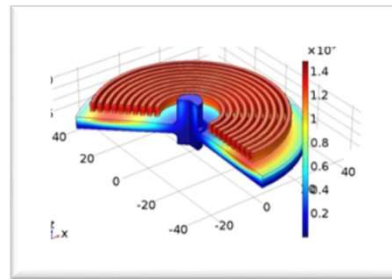
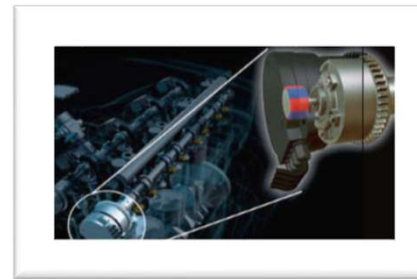


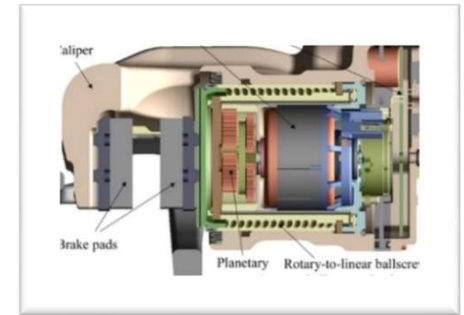
**Hybrid utility truck**  
Source: eaton.com



**Thompson-coil circuit breaker**  
Source: IEEE ECCE 2015



**Electric cam phaser**  
Source: Delphi (IEEE MTZ Zeitschrift, 2012)



**Electric brake**  
Source: Delphi (IEEE IAS Mag, 2009)

# Bruno Lequesne, PhD, Fellow IEEE

## E-Motors Consulting, LLC

[www.emotorseng.com](http://www.emotorseng.com)



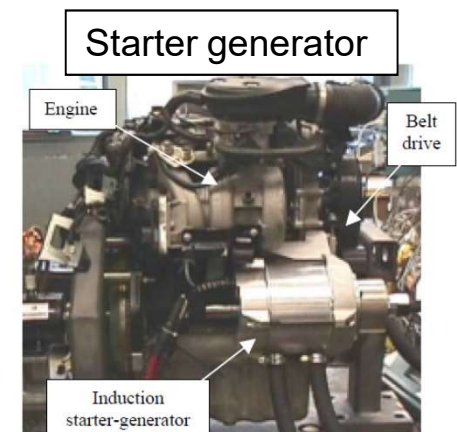
# Employment history

- 40+ years in automotive research and advanced engineering
- Independent consultant (E-Motors Consulting, LLC): 2014
- Eaton: 2010-2014
- University of Alabama: 2009-2010
- Delphi Research, Delphi Advanced Powertrain Group: 1999-2009
- General Motors Research Labs: 1984-1999
- Chair, IEEE Transportation Electrification Community (2019-2020)
- President, IEEE- Industry Applications Society: 2011-2012
- Education, Electrical Engineering:
  - Missouri University of Science and Technology, PhD, 1984
  - Ecole Supérieure d'Electricité, France, 1978

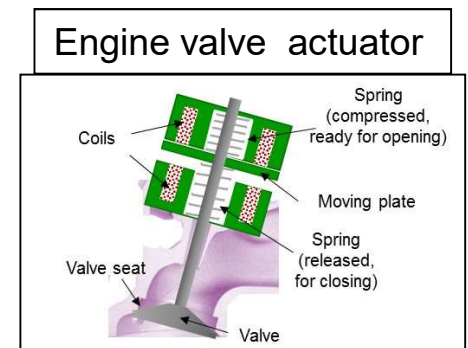


# Expertise: Electric drives and electromagnetism

- Electric machine design
  - Permanent magnet and induction motors as a consultant
  - Permanent magnet motors (e.g, for valve actuation, while at GM)
  - Induction motor (e.g., starter-generator, at GM, Delphi)
  - Switched reluctance motor controls (e.g., for brakes, at Delphi)
- Linear actuators
  - Linear motors, oscillatory actuators (e.g., valve actuators, at GM)
  - Control solenoids (e.g., fuel injectors, at GM)
- Sensor concepts
  - Position, based on Hall effect or variable reluctance (e.g., ABS, engine position, steering, at GM and Delphi)
  - Torque (e.g., for electric power steering, at Delphi)
  - Force, pressure, based on magnetostriction (e.g., for brakes, engine pressure, at Delphi)
- Electromagnetic simulation



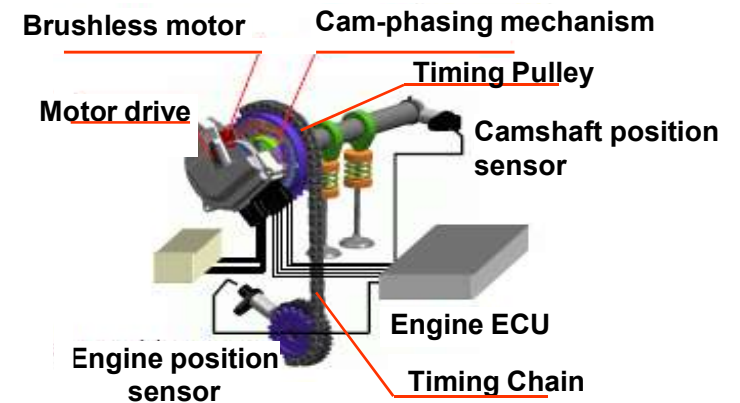
Source: IEEE TIA, 2002



# Expertise: Systems

- Electro-mechanical systems
  - For example, valvetrains: How to best electrify valve trains, from cam phasers to fully variable valve actuation (while at Delphi)
- Transportation electrification
- Hybrid systems
  - Starter-generators (while at GM, Delphi)
  - Commercial vehicles (while at Eaton)
  - Hybrid configurations (now at E-Motors)
- Micro-hybrid power generation

Engine cam phaser system



Source: denso.com

Hybrid utility truck



Source: eaton.com

# Expertise: Management

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- Chair, IEEE Transportation Electrification Community (2019-2020)
  - Volunteer position
  - The Transportation Electrification Community is tasked with coordinating all activities within IEEE concerning this technical field
- President, IEEE Industry Applications Society (2011-2012)
  - Volunteer position (supported by employer)
  - Technical engineering society; 11,000 members, \$3M budget
  - During tenure (2011-2012):
    - Oversaw creation of 3 technical committees (+10%)
    - Creation of 3 new journals
- Delphi Advanced Powertrain (2006-2009)
  - Group manager for development of new concepts in valvetrains, sensors, and fuel systems
- Project management throughout career

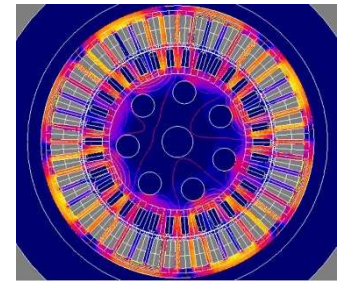
# Expert witness experience

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- Crandall Technologies LLC v. Greatcall, Inc., infringement case, 2019
- MPC Inc. v. Standex Electronics Inc., warranty dispute between two automotive suppliers, 2019
- Patent litigation case concerning electric motors for automotive applications, 2018
- AM General, LLC v. UUSI, LLC, 4 IPR cases, with deposition, 2016-2017
- SD3 LLC v. US PTO, with deposition and testimony at trial (US District Court), 2016

# Recent projects (E-Motors Consulting)

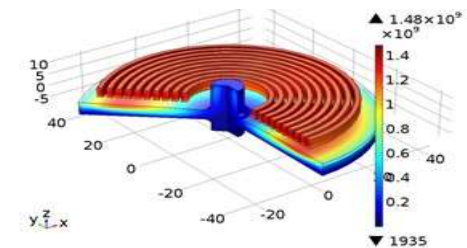
- Automotive systems:
  - Evaluation of electrical drive systems for hybrid applications
  - Motor designs for a Tier 1 automotive supplier
  - Role of magnetic hysteresis in actuator performance
- Aerospace:
  - Electric machine design for pump application
- Renewable energy:
  - Project manager for a start-up working on small hydro generation (under Dept. of Energy grant)
- Actuators:
  - Fast electromagnetic actuation for DC circuit breaker
- Expert witness with trial experience



Induction motor (400 Hz)

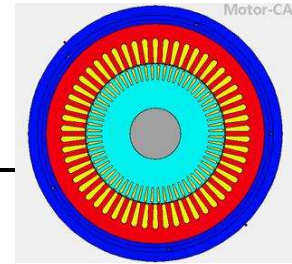


Prototype turbine for small hydro  
(with Cadens, LLC)

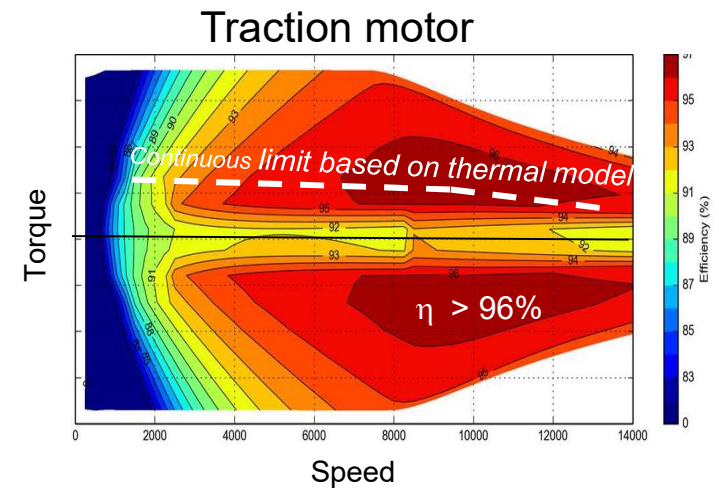


Thompson coil actuator  
(Trans. on Industry Appl.,  
2016)

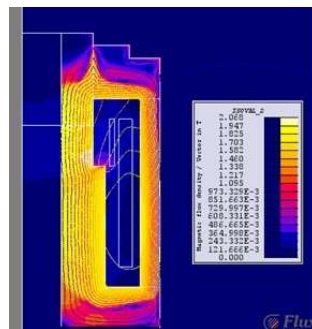
# Modeling tools



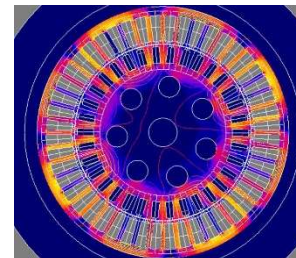
- Motor modeling: MotorCAD
  - Permanent magnet and induction
  - Electromagnetic and thermal models
  - Based on both closed form and finite element



- Finite element: Flux from Altair



Linear solenoid actuator



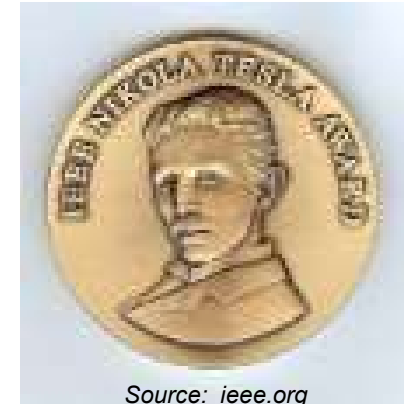
Aerospace motor



# Awards

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- IEEE Tesla award, 2016
  - “For contributions to the design and analysis of actuators, sensors, and motors for automotive applications”
- IEEE Fellow, 1997
  - "For contributions to the development of electromechanical actuators for automotive applications".
- IEEE Industry Applications Society, Gerald Kliman Innovator Award, 2007
- Best Paper awards:
  - IEEE Industry Applications Society, Second Prize Transactions Paper Award, 2016
  - IEEE Industry Applications Society, Second Prize Transactions Paper Award, 1996
  - IEEE Industry Applications Society, Electric Machines Committee, Best Paper Awards: 6 awards, 1987-2005
  - Society of Automotive Engineers:
    - SAE Vincent Bendix Automotive Electronics Engineering Award, 2006
    - SAE Arch T. Colwell Award, 2000
    - Excellence in Oral Presentation, 1998



# Publications

Available at: <http://www.emotorseng.com/selected-papers-and-presentations/>  
or for patents at: [https://www.google.com/?tbs=pts&gws\\_rd=ssl#tbs=pts&q=lequesne+bruno](https://www.google.com/?tbs=pts&gws_rd=ssl#tbs=pts&q=lequesne+bruno)

- Patents: 53
- Papers (most recent)
  - "Active damping of ultra-fast mechanical switches for hybrid AC and DC circuit breakers", C. Peng, L. Mackey, I. Husain, A. Huang. W. Yu, B. Lequesne, R. Briggs, IEEE Trans. on IA, Vol. 53, No. 6, Nov./Dec. 2017
  - "A fast mechanical switch for medium voltage hybrid DC and AC circuit breakers", C. Peng, I. Husain, A. Huang. B. Lequesne, R. Briggs, IEEE Trans. on IA, Vol. 52, No. 4, July/Aug. 2016
  - "Automotive electrification: The non-hybrid story", invited paper, IEEE Transactions on Transportation Electrification, May 2015
- Presentations (recent)
  - "Electric machines for automotive propulsion: History and future", keynote presentation, IEEE ITEC-Asia-Pacific 2019, May 2019.
  - "Automotive motors: Recent accomplishments and challenges ahead", Presentation at Special Session at IEEE Energy Conversion Conference & Exhibition (ECCE), 09-2016.
  - "Automotive electrification: The non-hybrid story", Keynote presentation, IEEE International Transportation Electrification Conference, 06-2015.



Bruno Lequesne, E-Motors Consulting, LLC

**VIEWPOINT**

## EV/HEV Technology: Are We There Yet?

By Bruno Lequesne

**P**ROGRESS IN TRANSPORTATION electrification and, more specifically, hybrid electric vehicle (HEV) and EV, has shifted and slowed, sometimes with large swings, over the last several decades. The enthusiasm around the "Toyota Prius" technical and commercial success led some to believe that we had finally reached a tipping point in terms of the acceptance of electric propulsion. Well, as matters on the contrary old transportation electrification road, have we reached our destination yet?

It is time to present my views by looking at the progression of EVs and HEVs from the perspective of the diffusion of innovation theory in Diffusion of Innovation, written by Everett R. Rogers in the 1960s [1]. This book popularized the S-curve (Figure 1), which illustrates the rate of penetration of an innovation into culture or of a new technology into the market, propagated initially by innovators and early adopters, before the majority and, finally, the laggards make use of the innovation. At that point, it has entered its present market.

In the case at hand, EVs and HEVs have been around since the beginning of the automobile and did successfully penetrate some niche commercial markets before, nevertheless they failed,

each with its own penetration and diffusion pattern, noise, fast and others alike, such that the overall market penetration S-curve is a combination of many S-curves. Along this entire time, many have pointed out that EV/HEV technology is actually part of a bigger reality, namely, the electrification of the automobile. More and more functions have been electrified, from fuel injectors and climate actuators to steering. Electric stop-start is now well up the penetration S-curve, with the

the Prius (R) success, since in the 1990s, starting equipment in the 1970s, and hybrid power-trains. In short, the time frame for the S-curve is measured in decades and is spanning over a century, so naturally large scale for mass vehicle penetration. This and other factors make it particularly difficult to assess where and when a penetration tipping point will be finally reached.

Perhaps one way to approach this is to realize that EV/HEV engineering actually leverages technology,

more vehicles.

reality, namely, the electrification of the automobile. More and more functions have been electrified, from fuel injectors and climate actuators to steering. Electric stop-start is now well up the penetration S-curve, with the

each with its own penetration and diffusion pattern, noise, fast and others alike, such that the overall market penetration S-curve is a combination of many S-curves. Along this entire time, many have pointed out that EV/HEV technology is actually part of a bigger reality, namely, the electrification of the automobile. More and more functions have been electrified, from fuel injectors and climate actuators to steering. Electric stop-start is now well up the penetration S-curve, with the

Market Penetration

Time

Tipping Point

Early Adoption

Early Majority

Late Majority

Time of Full Adoption

Time of Full Adoption

Figure 1. The figure illustrating the penetration of a new technology into the marketplace, with a lagging point to market after which the technology is considered to succeed.

IEEE Electrical Magazine / June 2015

Continued on page 10

# Customers



Bruno Lequesne, E-Motors Consulting, LLC

# Summary

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- Seasoned researcher, inventor, engineer and manager in the field of electric drives, actuators, sensors and electro-mechanical systems
- Expert in automotive and transportation electrification
  - Including expert witness with court experience
- Consulting on:
  - Technology roadmapping and strategizing, discerning new trends
  - Development of new concepts and products
  - Design of electric machines, linear actuators, and sensors
  - Intellectual property analysis and strategy, expert witness