**John B. Heywood**

## Education:

B.A., Cambridge University, 1960; S.M., 1962, and Ph.D., Massachusetts Institute of Technology, 1965.

## Experience:

Research Officer, 1965-1967, Group Leader, 1967-1968, Central Electricity Generating Board, UK.
Department of Mechanical Engineering, Massachusetts Institute of Technology, 1968-present
Assistant Professor, 1968-70; Associate Professor, 1970-76; Professor, 1976-1992;
Sun Jae Professor, 1992-2009
Director, Sloan Automotive Laboratory, 1972-2009
Co-Director, Leaders for Manufacturing Program, 1991-1993
Co-Director, Ford-MIT Alliance, 2003–2009
Currently, Professor of Mechanical Engineering

## Professional Interests:

Engines, combustion, air pollution, energy and fuels, engineering education, transportation technology

## Awards:

Ayreton Premium, Inst. of Electrical Engineers, 1969
Ralph R. Teetor Award, Society of Automotive Engineers, 1971, 1999
Arch T. Colwell Merit Award, Society of Automotive Engineers, 1973, 1981, and 1989
Mellon Overseas Fellow, Churchill College, Cambridge University, 1976-1977
Elected Fellow of Society of Automotive Engineers, 1982
Sc.D., Cambridge University, Cambridge, England, 1983
Society of Automotive Engineers Horning Memorial Award, 1983
Freeman Scholar for 1986, American Society of Mechanical Engineers
Honda Lecturer, 1990, American Society of Mechanical Engineers
U.S. DOT National Award for the Advancement of Motor Vehicle Research and Development, 1996
George Stephenson International Lecturer, Institution of Mechanical Engineers, 1997
Elected Member National Academy of Engineering, 1998
Doctor of Technology honoris causa, Chalmers University of Technology, Sweden, 1999
Soichiro Honda Medal, 1999, American Society of Mechanical Engineers
Elected Fellow of American Academy of Arts and Sciences, 2001
Society of Automotive Engineers Award for Research on Automotive Lubricants, 2002
Doctor of Science honoris causa, City University, UK, 2004
SAE Barry McNutt Award for Contributions to Automotive Policy, 2008

**Professional Activities:**

Member, American Society of Mechanical Engineers
Fellow, Institution of Mechanical Engineers
Fellow, Society of Automotive Engineers
Member, Distinguished Advisors' Panel, Auto/Oil Air Quality Improvement Program, 1989-96
Member, Advisory Panel, WBCSD Sustainable Mobility Project, 2002-04
Member of several NRC Study Committees, including the recent "America's Energy Future" Committee
2007-2009

**Books:**

1. Open-Cycle MHD Power Generation, edited by Heywood, J.B. and Womack, G.J., Pergamon, 1969.
2. Grad, F.P., Rosenthal, A.J., Rockett, L.R., Fay, J.A., Heywood, J.B., Kain, J.F., Ingram, G.K., Harrison, Jr., D. and Tietenberg, T., The Automobile and the Regulation of its Impact on the Environment, University of Oklahoma Press, 1975.
3. Internal Combustion Engine Fundamentals, Heywood, J.B., McGraw-Hill, 1988.
4. The Two-Stroke Cycle Engine: Its Development, Operation and Design, Heywood, J.B., and Sher, E., SAE and Taylor & Francis, 1999.
5. Transportation in a Climate-Constrained World, Schafer, A., Heywood, J.B., Jacoby, H.D. Waitz, I.A., MIT Press, 2009.

**Publications (last five years):**

Author or co-author of over 200 publications in journals and conference proceedings.

Ivanic, Z., Ayala, F., Goldwitz, J., and Heywood, J.B., "Effects of Hydrogen Enhancement on Efficiency and $NO_x$ Emissions of Lean and EGR-Diluted Mixtures in a SI Engine," SAE Paper 2005-01-0253, presented at the 2005 SAE World Congress, Detroit, MI, April 11-14, 2005.

Goldwitz, J.A., and Heywood, J.B., "Combustion Optimization in a Hydrogen-Enhanced Lean-Burn SI Engine," SAE Paper 2005-01-0251, presented at the 2005 SAE World Congress, Detroit, MI, April 11-14, 2005.

Costanzo, V.S., and Heywood, J.B., "Mixture Preparation Mechanisms in a Port Fuel Injected Engine," SAE paper 2005-01-2080, presented at the SAE Fuels and Lubricants Meeting, Rio de Janeiro, Brazil, May 11-13, 2005.

Gerty, M.D., and Heywood, J.B., "An Investigation of Gasoline Engine Knock Limited Performance and the Effects of Hydrogen Enhancement," SAE paper 2006-01-0228, presented at the SAE 2006 World Congress, Detroit, MI, April 3-6, 2006.

Ayala, F.A., Gerty, M.D., and Heywood, J. B., "Effects of Combustion Phasing, Relative Air-Fuel Ratio, Compression Ratio, and Load on SI Engine Efficiency," SAE paper 2006-01-0229, SAE Trans., Jrnl. of Engines, V115-3, presented at the SAE 2006 World Congress, Detroit, MI, April 3-6, 2006.

Ivanic, Z., and Heywood, J.B., "Predicting the Behavior of a Hydrogen-Enhanced Lean-Burn SI Engine Concept," SAE paper 2006-01-1106, presented at the SAE 2006 World Congress, Detroit, MI, April 3-6, 2006.

Schafer, A., Heywood, J.B., and Weiss, M.A., "Future Fuel Cell and Internal Combustion Engine Automobile Technologies: A 25-Year Life Cycle and Fleet Impact Assessment," Elsevier, Energy, pp. 1728-1751, 31, 2006.

Heywood, J.B., "Fueling Our Transportation Future," Scientific American, Vol. 295, No. 3, September 2006.

Lee, D., and Heywood, J.B., "Effects of Charge Motion Control During Cold Start of SI Engines," SAE paper 2006-01-3399, presented at the SAE Powertrain & Fluid Systems Conference & Exhibition, Toronto, Canada, Oct. 16-19, 2006.

Mittal, V., Revier, B.M., and Heywood, J.B., "Phenomena that Determine Knock Onset in Spark-Ignition Engines," SAE paper 2007-01-0007, SAE Fuels and Lubricants Meeting, Cape Town, S. Africa, January 23-25, 2007, SAE 2007 Transactions Journal of Engines.

Kasseris, E.P., and Heywood, J., "Comparative Analysis of Automotive Powertrain Choices for the Next 25 Years," SAE paper 2007-01-1605, SAE World Congress, Detroit, MI, April 16-19, 2007, Transactions, V. 116, Journal of Fuels & Lubricants, Section 4.

Ayala, F.A., and Heywood, J.B., "Lean SI Engines: The Role of Combustion Variability in Defining Lean Limits," ICE2007 – 8th International Conference on Engines for Automobile, SAE Paper 2007-24-0030, SAE Naples Section/SAE International, Capri, Naples, Italy, September 16-20, 2007.

Kromer, M.A., and Heywood, J.B., "A Comparative Assessment of Electric Propulsion Systems in the 2030 U.S. Light-Duty Vehicle Fleet," SAE Paper 2008-01-0459, SAE World Congress, Tory, MI, April 14-17, 2008, Int. Journal of Engines 1(1): 372-391, 2008.

Cheah, L., Bandivadekar, A., Bodek, K., Kasseris, E. and Heywood, J., "The Trade-off between Automobile Acceleration Performance, Weight, and Fuel Consumption", SAE, 2008-01-1524, SAE International Powertrains, Fuels and Lubricants Congress, Shanghai, China, June 23-25, 2008, SAE Int., J. Fuels Lubr. 1(1): 771-777, 2008.

Cheah, L., Heywood, J., and Kirchain, R., "Aluminum Stock and Flows in the U.S. Light-Duty Vehicle Fleet and Implications on the Material Cycle Energy Use,"Journal of Industrial Ecology, August, 2008.

Mittal, V., Heywood, J.B., "The Relevance of Fuel RON and MON to Knock Onset in Modern SI Engines," SAE 2008-01-2414, SAE Powertrains, Fuels & Lubricants Meeting, Rosemont, IL, October 7-9, 2008.

Hardy, A.J.J., Heywood, J.B., and Kenney, T.E., "Fuel Economy Benefits and Aftertreatment Requirements of a Naturally Aspirated HCCI-SI Engine System, SAE 2008-01-2512, SAE Powertrains, Fuels & Lubricants Meeting, Rosemont, IL, October 7-9, 2008, SAE Int. J. Engines 1(1): 1263-1277, 2008.

Evans, C., Cheah, L., Bandivadekar, A., and Heywood, J.B., "Getting More Miles per Gallon," Issues in Science and Technology, Volume XXV, Number 2, 2009.

Cheah, L., Evans, C., Bandivadekar, A., and Heywood, J., "Factor of Two: Halving the Fuel Consumption of New U.S. Automobiles by 2035," Chapter 4 in *Reducing Climate Impacts in the Transportation Sector*, Eds., D. Sperling and J. Cannon, Springer, 2009.

Heywood, J.B., and Welling, O.Z., "Trends in Performance Characteristics of Modern Automobile SI and Diesel Engines," SAE 2009-01-1892, SAE International Powertrains, Fuels & Lubricants Meeting, Florence, Italy, June 15-17, 2009.

Cheah, L., Heywood, J.B., and Kirchain, R., "Aluminum Stock and Flows in the U.S. Light-Duty Vehicle Fleet and Implications on the Material Cycle Energy Use," Journal of Industrial Ecology, August, 2008.

Schäfer, A., Jacoby, H.D., Heywood, J.B., and Waitz, I.A., "The Other Climate Threat: Transportation," American Scientist, pp. 476-483, November-December 2009.

Mittal, V., and Heywood, J.B., "The Shift in Relevance of Fuel RON and MON to Knock Onset in Modern SI Engines Over the Last 70 Years," SAE Paper 2009-01-2622, SAE 2009 Powertrains, Fuels & Lubricants Meeting, San Antonio, TX, November 2-4, 2009.

Heywood, J., Baptista, P., Berry, I., Bhatt, K., Cheah, L., de Sisternes, F., Karplus, V., Keith, D., Khusid, M., MacKenzie, D., and McAulay, J., "An Action Plan for Cars: The Policies Needed to Reduce U.S. Petroleum Consumption and Greenhouse Gas Emissions," An MIT Energy Initiative Report, December, 2009.

Mittal, V., Heywood, J.B., and Green, W.H., "The Underlying Physics and Chemistry behind Fuel Sensitivity," presented at the SAE World Congress, Detroit, MI, April 13-15, 2010, SAE paper 2010-01-0617. Also in SAE SP-2278.

McAulay, J., and Heywood, J.B., "Coordinated Strategies for Ethanol and Flex Fuel Vehicle Deployment: A Quantitative Assessment of the Feasibility of Biofuel Targets," SAE paper 2010-01-0735, presented at the SAE World Congress, Detroit, MI, April 13-15, 2010.

Heywood, J.B., "Assessing the Fuel Consumption and GHG Emissions of Future In-Use Vehicles," paper presented at the PEA-AIT International Conference on Energy and Sustainable Development (ESD 2010), Chiang Mai, Thailand, June 2-4, 2010.

**Recent Major Reports:**

Bandivadekar, A.P., and Heywood, J.B., "Coordinated Policy Measures for Reducing the Fuel Consumption of the U.S. Light-Duty Vehicle Fleet," MIT LFEE 2004-002 RP, http://lfee.mit.edu/publications/PDF/LFEE_2004-001_RP.pdf, in Sperling, D., and Cannon, J. (Editors), Driving Climate Change: Cutting Carbon from Transportation, Elsevier Academic Press, pp. 41-72, September, 2006.

Groode, T. "Review of Corn Based Ethanol Energy Use and Greenhouse Gas Emissions," June, 2006, LFEE Report 2007-01 RP.

Groode, T. A. and Heywood, J.B., "Ethanol: A Look Ahead," June, 2007, LFEE Report 2007-02 RP.

Kromer, M. A. and Heywood, J.B., "Electric Powertrains: Opportunities and Challenges in the U.S. Light-Duty Vehicle Fleet" June, 2007, LFEE Report 2007-03 RP.

Cheah, L., Evans, C., Bandivadekar, A., and Heywood, J.B., "Factor of Two: Halving the Fuel Consumption of New U.S. Automobiles by 2035," October, 2007, LFEE Report, 2007-04 WP.

Bandivadekar, A., Bodek, K., Cheah, L., Evans, C., Groode, T., Heywood, J., Kassereis, E., Kromer, M., Weiss, M., "On the Road in 2035: Reducing Transportation's Petroleum Consumption and GHG Emissions," MIT Laboratory for Energy and the Environment, Report No. LFEE 2008-05 RP, July 2008.

Heywood, J., Baptista, P., Berry, I., Bhatt, K., Cheah, L., de Sisternes, F., Karplus, V., Keith, D., Khusid, M., MacKenzie, D., and McAulay, J., "An Action Plan for Cars: The Policies Needed to Reduce U.S. Petroleum Consumption and Greenhouse Gas Emissions," An MIT Energy Initiative Report, December 2009.

Cheah, L., Heywood, J.B., and Kirchain, R., "The Energy Impact of U.S. Passenger Vehicle Fuel Economy Standards," paper presented at IEEE International Symposium on Sustainable Systems and Technology Conference, Washington, D.C., May 17-19, 2010.

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