N86-30204

DATA PRESENTATION TECHNIQUES FOR ROTATING MACHINERY MALFUNCTION DIAGNOSIS

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Modern industrial processes demand operation of rotating machinery over a wide range of pressures, temperatures, and flow rates. This variety of operating conditions dictates a similarly large distribution of machinery types and mechanical configurations. Although the variables involved are extensive, a common focal point appears when reliability and mechanical integrity are discussed. In all cases, it is economically favorable to evaluate the on-stream mechanical condition of the process machinery. Furthermore, when problems do appear, the early detection and diagnosis of the malfunction is not only desirable, but often mandatory. In the pursuit of parameters to accurately access mechanical condition, the measurement of machine vibration characteristics has consistently proven to be a powerful tool.

Successful vibration measurement and analysis requires that the vibration signals must be reduced to hard copy data for engineering evaluation. The format utilized for data presentation can enhance the information, yielding a direct identification of the occurring mechanism.

Baseline steady-state data is excellent for documentation of vibration signals at normal operating conditions. Assuming that a set of initial data was acquired with the machinery in a good state of repair, any future changes or deterioration in mechanical condition can be easily compared to the baseline information. Often this type of comparison will yield sufficient information for evaluation of the problem. However, many malfunctions require the analysis of transient data in order to identify the malfunction.

Steady-state data formats consist of:

- Time Base Waveform
- Orbit
- Spectrum

Transient data formats consist of

- Polar
- Bodé
- Cascade

OBJECTIVE

Our objective is to demonstrate the use of the above formats to diagnose a machine malfunction. A turbine-driven compressor train is chosen as an example. The machine train outline drawing is shown as Figure 1.

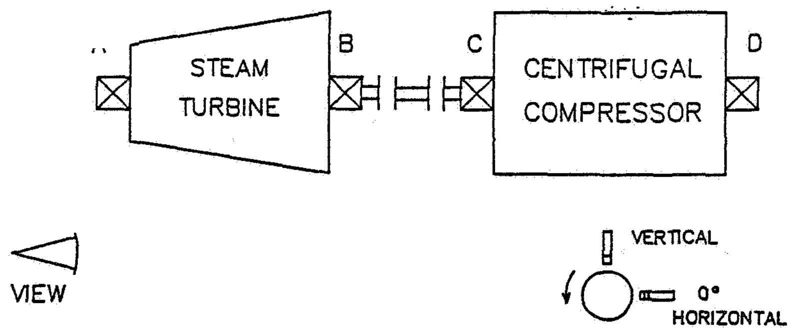


Figure 1. - Machine outline drawing.

Vibration data taken during start-up from the X-Y proximity probes at the "C" bearing has been stored in digitized form in the computer. The ADRE® transient software will be used to produce Bodé, Polar, and Cascade plots from the horizontal transducer. Copies of these plots are given as Figures 2 through 5.

ANALYSIS

Observation of the filtered synchronous amplitude and phase information on the Bodé (Figure 2) indicates that the synchronous vibration amplitudes are low and that the first balance resonance occurs in the region from 4750 to 7000 rpm.

The polar plot (Figure 3) confirms this data.

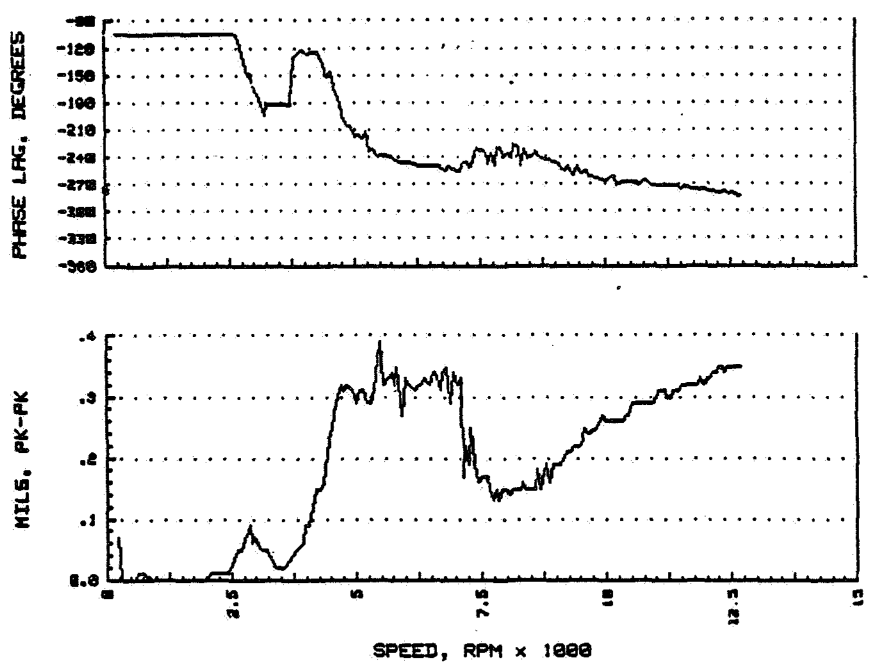


Figure 2. - Bodé plot of compressor inboard horizontal response.

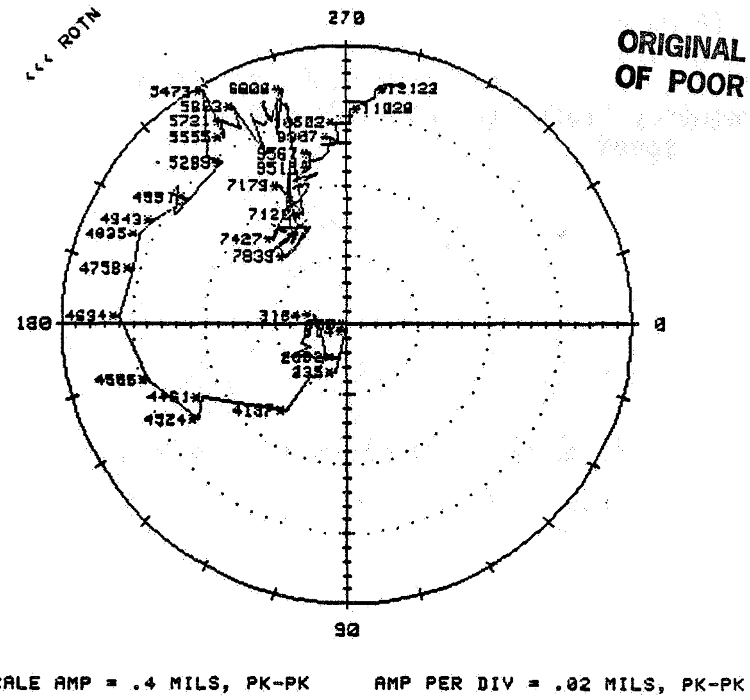


Figure 3. - Polar plot of compressor inboard horizontal response.

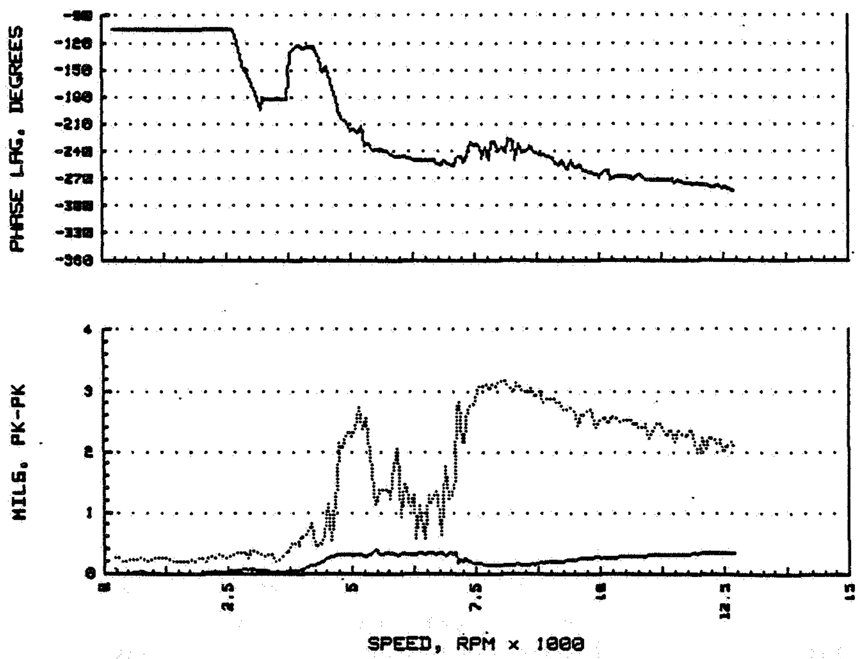


Figure 4. - Bodé plot of compressor inboard horizontal response with unfiltered vibration versus speed plot superimposed.

Figure 4 is a Bodé plot with a graph of unfiltered amplitude versus running speed superimposed. The unfiltered amplitude substantially exceeds the synchronous throughout the speed range. This indicates that the malfunction is not related to synchronous vibration.

The cascade plot (Figure 5) presents the same start-up data in the frequency domain format. Analysis of this data indicates that vibration occurs at a frequency of approximately 50% of running speed from 5,000 rpm to 8,000 rpm. After 8,000 rpm, the vibration frequency "locks-in" at 4,200 cpm and no longer increases with an increase of running speed.

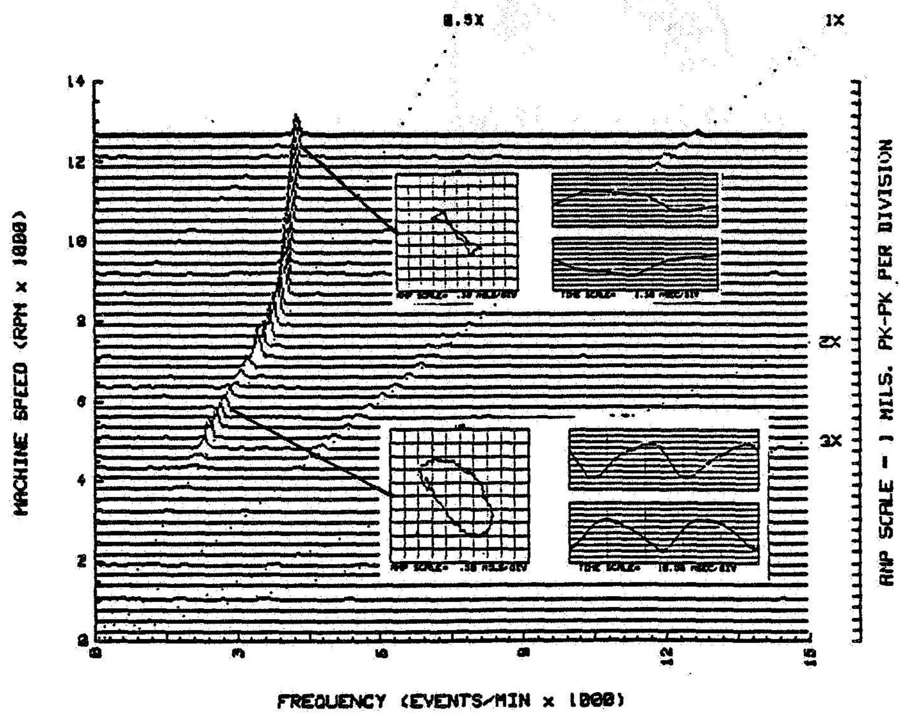
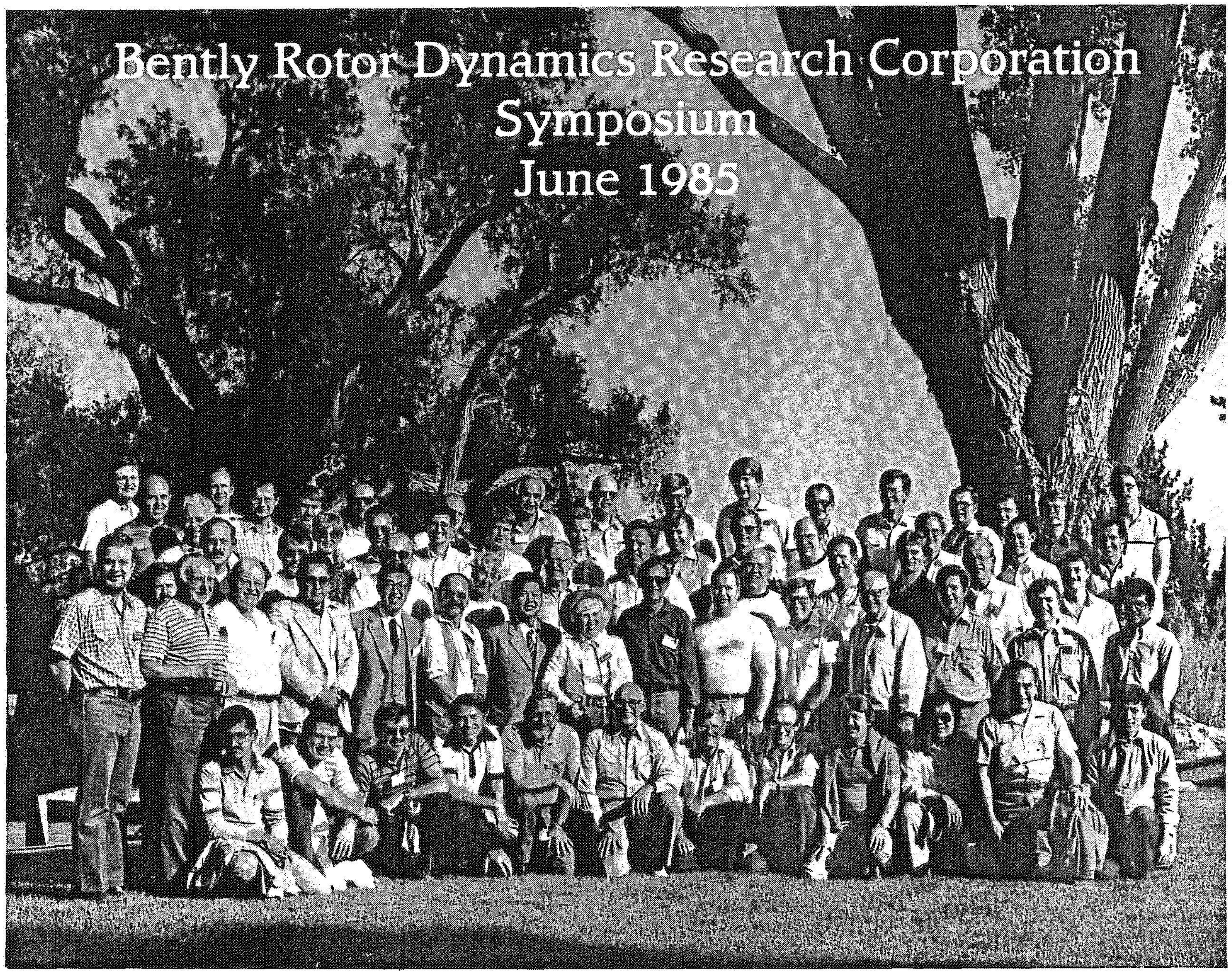


Figure 5. - Cascade spectrum plots of compressor inboard horizontal response.

The orbit plots taken at 5,000 rpm and 12,600 rpm, superimposed on the cascade plot, show the characteristic multiple keyphasor per revolution associated with "oil whirl" and "oil whip," respectively.

CONCLUSION

It is apparent that a wide variety of data presentation techniques are available to the machinery diagnostician. Since mechanical malfunctions have a tendency to disguise themselves with side effects and misleading disturbances, it is essential that the acquired data be reviewed in every reasonable manner prior to forming a conclusion. Failure to perform this additional work will commit the machinery diagnostician to a life of treating symptoms rather than identifying and solving the basic problems.


Bently Rotor Dynamics Research Corporation
Symposium
June 1985