NICHOLAS EARNHART
Georgia Institute of Technology

Degrees:

- BS, Purdue University, 2007
- MS, Georgia Institute of Technology, 2009
- PhD, Georgia Institute of Technology, 2012

Scholar Donors:

Frannie and Bill Graves

About the Scholar:

For his graduate work, Dr. Earnhart investigated microstructured, engineered materials for noise control for fluid power systems. Fluid power is advantageous for its power density, among other benefits, but is known for undesirable noise. A challenge for addressing fluid-borne noise (which couples with structure-borne noise to create air-borne noise) is that hydraulic fluid has a high speed of sound and the fundamental frequency of noise generated by pumps is very low, resulting in very long wavelengths of sound. Furthermore, noise control devices typically used for systems with air such as Helmholtz resonators and tuning coils scale in size with the speed of sound, and unmodified, are impractically large for use in fluid power systems. The materials being investigated are novel for being very compliant at high pressure, which when used in resonant devices as mentioned earlier allows them to scale down in size by up to two orders of magnitude. This makes noise control of a hydraulic system much more practical. Further investigation of the material behavior includes the dependence of pressure, temperature, and the structure of the material on the compliance, and thus, the efficacy of the device.

Benefits to Society:

While fluid power has many advantages such as power density and scalability, a downside to its use is often noise. Noise is a barrier-to-entry for both existing fluid power technology in new markets and for new fluid power technology. For example, fluid power is difficult to implement in noise-sensitive environments like the home or in prostheses worn on the body. Noise is also a deterrent to new fluid power technologies such as “digital” pumps and valves, which promise greater efficiencies but by their nature generate large pressure fluctuations, which results in increased noise. Also, technologies such as hydraulic hybrid vehicles where the NVH (noise, vibration, and harshness) properties need to be tuned to a market accustomed to cars with conventional powertrains.

Treatment of the fluid-borne noise produced by pumps and valves in fluid power systems with the microstructured, engineered materials being investigated in this research will subsequently reduce structure-borne noise and thus air-borne noise. Creating quieter systems will allow system and device designers to take advantage of the benefits of fluid power.

Awards and Honors:

- Georgia Tech President’s Fellowship, 2007-2011
- Leo Beranek Student Medal for Excellence in the Study of Noise Control, 2012
- Distinguished Paper, 7th FPNI PhD Symposium, 2012
- Best Poster, North Carolina ASA Poster Competition
- Best Poster, Georgia Institute of Technology ASA Royster Competition

Publications and Posters:

Archival Publications

1. Earnhart, N.E. “Modeling and validation of a syntactic foam lining for noise control devices for fluid power systems.” PhD Thesis. 2012.
2. Marek, K.A., Earnhart, N.E. and Cunefare, K.A. “Analytical model for a cylindrical in-line hydraulic silencer with a solid compressible liner.” Journal of Sound and Vibration. Manuscript in review.
3. Earnhart, N.E. and Cunefare, K.A. “Compact Helmholtz resonators for hydraulic systems.” International Journal of Fluid Power. Vol. 13 (2012) No. 1, pp. 41-50.

Refereed Conference Publications

1. Earnhart, N.E., Marek, K.A., and Cunefare, K.A. “The role of compliance in devices for reduction of fluid-borne noise. Proceedings of the 7th FPNI PhD Symposium on Fluid Power, Reggio Emilia, Italy, 27-29 June 2012. CD Proceedings.
2. Marek, K.A., Earnhart, N.E., and Cunefare, K.A. “Compliant-wall methods for fluid-borne noise reduction.” Proceedings of the 162nd Meeting of the Acoustical Society of America, San Diego, CA, 31 October – 4 November 2011.
3. Cunefare, K.A., Earnhart, N.E., Walsh, M., Erdirisinghe, R., Marek, K.A. “Noise control devices for fluid systems.” Proceedings of NoiseCon 2011, July 25-27, Portland, OR, 2011. CD Proceedings.
4. Earnhart, N.E. Marek, K.A. and Cunefare, K.A. “Passive Noise Control in Fluid Power.” 52nd National Conference on Fluid Power, Las Vegas NV, March 2011. CD Proceedings.
5. Earnhart, N.E., Marek, K.A. and Cunefare, K.A. “Novel, Compact Devices for Reducing Fluid-Borne Noise.” Proceedings of 2011 SAE Noise and Vibration Conference, Paper No. 11NVC-0138, Grand Rapids, MI May 2011. CD Proceedings.
6. Earnhart, N.E., Marek, K.A. and Cunefare, K.A. “Modeling and validation of an in-line hydraulic silencer.” Proceedings of the 6th FPNI – PhD Symposium, West Lafayette IN 2010. Vol. 1, p. 101-113. CD Proceedings.
7. Earnhart, N.E., Marek, K.A. and Cunefare, K.A. “Evaluation of hydraulic silencers.” Proceedings of NoiseCon 2010, joint with the 159th Meeting of the Acoustical Society of America, Baltimore, MD, 19-23 April, 2010. CD Proceedings.
8. Marek, K.A., Earnhart, N.E. and Cunefare, K.A. “Model for the design of a hydraulic silencer with a dispersive liner.” Proceedings of NoiseCon 2010, joint with the 159th Meeting of the Acoustical Society of America, Baltimore, MD, 19-23 April, 2010. CD Proceedings.
9. Earnhart, N.E., Marek, K.A. and Cunefare, K.A. “Evaluation of hydraulic silencers.” Proceedings of the 158th Meeting of the Acoustical Society of America, San Antonio, TX, 26-30 October 2009.
10. Marek, K.A., Earnhart, N.E., Cunefare, K.A. “Numerical model for a hydraulic in-line silencer with dispersive lining.” Proceedings of the 158th Meeting of the Acoustical Society of America, San Antonio, TX, 26-30 October 2009.

Other Publications

1. Earnhart, Nicholas E. and Cunefare, Kenneth A. “Cancelling noise at its source.” Hydraulics & Pneumatics Magazine, August 2011.