Health Index Development of An Engineering Asset

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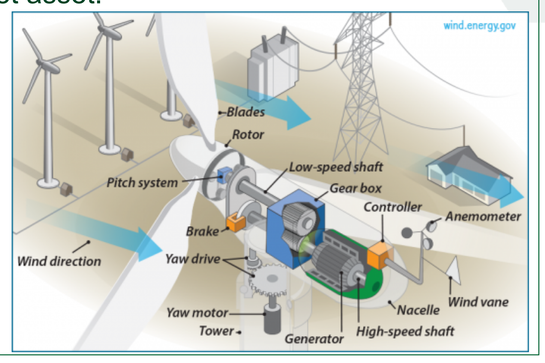
BACKGROUND

Engineering assets are used for energy generation and delivery. These assets include infrastructure assets such as transmission lines, pipelines, and transformers. They also include wind turbines and thermal power generation stations. All such assets require proper design, construction, operation, and maintenance. To maximize their effectiveness over their lifecycles, condition monitoring is used and proper health indexes (HI) can be developed utilizing such condition monitoring data. In this study, we use wind turbine gearbox (WTG) as a target asset.

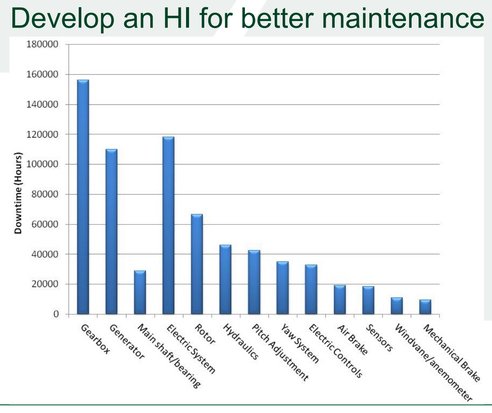


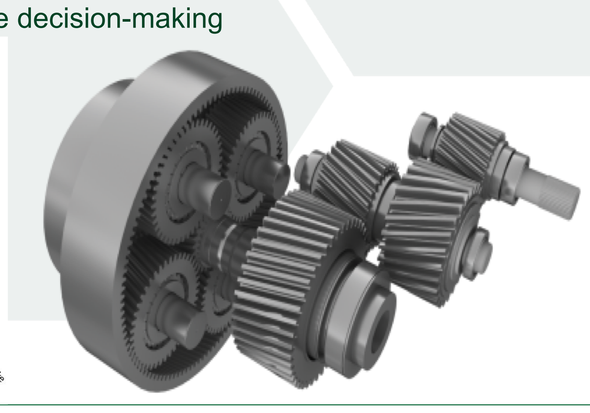
AIMS AND OBJECTIVES

AIM Develop an HI of WTGs considering multiple condition monitoring features for cost-effective maintenance of WTGs

OBJECTIVES

- Investigate the effect of multiple condition monitoring features in reflection of WTG degradation
- Develop an HI for better maintenance decision-making





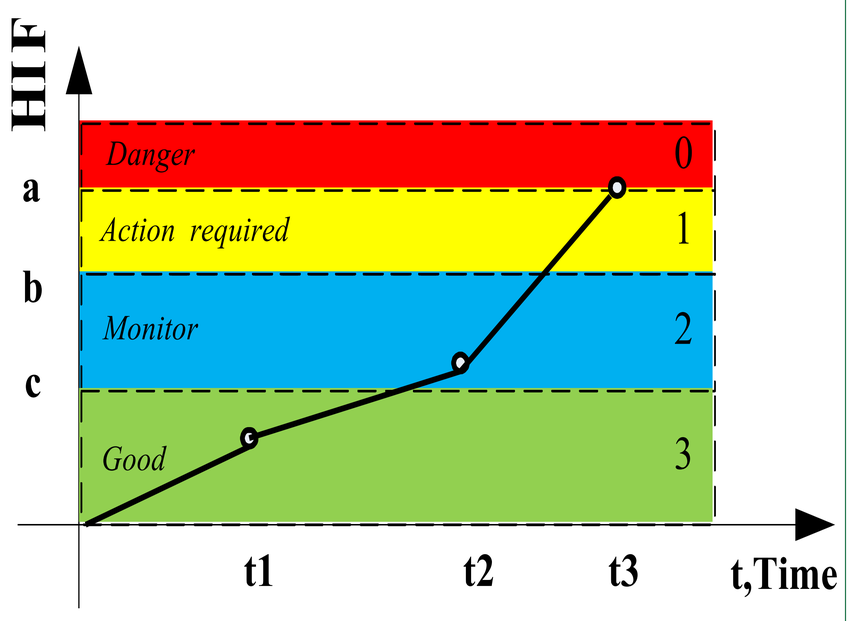
RESULTS

HEALTH INDEX FACTORs OF MULTIPLE CONDITION MONITORING FEATURES

We use health index factors (HIF) as one of many health condition measures which are derived from certain types of condition monitoring data. HIF may take four integer values, 3, 2, 1, and 0, meaning that the health condition to be “Good”, “Monitor”, “Action required”, and “Danger”, respectively. The thresholds between two regions are determined by maintenance work orders from WTGs, engineering standard (e.g. ISO, ASTM, etc.) for WTGs, and/or experiment observations of WTGs.

HEALTH INDEX OF WIND TURBINE GEARBOXES

Each engineering asset is composed of many components. How to obtain a good HI for the whole asset from multiple HIFs depends on two factors: (1) how the components are connected to constitute the asset system: and (2) which component(s)’ health condition the HIF is reflecting. For example, our target asset WTG has three critical components : bearings, planetary gears, fixed-shaft gears. We think these three groups of components are connected in series in their logical relationship. The HI of the WTGs should be dominated by the weakest component. WTGs are usually monitored by vibration, acoustic emission, oil debris, and gear lubrication temperature. Vibration and acoustic emission monitoring can reflect the health condition of bearings, planetary gears, and fixed-shaft gears. Oil debris and gear lubrication oil temperature can also reflect the health of these three components. How to integrate these HIFs and develop an effective HI of WTG will be addressed in the next step.



FUTURE DIRECTIONS

HI DEVELOPMENT AND COST-EFFECTIVE MAINTENANCE OF WTG

The next stage work is to investigate effective HIFs in detail. Candidate HIFs based on literature review are vibration features, acoustic emission features, oil analysis features, temperature monitoring features, and performance monitoring features. Candidate indicators for the candidate HIFs will be selected and condition monitoring data collected from WTG will be tested. In addition, the relationship between a HIF and a type of failure mode of a component will be investigated. A comprehensive HI model for WTG will be developed, and optimized maintenance decision may be made based on the HI of WTG.

FUTURE FES MILESTONE

Development of HI for measuring health condition and performance of WTG risk conditions and failures and optimizing operation and maintenance for other non-electrical infrastructure assets.

PARTNERS

FUTURE EXTERNAL PARTNERS

Our future external partners may include the following

- Colleagues at NAIT
- Colleagues at other Canadian Universities
- International Colleagues
- Industry partners currently collaborating with us on applied research
- New industry partners

FES PROJECT OVERVIEW

T11-P01 Decision support systems for improved construction and maintenance of non-electrical infrastructure for energy

The processes of constructing, operating and maintaining long-life energy infrastructure assets, involve many complex risks. Developing effective health indicators for such assets will help assess and mitigate such risks. Data required for HI model validation may be limited or may not exist and so expert knowledge will be required for effective decision-making.

To address these issues, innovative modeling and decision-making approaches will be developed to address the unique characteristics of energy projects (e.g. WTGs), deal with new types of risks, and address data limitations in developing and validating models and decision-support tools.

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