Adoption of Structural Analysis Capabilities in an IOT Based Scenario for Connected Assets

Sparshad Kasote(✉), Suvodeep Das, and Santhosh Rao

Sap Labs India Pvt. Ltd., #138, EPIP Zone,
Whitefield, Bengaluru 560066, Karnataka, India
sparshad501@gmail.com

Abstract. This case study showcases the exploration and integration of structural analytical methods into an IOT based scenario which comprises of assets that have structural significance. The work showcased in this study was pursued at Sap Labs, Bengaluru as a part of the Digital Assets and IOT team. It would mainly revolve around the various stages and scenarios that the project underwent. The scenarios considered for the explorations were chosen based on their ability to portray what structural analysis is, and to portray how structural analysis would be critical when integrated in an IOT scenario.

Keywords: User experience · IOT · Structural analysis · Lifetime analysis · Interaction design · Industrial internet · Industry 4.0

1 Introduction

With the rise of Industry 4.0, the ability of Industrial IOT to impact lines of businesses in their fundamentals is growing. We all know that the adoption of Industrial internet is beginning to impact the optimum utilization of an asset and reduce operational cost in respective contexts. This in turn affects the sustainability ecosystem of the industrial scenario [1]. This case study elaborates the intent of the adoption of certain structural simulation technologies in an Industrial scenario. The broad goal of the adoption is to showcase the capability of structural analysis within two scenarios that comprise of connected assets. The structural integrity of these assets plays a critical role for that industry to operate within its digital economy. This capability is expected to enhance the optimum maintenance and operation of assets in their predictive life cycle, under the influence of external factors or natural wear and tear.

The assets that have structural significance in an industrial scenario could be from a large spectrum of sizes. From wind turbines and aircrafts, to oil well heads and railway switches, these assets are largely dependent on their structural integrity to efficiently operate in their respective industry. The adoption of this capability commenced when SAP acquired a dynamic structural simulation technology called ‘FEDEM’ (Finite element dynamics in elastic mechanisms).

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1.1 Structural Analysis Process

The approach used for structural analysis in the capability is the 'FEA' (Finite element analysis) approach. FEA is widely used in the field of mechanical systems to predict and visualize the stress and strain related parameters of a structure [2]. These parameters are then used to predict the useful lifetime of an asset. This method provides real time visualization of the physical state of the structure, which comprises of the fatigue and registered stress cycles. The historic analysis of these cycles estimates the lifetime consumption of the asset.

This is visualized to the user by creating a digital twin of the structure which is actually a digital model of the asset. The stress and strain related data is overlaid on this model based on the information received from the sensors that are mounted on the asset (Fig. 1).

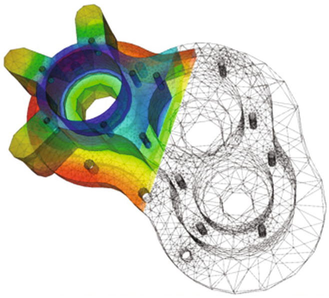

Fig. 1. Finite element model with overlaid stress data.

1.2 Scenarios

The two scenarios considered for showcasing the adoption of this capability were that of a windfarm and a network of railway switches. Both these scenarios were considered for adoption, as they comprised of assets that have their structural integrity as a key performance indicator for that business. The maintenance costs, output efficiencies, safety measures and equipment investment of these scenarios were largely dependent on the structural integrity of their respective assets.

Windfarm Scenario

This scenario consists of a windfarm operator as a persona who is responsible for maintaining a set of windfarms that comprise of wind turbines as assets. With all the assets (wind turbines) being connected, the user is able to monitor the health of an asset and generate optimum maintenance requests, that reduce the total downtime. The stresses and loads experienced by each asset can be analyzed to a component level that in turn drives the maintenance schedules for required instances.

In Fig. 2 we see a map view of a windfarm and a side panel on the right which shows relevant structural alerts of asset components. The user story revolves around the selection and inspection of an asset that needs attention, after which the user generates appropriate maintenance requests that ultimately optimize the lifetime of the asset. We shall see more about lifetime analysis in the following sections.

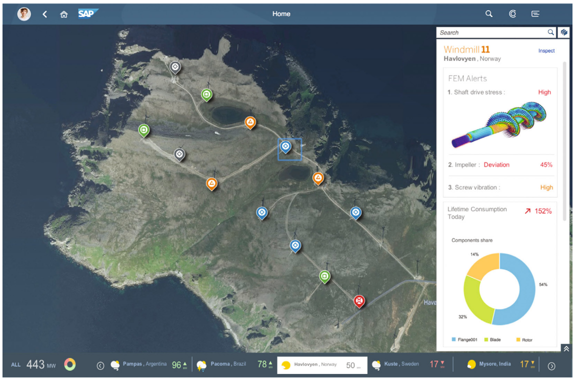

Fig. 2. Map view of a windfarm

Railway Switches Scenario

The scenario catered here is that of a railway network, where the user needs to monitor the railway switches in the respective railway cluster. The lifetime consumption of these switches is monitored and maintenance requests are scheduled efficiently. Figure 3 shows the railway switch cluster map that is shown to the user who is a railway switch operator.

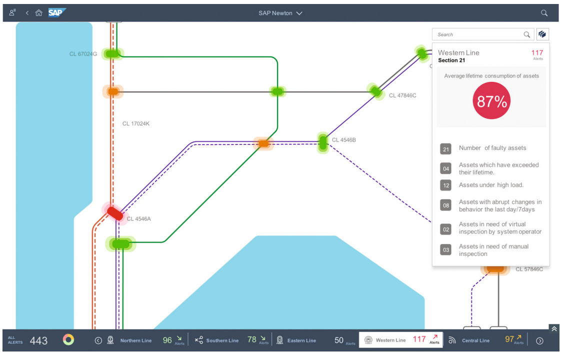

Fig. 3. Railway switch cluster map

2 Framework Approach and Discussion

To cater both the scenarios, a common framework was devised. Figure 4 shows the activity flow diagram of one of the use cases in the framework (windfarm).

Fig. 4. Activity flow

In the flow, the "digital inspection" and the "lifetime observation" steps showcase the structural capability of the adoption. Digital inspection is done with the alerts being played as a structural visualization on the 3D model of the asset. Figure 5 shows the lifetime consumption time series of the asset or component, where the expected life can be optimized by scheduling appropriate maintenances.

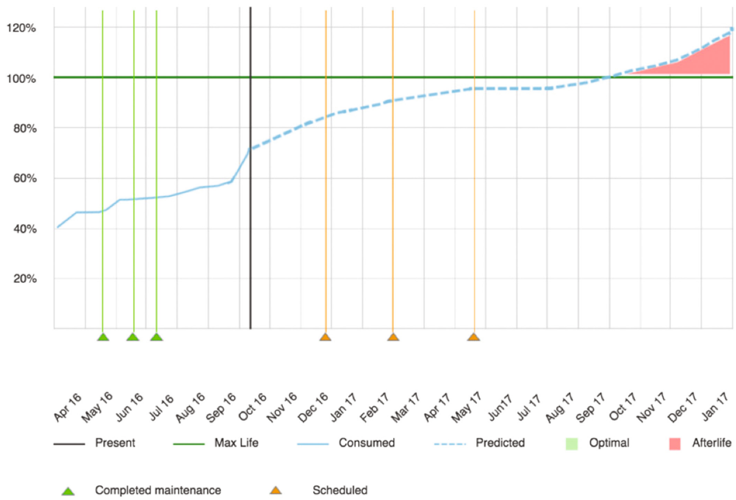

Fig. 5. Lifetime consumption time series

The framework devised in this adoption could be integrated in various industrial 4.0 scenarios in the future. With this framework, constructive measures could be taken to possibly reduce the maintenance cost and equipment investment and increase the operating efficiency of a large gamut of Industrial IOT scenarios. There also lies a vast opportunity in exploring this adoption for not only industrial but also consumer scenarios in which products or assets have structural significance.

References

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