

**CLOUD
COMPUTING 24**
A revolutionary IT
tool, or a bunch of
hype?

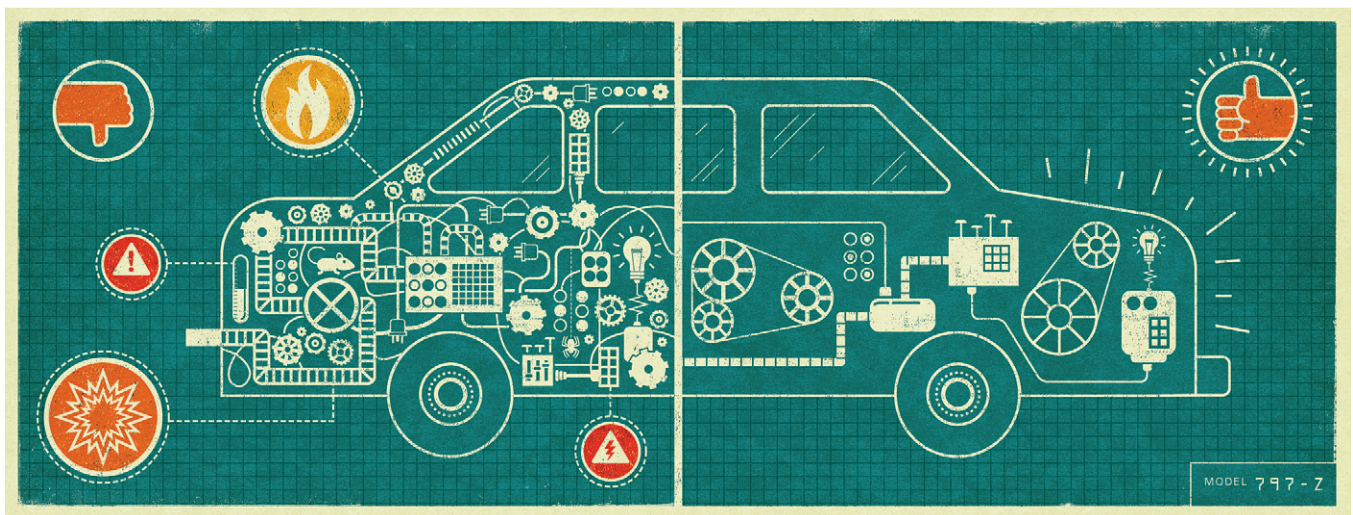
**MANAGING
PEOPLE 26**
Why your employees
aren't being frank
with you

**DEFEND YOUR
RESEARCH 32**
The more customers
want it, the less
they'll like it.

DAN ARIELY 38
How to get CEOs
to care about more
than stock price

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FIRST

Why Dinosaurs Will Keep Ruling the Auto Industry

Get ready for the complexity revolution. by John Paul MacDuffie and Takahiro Fujimoto

The automobile is a paradox. When you get down to basics, it's the same as it was a hundred years ago: a metal box on four wheels connected by a suspension and powered by an internal combustion engine, which runs on a petrochemical fuel. Yet the Tin Lizzie and the Prius are worlds apart in every other way.

Many companies have long believed they could emerge as industry leaders by placing the right bets on markets to enter, car types to make, and technologies to pursue. But now there's a trend that eclipses those factors in determining which players

will win: the rapidly increasing complexity of vehicle design in advanced-economy markets. The typical car contains about 2,000 functional components, 30,000 parts, and 10 million lines of software code.

Why all the intricacy? Automobiles are heavy, fast-moving objects operating in public space. Making them safe and reducing their environmental impact are important concerns mandated by regulation. At the same time, their high cost raises consumer expectations for styling, power, handling, reliability, and amenities. Satisfying both these masters results in massive

complexity. Toyota's highly publicized recalls earlier this year were not outliers but, rather, emblematic of an industry challenge that will only intensify as vehicles integrate ever-more-elaborate hardware, software, safety equipment, and creature comforts.

Meeting both regulatory and consumer demands involves managing interdependencies among subsystems. (This is, in a way, like operating within the auto world itself, which Peter Drucker famously called "an industry of industries.") But companies and their designers can't do that using current best practices.

New Solutions Beget New Problems

Many product engineers like the simplicity and flexibility of a modular approach. But that works best for products such as consumer electronics, which are small and unobtrusive, operated mostly in private space, and relatively cheap, with few negative

What We're Watching in...

Cloud Computing

Cloud computing is either a revolutionary IT management tool or a nebulous puff of marketing hype, depending on whom you ask. For now, we're thinking it's puffery—but intriguing developments are under way.

A Cloudy Concept

Rather than house your own IT servers or rent the maximum processing and storage capacity you'll ever need, why not pay only for what you use, when you use it? That's the basic idea behind cloud computing—and it's an alluring possibility for many reasons, not least the desire to contain

costs and reduce energy consumption. But it turns out that much of the appeal is based on a murky understanding of the concept.

According to research by Gartner group vice president **Mark McDonald**, the percentage of CIOs interested in cloud computing has grown consider-

ably, from 5% in 2009 to 37% earlier this year. And the bigger the company, the more likely management is to say that cloud computing is a top-five IT priority.

But three out of four respondents who profess interest in cloud computing report little to none in three of the

CONTINUED FROM PAGE 23

The typical car contains about 2,000 components, 30,000 parts, and 10 million lines of software code.

consequences of malfunction other than annoying owners. By contrast, auto design requires intensive coordination to keep track of all its various aspects, and its engineering culture prefers unique (nonmodular) solutions. Compared with car design's advanced calculus of millions of simultaneous complex equations, the iPad's design is basic arithmetic.

Automakers' efforts to deal with design complexity so far have hinged on building capabilities for front-loaded problem solving. They've been aided by digital design tools and simulations for testing how any of those 2,000 components perform under stress and for evaluating interactions among them. In addition, companies have been leaning on suppliers to take on important design and testing work; they're relying on their partners' deep knowledge about the components they build.

All this has helped untangle things somewhat. Manufacturers have reduced the complexity of how they design and make cars but not of the cars themselves (at least in developed markets). The shift to digital design and testing tools has facilitated shorter product life cycles, but this leaves less time up front for problem solving and functional testing. Suppliers' increased involvement takes aspects of design out of the automaker's direct control, yet the manufacturer remains accountable

when safety or other issues arise. Witness the steadily growing number of recalls in developed countries. Recalls reflect failures to meet ever-tougher regulatory requirements, as well as greater consumer (and producer) sensitivity to defects. They will continue to increase right along with complexity—not necessarily bad news if that improves quality and safety, but surely evidence of the burdens of complexity.

No case illustrates the challenge of integrating many parts, systems, and processes better than the recall of Toyota's Prius for a problem caused by interactions among the three elements of its braking system. As part of an effort to improve fuel efficiency, the software that controlled this system was tuned to draw more heavily on the

regenerative brakes. The problem occurs when the car hits rough pavement or something slippery. The software automatically switches to antilock braking (ABS), which gives the sensation of a sudden drop in braking power. If the driver quickly hits the pedal, the hydraulic brakes immediately kick in; if not, the ABS "takeover" interrupts the driver's anticipated deceleration, creating a feeling of speed increase but not actual acceleration. The real safety risk is zero (the brakes continue to work and will stop the car if pressed more fully), but the unease felt by drivers was enough to prompt the recall.

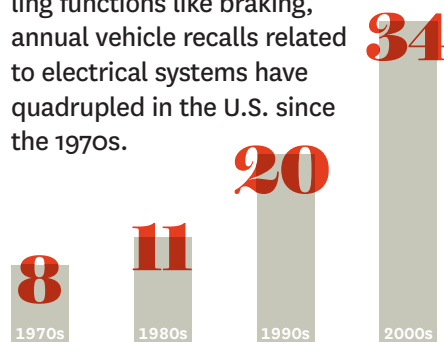
Not all automotive recalls have such a complex genesis. Toyota's accelerator pedal recall, which affected a vast number of vehicles, came down to design flaws in a single, relatively simple part used on many models and sourced from a non-Japanese supplier in order to diversify the supply chain and reduce costs. Yet this is consistent with the overall product's trend toward higher complexity: Defects appear in unpredictable places, whether in simple hardware parts like the accelerator pedal or in complex software control systems.

Incumbents Have an Edge

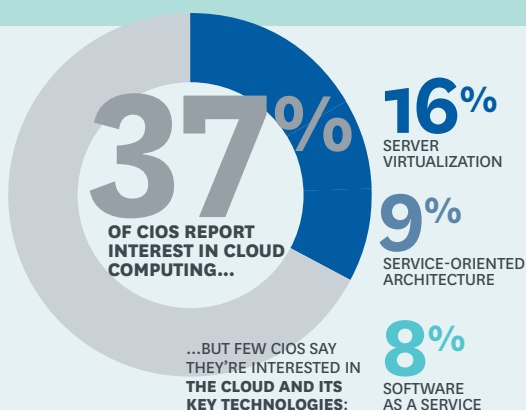
If complexity tripped up Toyota, how will the growing number of challengers fare? Their odds of success are even lower than

BACK TO THE MANUFACTURER

With more computers controlling functions like braking, annual vehicle recalls related to electrical systems have quadrupled in the U.S. since the 1970s.



SOURCES: BLOOMBERG; NHTSA



key technologies it entails: server virtualization, service-oriented architecture, and software as a service. Further, nearly half the respondents equate cloud computing with virtualization alone, which shows that many executives have an incomplete view of it.

Cloud computing has rapidly risen to what McDonald calls “the peak of inflated expectations.” And where is it headed next? The “trough of disillusionment,” he says. That’s because few people can even seem to agree on what cloud computing is, never mind how on earth it should work.

The National Institute of Standards and Technology (NIST) IT laboratory’s definition, version 15, is more than 760 words long and includes five characteristics, three service models, four deployment models, and a disclaimer saying, in essence, that the definition will change again soon.

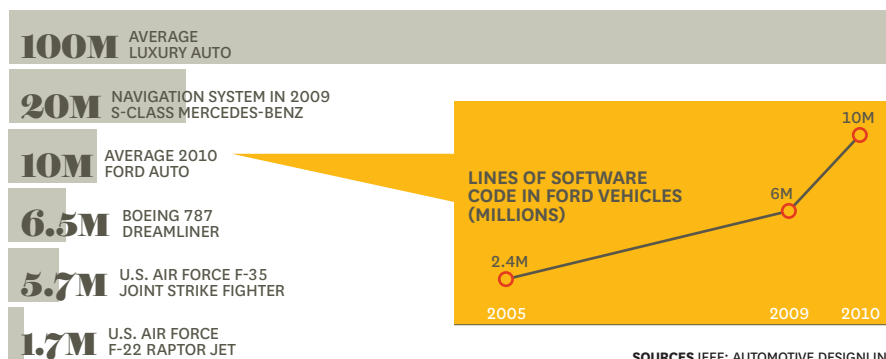
incumbents’. Tata’s Nano has a comparatively simple design tailored to developing-economy consumers. It meets India’s somewhat relaxed regulatory standards, but it would need to be substantially redesigned to be sold in the U.S. or Europe. Chinese autos will need tremendous improvements in drivability, ride smoothness, cabin comfort and quiet, and body “fit and finish” to fulfill the high quality expectations in developed countries. Electric car start-ups must gain the design and testing capabilities to satisfy regulations and to provide the flawless integration of vehicle functions that drivers expect. Being masters of the new drive-train technology won’t be enough.

Which companies are best equipped to design the cars of the future? Those that have amassed the systemic knowledge to coordinate all the work and the many partners involved. Few developing-country automakers and green vehicle start-ups possess that yet. This doesn’t limit the field to incumbents, nor does it guarantee that they will be around in 20 to 30 years. But it does mean that new rivals will have to slog through the long, slow process of catching up with the veterans. Otherwise, no new-comer can expect anything more than niche status in this industry.

What’s more, companies will have to battle the demons of complexity for an eternity—or at least as long as consumers demand that cars keep them safe, run relatively clean, perform well, and are attractive and comfortable. The long-term lesson of Toyota’s recalls is that automakers will have to build a much better institutional capability for reading faint signals amid

MORE COMPLEX THAN A FIGHTER JET

Safety regulations and consumer demand for performance and convenience have led to an exponential spike in cars’ software complexity.



the “noise” of consumer experience data. As overall vehicle reliability increases, the failures that come will be harder to forecast and much tougher to trace to root causes, since diagnoses will be made on the basis of rare occurrences.

Given the wide variation in government regulation and consumer demand around the world, automakers targeting advanced markets must do two basic things to survive. First, they’ll have to reduce complexity by striving for modularity in whatever limited ways they can and decreasing product line-ups, model varieties, and option variants. Second, they must improve their handling of the complexity that remains.

Furthermore, a global automaker will want to pursue simple designs for developing markets and complex ones for the developed world. The trick is to avoid homogeneous designs overengineered for the former and underengineered for the latter.

Consensus on one new dominant design (say, all-electric vehicles) would mean a simpler world for automakers, yet this is far off at best, and it might never happen given consumer preferences for variety. Most likely, firms will need to continue producing both simple and complex products.

Many strategists think that new entrants are ready to reinvent the industry. They see the automakers that dominated the twentieth century as dinosaurs: large, slow, and facing extinction. But this is one industry in which the dinosaurs—at least those that can successfully wage war on complexity—are positioned to beat new challengers for at least the next few decades. ▀

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