

## **NVF: Noteworthy IEEE Article -- "Software has become the major contributor of value in cars"**

*In a recent issue of IEE Spectrum, contributing editor **Robert N. Charette** spotlighted the rising contribution of software to both the value and cost of a new vehicle today. The excerpts below are from his article "This Car Runs on Code". The creation of this software and information technology value will be explored at an upcoming elite workshop in June in South Carolina on the "Networked Vehicle". For more information on participating with the heads of companies like HP, INTEL, IBM, Cisco and CA, please contact Emily Boucher at: [eboucher@networkedvehicle.org](mailto:eboucher@networkedvehicle.org)*

### **Excerpts from "THIS CAR RUNS ON CODE"**

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The avionics system in the F-22 Raptor, the current U.S. Air Force frontline jet fighter, consists of about 1.7 million lines of software code. The F-35 Joint Strike Fighter, scheduled to become operational in 2010, will require about 5.7 million lines of code to operate its onboard systems. And Boeing's new 787 Dreamliner, scheduled to be delivered to customers in 2010, requires about 6.5 million lines of software code to operate its avionics and onboard support systems.

These are impressive amounts of software, yet if you bought a premium-class automobile recently, "it probably contains close to 100 million lines of software code," says Manfred Broy, a professor of informatics at Technical University, Munich, and a leading expert on software in cars. All that software executes on 70 to 100 microprocessor-based electronic control units (ECUs) networked throughout the body of your car.

Alfred Katzenbach, the director of information technology management at Daimler, has reportedly said that the radio and navigation system in the current S-class Mercedes-Benz requires over 20 million lines of code alone and that the car contains nearly as many ECUs as the new Airbus A380 (excluding the plane's in-flight entertainment system). Software in cars is only going to grow in both amount and complexity. Late last year, the business research firm Frost & Sullivan estimated that cars will require 200 million to 300 million lines of software code in the near future.

Jonas Bereisa, a GM engineer, wrote in a 1983 article in *IEEE Transactions on Industrial Electronics* that "software development will become the single most important consideration in new product development engineering." How right he was. Broy estimates that more than 80 percent of car innovations come from computer systems and that **software has become the major contributor of value (as well as sticker price) in cars**. The cost of electronics as a percent of vehicle costs climbed from around 5 percent in the late 1970s to 15 percent by 2005 (excluding final assembly costs). For hybrids, where the amount of software needed for engine control alone is nearly twice as great as that for a standard car, the cost of electronics as a percent of vehicle costs is closer to 45 percent. Within 10 years, some experts predict that the percentages relating to the cost of electronics as a percent of vehicle cost are expected to rise to 50 percent for conventional vehicles and 80 percent for hybrids.

For today's premium cars, "the cost of software and electronics can reach 35 to 40 percent of the cost of a car," states Broy, with software development contributing about 13 to 15 percent of that cost. He says that if it costs US \$10 a line for developed software—a cost he says is low—for a premium car, its software alone represents about a billion dollars' worth of investment.

Besides monitoring their own internal health, cars are beginning to analyze the world around them. "We're getting into this era where in addition to sensing what's going on inside the car, we are using things like radars to detect the presence of external objects, lasers to measure distance for cruise control, and video and ultrasonics to detect objects behind you," says Thomas Little, an electrical engineering professor at Boston University in Massachusetts. "The trend will be to extract information external to your vehicle about other vehicles and then exploit this information" to improve safety. For example, cars in front of you will let your car know whether there is ice on the highway or an accident.

Says Little, "We are giving up little pieces of control in exchange for safety. The interesting question is, at what point will you and I be willing to say, 'Okay. I am not going to drive the car; it is going to drive me.' "

The original article can be found at:

<http://www.spectrum.ieee.org/feb09/7649>

The Networked Vehicle Foundation (NVF) provides information to advance the era when vehicles will be connected to the modern mobile broadband communications infrastructure. The Agenda for the June 15-17 Workshop in Greenville, South Carolina, can be found at:

[http://www.networkedvehicle.org/NVF\\_june2009\\_event\\_agenda.pdf](http://www.networkedvehicle.org/NVF_june2009_event_agenda.pdf)