operational conditions are used to regularly update that forecast and modify it on the basis of detected changes in the integrity of the structure. The actual condition, use, and performance of the structure changes over time. This will require updating of maintenance requirements in relation to scheduling and budgeting, as well as corresponding decisions on limiting or expanding the operational use, and resulting predictions of remaining useful service life.

Lifecycle management can evoke risk-based inspection, which rather than using a preset timetable for inspection and structural assessment, establishes inspection intervals on the basis of the probability of deterioration or fatigue fracture and the consequences of such failures. Structural health monitoring is an important part of that process, providing updates based on actual operation and indications of changes in the structure.

Establishment of a digital twin of the structure is a new concept that exploits the capability for structural computations and management of data. A mathematical model of the structure is constructed through finite element modeling, and that model is constantly updated as information from condition assessments, structural hull
monitoring, and other sources such as modification and repairs to the structure is received. This twin can then be used for “what-if” studies of different scenarios of operation, inspection, maintenance, and repair for management of the structure over its lifetime.

Furthermore, such a digital model allows to study the effect of noise and disturbances associated with the measurement system. For a given model with known properties, the accuracy of the estimated properties which are obtained based on application of relevant system identification algorithms can be studied as a function of the noise level. Such studies can be performed offline, and allows required enhancements of the monitoring and measurement systems to be determined. This implies that there will be an optimal “cross-fertilization” between the instrumented physical structure itself and its numerical representation.

For a given number of sensors and a given location, it is accordingly possible to determine the required noise level in order to achieve an adequate prediction accuracy. Conversely, for given sensor properties, the optimal locations and number of sensors can be identified.