Methods for Validation of a Turbomachinery Rotor
Blade Tip Timing System

Todd M. Pickering

Thesis submitted to the faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Master of Science
In
Mechanical Engineering

Walter F. O’Brien, Chair
Robert L. West
Alfred L. Wicks

March 4, 2014
Blacksburg, Virginia

Keywords: Blade Tip Timing, Non-Intrusive Stress Measurement System, Turbomachinery, Optical Sensor, Piezoelectric

Copyright 2014, Todd M. Pickering
Todd Pickering - Methods for Validation of a Turbomachinery Rotor

Blade Tip Timing System

Summary of Copyright Status of External Figures Included in Thesis

Figure 1: AFRL (US Air Force) Public Report, Unlimited Distribution -> Public Domain
Figure 2: NASA Public Report, Unlimited Distribution -> Public Domain
Figure 3: NPS (Navy) Public Report, Unlimited Distribution -> Public Domain
Figure 4: See attached -> Fair Use
Figure 5: See attached -> Fair Use
Figure 6: NPS (US Navy) Public Report, Unlimited Distribution -> Public Domain
Figure 7: See attached -> Fair Use
Figure 9: See attached -> Fair Use
Figure 10: See attached -> Fair Use
Figure 11: See attached -> Fair Use
Figure 27: See attached -> Fair Use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: TODD PICKERING


Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: TODD PICKERING


Report generated on: 03-30-2014 at 16:17:23

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: TODD PICKERING

Description of item under review for fair use: Figure 2; I. Goltz, H. Böhmer, R. Nollau, J. Belz, B. Grueber and J. Seume, "Piezo-Electric Actuation of Rotor Blades in an Axial Compressor".

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: TODD PICKERING

Description of item under review for fair use: Figure 2 and 3; P. Prevéy, D. Hornbach, J. Cammett and R. Ravindranath, "Damage Tolerance Improvement of Ti-6-4 Fan Blades with Low Plasticity Burnishing," in 6th Joint FAA/DoD/NASA Aging Aircraft Conference, 2002.

Report generated on: 03-30-2014 at: 16:25:24

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: TODD PICKERING

Description of item under review for fair use: Figure 7; G. Morse, "Analysis of Engine Damage - Engine SN 451-133," Failure Analysis Service Technology, Inc, 2007.

Report generated on: 03-30-2014 at : 16:27:57

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: TODD PICKERING


Report generated on: 03-30-2014 at : 16:31:00

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3

Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use
Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: TODD PICKERING
Figure 27 in my thesis

Description of item under review for fair use: Figure 3; Omega Engineering Inc., "DMD-465WB Bridgesensor AC Powered Signal Conditioner," 1999.

Report generated on: 03-30-2014 at : 16:35:07

Based on the information you provided:

Factor 1
Your consideration of the purpose and character of your use of the copyright work weighs: in favor of fair use

Factor 2
Your consideration of the nature of the copyrighted work you used weighs: in favor of fair use

Factor 3
Your consideration of the amount and substantiality of your use of the copyrighted work weighs: in favor of fair use

Factor 4
Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: in favor of fair use

Based on the information you provided, your use of the copyrighted work weighs: in favor of fair use