

calculated by SolidWorks[®]. After we figure out the detailed design of the shaft, the connectors between the shaft and the winding, and the optical encoder we are going to use, a larger total rotor inertia is expected [21], as will be presented in a companion paper. Also note that the entries in the bottom three rows are not functions of the actuator alone, but of the actuator, the balance of the EMV, and the control strategy. These entries present each option as favourably as possible and the limited-angle actuator stands out with the low enough power consumption, fast enough transition, and small enough package.

Table V. Comparison of two commercial motors and the LA actuator.

	Brush motor (experiments)	Brushless motor (experiments)	LA actuator (simulation)
Size (mm*mm*mm)	69*69*119	28*28*90	28*36*60
Volume (mm ³ /normalized)	566559/8	70560/1	64480/0.86
Rotor Inertia (10 ⁻⁴ Kg·m ² /s /normalized)	3.5/2.9	1.2/1	1.3/1.08
Winding Loss (W/normalized)	31/0.26	118/1	34/0.29
Power Consumption (W/normalized)	49/0.36	138/1	56/0.405
Transition Time (ms)	2.7	2.4	2.8

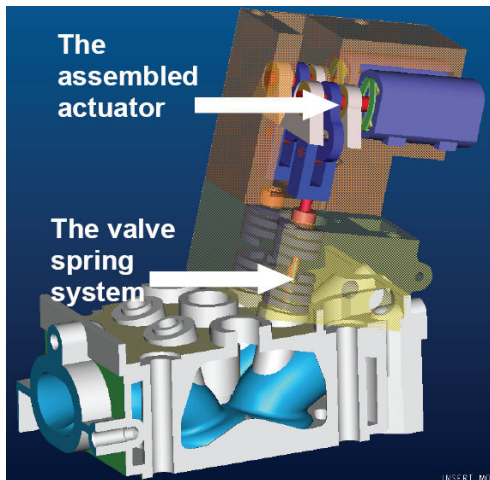


Fig. 13. Independent valve actuation system mounted on an engine head (courtesy to ITRI).

5 Conclusions

This paper addresses a custom-designed limited-angle actuator, which fits in an electromechanical valve drive to provide VVT in IC engines within a package small enough to fit in the limited space over the engine head, with a transition time fast enough to accommodate faster engine speed, and a low power consumption. The customized limited-angle actuator enabled the projection of independent valve actuation for a 4-cylinder 16-valve IC engine with reasonable power consumption and high engine speed.

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