Science & Religion

A World with Self-Driving Cars

By Jeffrey M. Bradshaw · June 13, 2016

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Editor's Note: The following is Part 2 in a series that expands upon a presentation given at the Second Interpreter Science and Mormonism Symposium: Body, Brain, Mind, and Spirit *at Utah Valley University in Orem, Utah, 12 March 2016. To see the previous installment, click here.*

A book based on the first symposium, held in 2013, has recently been published entitled "Science and Mormonism: Cosmos, Earth, and Man." For more information, including free videos of these events, see http://www.mormoninterpreter.com.

By way of introduction to this theme, I want to state that I admire the courage and creativity of pioneers such as Sebastian Thrun of Stanford University whose tireless research and fearless advocacy of self-driving cars at Google both created groundbreaking technologies and opened up what will surely prove to be one of the biggest transportation developments of the coming century. In January 2016, I was honored to participate in the 174th Dies Natalis ceremonies at the TU Delft, the top Dutch university for science and engineering, where Thrun received an honorary doctorate. I highly commend to anyone, regardless of their background in science and technology, the inspirational video made of his remarks at that event, entitled “Moonshot Thinking.”[i]

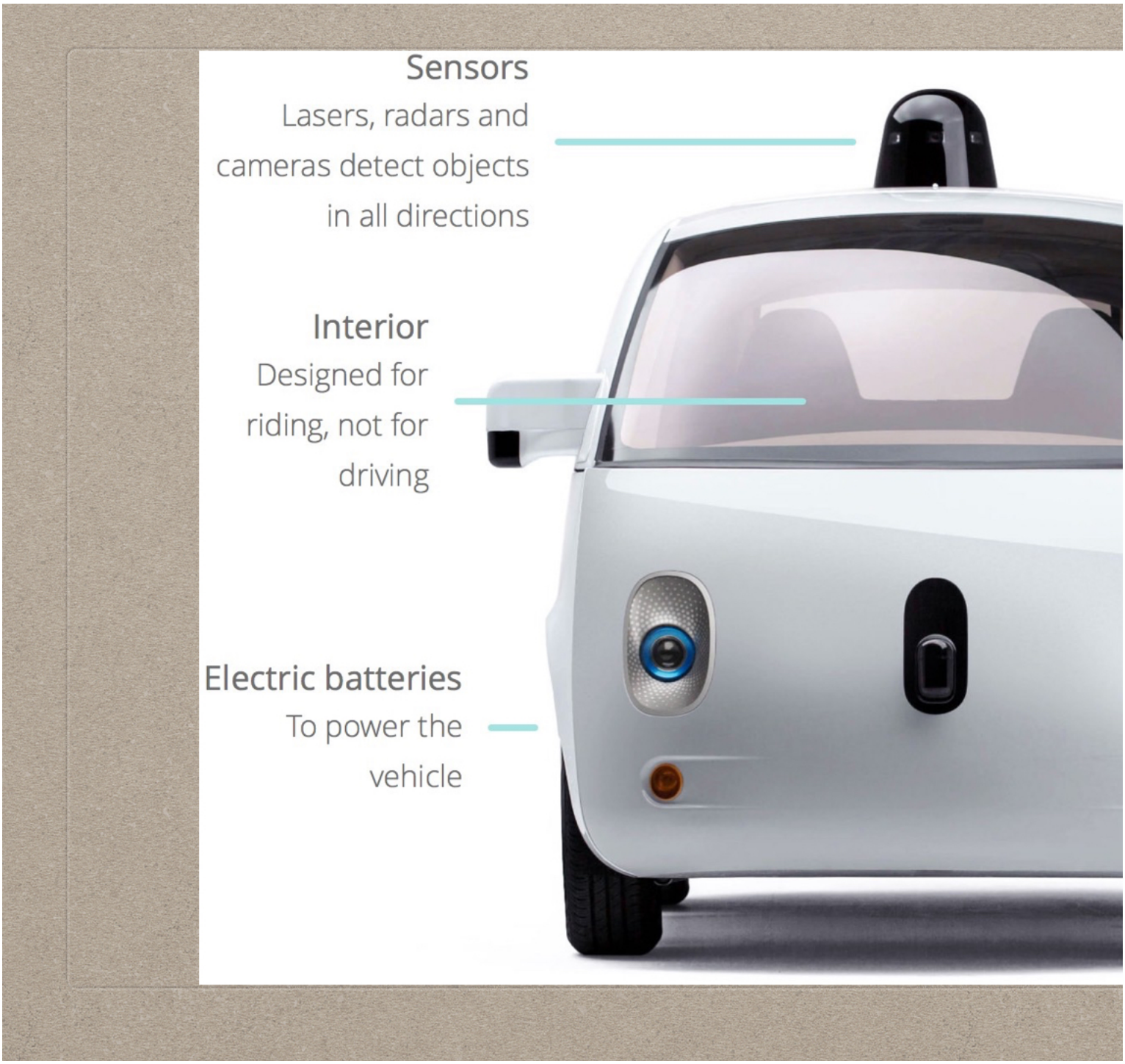

Figure 2[ii]

The Google Koala prototype that was publicly unveiled in the fall of 2015 is the most easily recognized self-driving car today. It is a successor to the early efforts of Thrun, and a tribute to him and to the many able researchers that have followed in his footsteps. With the fast-paced evolution of thinking that is currently taking place in the field, no doubt the vehicles of 2025 will look and function much differently than the prototypes of 2016.

The image tells you about the current features of the Google Koala but it does not explicitly reveal what features of an *ordinary* car have been removed, namely, the steering wheel, the gas pedal, and the brake pedal.[iii] The omission of these three pieces of heretofore standard equipment is a specific example of the incurable optimism of technologists.

Success in fielding large numbers of *general-purpose* self-driving cars meaning cars that are intended to successfully negotiate the vast majority of situations that manually driven cars do today as opposed to cars that operate in specific, well-constrained niches — depends on solving several difficult problems. The biggest challenges are not in the basics of autonomous driving — getting from A to B. The devil is in the myriad details of unexpected events that can occur while driving.[iv]

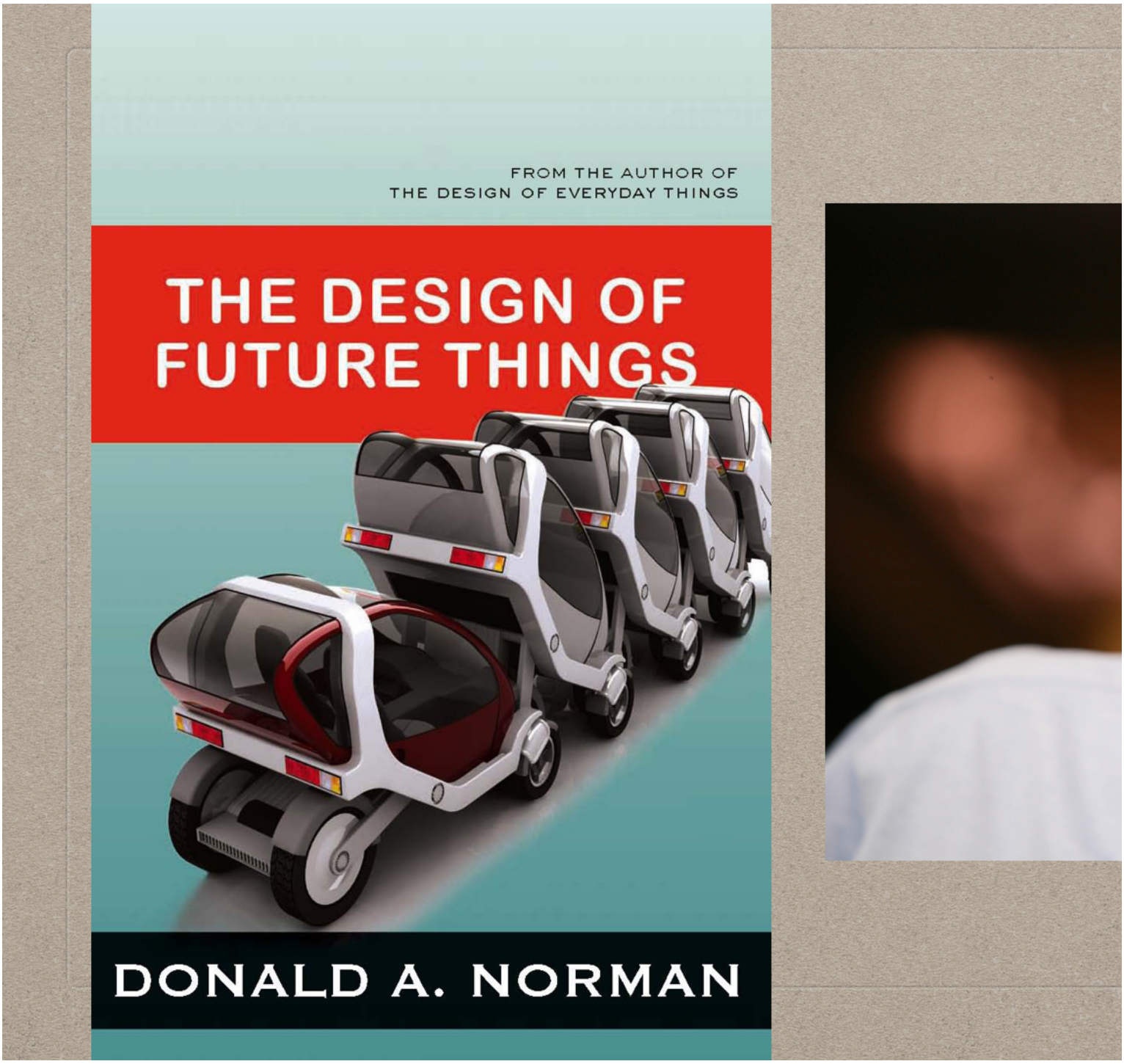

Figure 3[v]

My colleague on the Nissan Science Advisory Council,[vi] Donald Norman says it this way: "We know two things about unexpected events: first, they always occur, and second, when they do occur, they are always unexpected."[vii] He continues:[viii]

> The conflict between human and machine actions is fundamental because machines, whatever their capabilities, simply do not know enough about the environment, the goals and motives of the people, and the special circumstances that invariably surround any set of activities.

The California driving authority has tried to do something about this problem. As a result of ongoing discussions about the safety of autonomous vehicles, it has implemented rules whereby such vehicles are required "to have means whereby a person sitting in the car could intervene at any time, if the technology fails."[ix] Sounds like a good idea, right?

Figure 4[x]

Here's the rub: what Norman calls "halfway automation" or what other researchers sometimes call "the handoff problem." In defense of Google's apprehensions about allowing passengers to exert control in starting, stopping, and steering self-driving cars, "*halfway* automation" is sometimes a much bigger problem than *full* automation:[xi]

> I once argued[, writes Norman,] that the current state of automation was fundamentally unsound because it was in the dangerous middle ground, neither fully automated nor fully manual. Either have no automation or full automation, I argued, but what we have today is halfway automation. Even worse, the system takes over when the going is easy and gives up, usually without any warning, when the going gets tough — just the reverse of what you would want. …
>
> If one cannot automate fully, then the automation that is possible must be applied with great care, sometimes not being invoked, sometimes requiring more human participation than is really needed in order to keep the human drivers informed and attentive.
>
> Full manual control of automobiles is dangerous. Fully automatic control will be safer. The difficulty lies in the transition toward full automation, when only some things will be automated, when different vehicles will have different capabilities, and when even the automation that is installed will be limited in capability. I fear that while the partial automation of driving will lead to fewer accidents, the accidents that do happen will be greater in magnitude, involve more cars, and exact a higher toll. The joint relationship between machines and their humans must be approached with caution.[xii]

Will Nissan Beat Google and Uber to Self-Driving Taxis?

By Mark Harris
Posted 26 Feb 2015 | 15:43 GMT

Photo: Nissan

These Nissan taxis are conventional gasoline-powered vehicles, driven by humans. But Nissan is collaborating with NASA to develop a fleet of electric autonomous cabs.

Who will build the first robot taxis? Google has a working prototype but no experience in manufacturing cars (http://spectrum.ieee.org/cars-that-think/transportation/self-driving/googles-selfdriving-car-pals-revealed). Uber, meanwhile, knows the transportation business but has only just started working on autonomous vehicles (http://spectrum.ieee.org/cars-that-think/transportation/self-driving/uber-turns-from-google-teams-up-with-carnegie-mellon-on-selfdriving-cars) with Carnegie Mellon University.

Documents obtained by *IEEE Spectrum* suggest the first cab capable of driving itself (and that you won't feel obliged to tip) might be made by Nissan. In January, the Japanese automaker announced (http://spectrum.ieee.org/cars-that-think/transportation/self-driving/nasa-and-nissan-chase-selfdriving-car-technology) that it would be working with NASA to "demonstrate proof-of-concept remote operation of autonomous vehicles for the transport of . . . goods . . . and people." Using a California Public Records Act request, *Spectrum* has uncovered more details on the particular technologies Nissan and NASA plan to share and, more important, that the main goal of their collaboration appears to be the development of a fleet of remotely-supervised autonomous taxis.

Figure 5[xiii]

The incurable optimism of researchers must be handled with extreme deftness and skill by traditional auto company CEOs. This is not only because they need to temper public expectations but also because many are hoping for partnerships with technology companies such as Google and Apple.[xiv] In a 2015 article entitled "Will Nissan beat Google and Uber to self-driving taxis?" Nissan's interest in research and development of fleet management services for autonomous vehicles was leaked to the public through a California Public Records Act request.[xv]

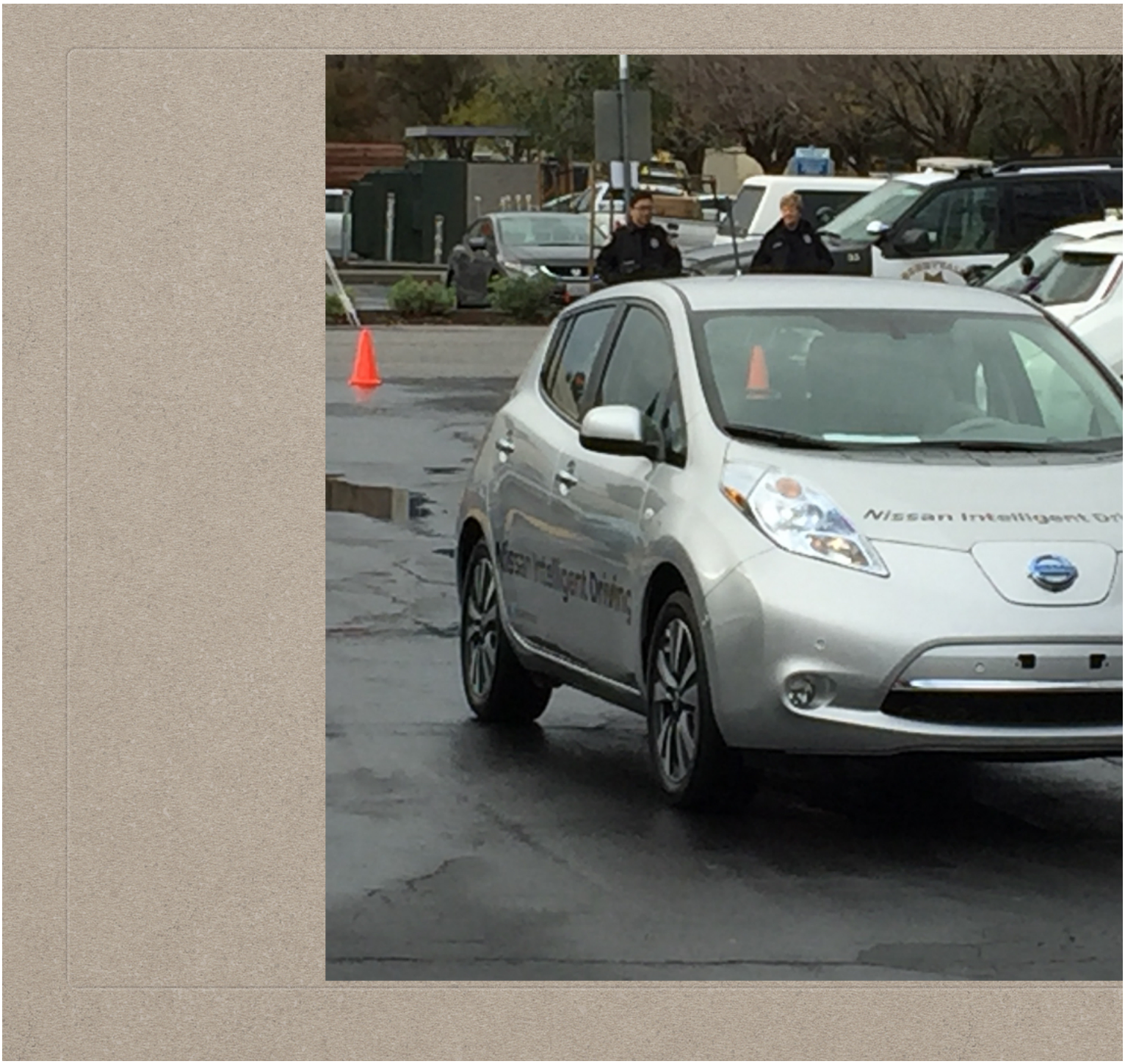

Figure 6[xvi]

On the drizzly day of January 6, 2016, our research team participated with our colleagues at NASA and Nissan in a series of demonstrations of Nissan autonomous driving technologies to various executives, including the chairman and CEO of the Renault-Nissan alliance, Carlos Ghosn. Situations as commonplace as bad weather and standing water or snow on roadways can wreak havoc with self-driving automobile sensors, which is one reason why road testing occurs in California much more than it does in Alaska. Fortunately, the drizzle cleared up quickly, and the demonstrations went forward successfully.[xvii]

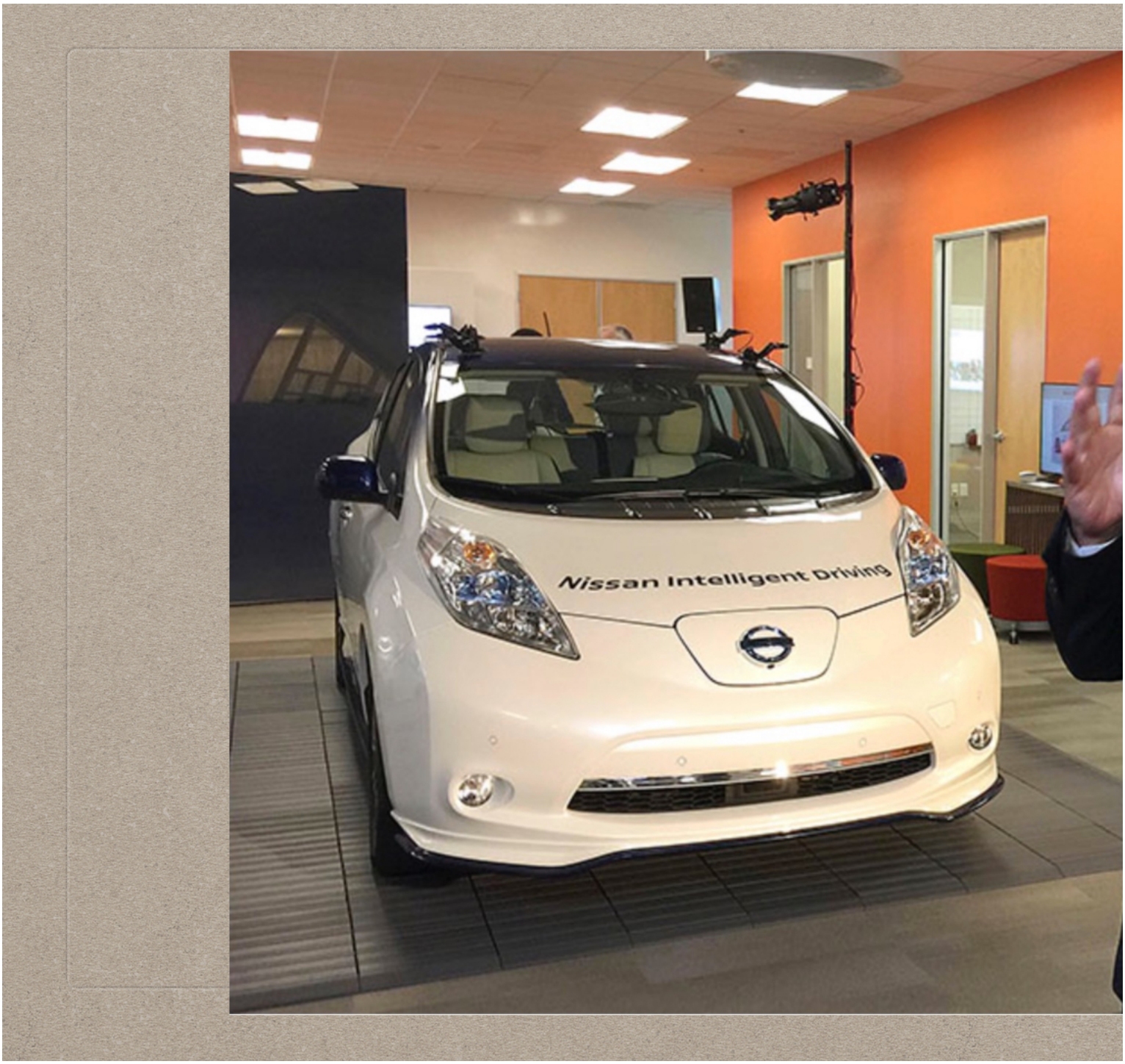

Figure 7[xviii]

The next day, *The New York* Times reported Carlos Ghosn's announcement that Nissan:[xix]

> would introduce ten new autonomous vehicles in the next four years.
>
> Elon Musk, the chief executive of Tesla, upped the ante. In a conference call with reporters …, he asserted that the so-called Autopilot feature introduced in the Tesla Model S last fall was "probably better than a person right now."
>
> Mr. Musk also said that within a year or two, it would be technically feasible to summon a Tesla from the opposite side of the country.
>
> But[, continued the *Times*,] there is a growing gap between what these executives are saying and what most people think of when they hear executives or scientists describing … driverless cars.
>
> What Mr. Musk and Mr. Ghosn are describing — cross-country-driving hyperbole aside — are cars with advanced capabilities that can help drive or even take over in tricky situations like parallel parking on a busy street.

> Truly autonomous cars that do all the work, like the bubble-shaped vehicles Google has been testing near its Silicon Valley campus, are still at least a decade away from ferrying people around town.

Mary (Missy) Cummings, another colleague who served for a time on the Nissan Science Advisory Council gave insightful, sobering testimony to the U.S. Senate Committee on Commerce, Science, and Transportation on March 15, 2016 of some of the "scenarios that highlight limitations of current self-driving car technologies," concluding with these words:[xx]

Let me reiterate that as a professor in the field of robotics and human interaction, I am wholeheartedly in support of the research and development of self-driving cars. But these systems will not be ready for fielding until we move away from superficial demonstrations to principled, evidenced-based tests and evaluations, including testing human/autonomous system interactions and sensor and system vulnerabilities in environmental extremes. To this end, in collaboration with private industry, [the National Highway Traffic Safety Administration] should be providing strong leadership and guidance in this space.

(To be continued in Part 3)

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[i] For a link to the video of Sebastian Thrun's presentation, see www.jeffreymbradshaw.net. Prior to the ceremony, Thrun (Stanford), Tom Sheridan (MIT), Dirk Helbing (ETH Zurich), Catholijn Jonker (TU Delft) and I presented at a public seminar on "Intelligent Robots: Tools or Teammates" (Exploring our robotic future; The week of… Sebastian, Jefferey & Thomas). My talk at the seminar was a critique of the current overselling of "full autonomy" and a brief overview of Human-Agent-Robot Teamwork, with examples from IHMC projects (J. M. Bradshaw et al., Human-Agent-Robot Teamwork Through Coactive Design).

[ii] *How it works*.

[iii] *How it works*.

[iv] Cf. L. D. d. L. Rochefoucauld, *Maxims*, 106, p. 31: "Knowledge is an absolute mastery of details, and since of details there is no end, ours is always an imperfect and superficial knowledge." (L. D. d. L. Rochefoucauld, *Maxims*, 106, p. 24): *« Pour bien savoir les choses, il en faut savoir le détail, et comme il est presque infini, nos connoissances sont toujours superficielles et imparfaites. »*

To their credit, Google has invested heavily in empirical research on driving in real-world environments and has openly critiqued failures of autonomous capabilities in these situations. For example, see this assessment, briefly summarized in R. Lindner, Google Warning:

Since 2009, when Google began working on self-driving cars, its fleet has so far covered more than two million kilometers in autonomous mode. During that time, there were, according to the group's report, 272 cases where a failure of the autonomous capabilities had been determined. In 69 cases, the driver had intervened to avert accidents. Subsequent simulations had shown the probability that in 13 of these cases an accident would have occurred had there been no intervention by a human driver. In a blog post Google pointed out, however, that the number of such incidents is declining. Of the 13 dangerous situations, eight had occurred eight in 2014, while only five took place last year. But Google also warned that the number could rise again if the autonomous cars were used under complex conditions — for example in bad weather.

[v] http://johnnyholland.org/wp-content/uploads/DonaldANorman.jpg.

[vi] Bradshaw to Chair; New Scientific Advisory Council.

[vii] D. A. Norman, *Design of Future Things*, p. 13.

[viii] Ibid., p. 15.

[ix] R. Lindner, Google Warning.

[x] W. C. Fields in an unknown movie clip.

[xi] D. A. Norman, *Design of Future Things*, pp. 113, 116.

[xii] Ibid., p. 116.

[xiii] M. Harris, Will Nissan Beat Google and Uber.

[xiv] See, e.g., R. Lindner, Google Warning:

Meanwhile, Google is looking for ways for its autonomous vehicles to close ranks with the auto industry. John Krafcik, who is in charge of the project, said on Tuesday at a press conference that took place near the auto show in Detroit that Google wants to enter into collaborations with many different companies. A number of automakers have sought contact with Google. A few weeks ago there was speculation that Google held discussions with the American automaker Ford shortly before the announcement of the alliance. Some wonder whether Ford could be contracted to manufacture Google's next generation of self-driving cars. So far, these speculations have not materialized. Ford's CEO Mark Fields distanced himself last week at the electronics show in Las Vegas from such cooperation and said he would not be limited to the role of a supplier for the technology industry.

[xv] M. Harris, Will Nissan Beat Google and Uber. See also the discussion of some of IHMC's recent work with Nissan on intelligent fleet management services in Excavating.

[xvi] Jeffrey M. Bradshaw, 6 January 2016, Image Reference IMG_6117.jpg.

[xvii] Although the details of many aspects of Nissan research are confidential, I was invited to give a public presentation at a meetup of the Silicon Valley Autonomous Vehicle Enthusiasts about IHMC's research on visualization for fleet management. See J. M. Bradshaw et al., Agents, Ontologies, Policies, and Visualization for a video of that presentation.

[xviii] AP PhotøTerry Chea, in M. Liedtke, *Renault-Nissan to Introduce*.

[xix] J. Markoff, For Now Self-Driving Cars.

[xx] J. Thune et al., Hands Off. See also M. L. Cummings et al., Who Is In Charge?