Building Your Wings on the Way Down
Remarks of NASA Administrator Daniel S. Goldin to
J.D. Power & Associates
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Good morning everyone. Thank you for inviting me to the International Automotive Roundtable. I can t wait to try out the concept cars.

Your cars capture the world s imagination like NASA s missions do, but we are unmatched in acceleration. When the Space Shuttle clears the lightning mast at the top of the launch pad, it s traveling about 73 miles an hour.

To convert that to automotive terms, the shuttle goes zero to sixty in 5.2 seconds.

Now you may think 5.2 is fast, but not that fast. Just remember our vehicle weighs four-and-a-half million pounds.

It s great to be back in Orlando. I was here last week addressing the Florida Space Summit. That day, I made the mistake of predicting a Washington victory over Tampa Bay in their playoff game. I guess if I d been a member of the Power Information Network, I d have known better.

I am pleased to be here, because NASA and J.D. Power & Associates are partners in the drive toward improved quality. In fact, you are working closely with Kennedy Space Center on our customer satisfaction initiatives.

Another thing NASA shares with J.D. Power & Associates is a willingness to take risks to achieve great things.

Author Ray Bradbury once said, Living at risk is jumping off the cliff and building your wings on the way down.

I guess that means I m telling you to go take a flying leap not because I dislike you, but because I know you have the intelligence and persistence to build your own wings.

We take that leap everyday at NASA.

We have ambitious goals, and we need robust high-performance vehicles to reach our goals.

We want to explore the origins of the universe and our solar system, with incredibly powerful telescopes, robotic precursor probes and eventually humans.

We have already detected planets orbiting other suns. Now we want to place giant telescopes in space to give us such detailed images of those planets that we can see oceans and continents on them, if they exist.

We want to send robotic colonies to other planetary bodies in our solar system, to set up the infrastructure for eventual human exploration.

We want to build colonies on the moon, Mars, the moons of other planets and even nearby asteroids.

We want to make space tourism and commerce routine.

We want to send autonomous spacecraft into interstellar space over tens of trillions of miles to explore and gather information about far away planets and stars. And we want them to make the journey in decades, not centuries or millennia.

We may even develop a Coke-can sized spacecraft that can land on an asteroid and suck up metals and minerals from the asteroid to morph itself into whatever spacecraft configuration the mission requires.

To reach these goals, to achieve our destiny in space and explore the depths of the universe, we need:

-- Autonomous systems that think for themselves, understand uncertainty and create information and knowledge from data.

--˚Robust systems that achieve much higher levels of safety and productivity with fewer people.

-- Resilient systems that perform self-diagnosis and repair and are highly durable and damage tolerant, even in the harshest conditions. You think a car has a tough time, think about a vehicle encountering vacuum radiation equivalent to a nuclear reactor.

--˚Evolvable systems that grow and expand capability to exploit new opportunities.

--˚Adaptive systems that change form and function to meet shifting demands and overcome unanticipated problems.

--˚Self-sufficient systems that require minimal on-board resources and can live off the land, without a lifeline to Earth.

-- Highly distributed systems that establish a road, continuous presence and coverage throughout the universe with highly interactive networks to achieve maximum capability and economy.

--˚Ultra-efficient systems that travel around the Earth and across the solar system rapidly, safely and at low cost with an optimal utilization of mass, power and volume.

But how do we get there?

The key will be developing biologically inspired technologies.

The main advantage biological systems have is the ability to adapt. They are robust, self-reliant, adaptable -- even evolvable — and heal when they are damaged.

Nature has all the best patents already. Just look at the human body.

The fastest computer we have today processes about a trillion operations per second and needs a megawatt of power. Now, compare that to the human brain. It processes one million times faster and requires only a fraction of a watt of power -- that's where we need to be in computing.

Biologically-inspired technologies will enable NASA and the automobile industry to achieve improved safety and reliability in the future.

How?

Faster, better, cheaper designs; more and better information; and more effective and continuous education.

The faster, better, cheaper designs will come from revolutionizing the basic approach we take for the entire design process what NASA calls the Intelligent Synthesis Environment (ISE).

This system will enable geographically distributed teams using very different computers, networks, and analytic systems to work together in a totally immersive, multi-sensory virtual environment integrating sight, sound, touch, and possibly even smell.

We could pre-build entire systems in cyber space totally within the computer. Auto and spacecraft designers wouldn t use clay or plastic mockups, but they would be able to feel the design as if an actual model were in their hands.

It will help cut design and development time by, perhaps, a factor of 10 or more and eliminate most of the testing and subsequent rework that occurs during the design process. We also want to predict cost, reliability and safety with a high degree of accuracy.

One of the biggest problems in managing huge complex programs is that we have to commit 90 percent of our resources early in the process when we only have 10 percent design knowledge. If we could simulate everything first and focus our resources where they are needed most. When ready, we will have bounded 90 percent of uncertainty and have full confidence in the total system life cycle, cost, safety, quality, and performance.

We could plan and develop every step of every mission from concept to disposal before we ever place a single order or bend a single piece of metal.

Think about what end-to-end physics-based design means for the automotive industry. Everything from styling exercises to crash tests will happen in the computer, all with a fidelity that conveys realism in what we see, touch and hear and in the analytical predictions engineers make.

Digital factories will fully model the assembly process, with anthropomorphically accurate human models.

And design teams will not be co-located, but assembled from the best talent available and brought together in 3-D, full sensory virtual reality environments.

This is not a new vision. It has been a Holy Grail of engineering visionaries for a long time. However, over the last several years mainly due to the Internet explosion there have been dramatic advances in the key technologies to make this a reality.

The combination of high speed computers and networks is creating the basis for a virtual computing environment that can be accessed over commercially available lines using low cost, high performance workstations. Essentially, whatever computing power may be needed at any given time will be available over the Internet.

Advances in computing power and networking capability have been enhanced by the way we interact with the computer itself. Today, an engineering team surrounds a small computer monitor. Tomorrow, the engineering team will be surrounded by images in true 3-D enabling us to see, feel, hear and smell our designs as they really are and to view scientific data with new insight and clarity.

Just imagine the day when computers behave more like we do. We will communicate with them using all our senses through totally immersive environments including natural language -- not simply through characters typed on keyboard. They will understand our intentions and even sense our physical state.

Sound like science fiction? We re working on everything I m talking about today.

Aboard an experimental NASA F-15 fighter, neural networks, through adaptive learning, can rapidly react to catastrophic failures of critical flight control components, such as partial loss of a wing or damage to control surfaces or hydraulics. The network then rapidly reconfigured the remaining systems to maintain aircraft control and stability.

Technology is also being developed to use natural language to communicate with computers and to employ touch and sound in the way information computers convey information.

Engineering analysis tools are incorporating ways to account for uncertainty by embedding fuzziness directly into the basic equations and getting fuzzy answers directly back. The answer to how much load a structural member can carry will not simply be 500 pounds plus or minus 50 pounds. We will pick the level of reliability needed for that car or that spacecraft, say one failure in a million, and our design system will converge on the right design.

We can do some of this today, but not for an entire system. And we certainly can t use it late in the life cycle of a vehicle. Our goal is to employ the Intelligent Synthesis Environment, from concept through design, manufacturing and operations to disposal.

NASA needs these intelligent systems for our deep space missions, where spacecraft are simply too far away to continuously rely on commands from Earth. In deep space, vehicles need to be very self-reliant. The tow truck would never be able to catch up.

I m sure you all remember the little rover we sent to Mars a few years ago. It was totally dependent on Earth-based operators to tell it where to go; and basically it could only go in straight lines or make turns by moving, stopping, turning the wheels and moving again.

It was very good at knowing when it was in trouble, when it could not get to its destination because of an obstacle, loose ground or anything else that could inhibit its course. But it could not devise a corrective solution on its own.

When in trouble it stopped and called home — which it did very well. This may not seem like much, but 140 million miles from home is a bit far to call for a tow if it is stuck in the sand. Imagine getting that call from your teenager.

The engineers that developed the rover s primitive brain used very simple commands and tested every possible scenario they could conjure up.

Future missions will be even more challenging than moving a rover over the Martian surface. Sometime this decade we plan to send a spacecraft below the ice on Europa, one of the Jupiter s moon s.

Current observations indicate a strong possibility of a liquid water ocean below Europa s icy surface. If this holds true our spacecraft —- or whatever you would call a submarine in space —- will travel on its own in a totally unknown environment. The real interest behind this mission is that biologically speaking, where there is liquid water on Earth, there is the possibility of life and Europa is, we believe, one of the few places in our solar system, other than Earth, where there is evidence of liquid water.

So the question is how do we send a submarine all the way to Europa, get it through the surface ice, propel it through the water on Europa, collect as much data as possible, and get the information back to Earth?

The system has to be pretty smart . . . almost like a human brain.

NASA s approach is to invest heavily in fundamental intelligent systems: hardware, software, a broad class of what is called soft-computing systems that include neural networks, generic algorithms that mimic biological evolution and fuzzy logic, which allows computers to work with the notion of maybe and could be, not just yes and no or off and on.

Think about the implications of these systems for the automotive industry.

Systems of the future will be safer and more reliable, in part, because they will be smarter.

We are taking the spacecraft-car link a step further with on-board navigational systems that use the constellation of Global Positioning Satellites GPS. And some systems provide direct communications access to a central service center.

We re taking it a step further by developing an Interplanetary Internet, which will support navigation and communications for missions to Mars and beyond.

Today, a modern aircraft can take-off, travel enroute and land automatically. The space shuttle routinely goes into orbit and returns from orbit automatically. While the human is always in the loop to take over if needed, automated control removes the human error that is responsible for most accidents.

Imagine telling your car where you want to go and then relaxing and enjoying the trip. Even rush hour traffic can be so much nicer when someone else is doing the driving.

All these new technologies and advanced systems are great but not if the only people who know how they work are the scientists and engineers who invent and develop them. The nation s space and aeronautic systems, like the millions of vehicles on the highways, are supported by thousands of people who make them work day by day and deal with the things that go wrong.

The same technology we will use to design our vehicles better, faster and cheaper will enable us to provide life-long training and education for the entire work force. Smarter cars **and** smarter people.

We already have the virtual classroom, but in the future, students will participate in laboratory experiments and work on fully realistic 3-D digital models.

Each person in the class will feel like they are all in the same place at the same time. When your senses say you are there, the geographic reality is irrelevant. Technicians, engineers, and managers will be engaged in this process throughout their entire careers.

This also means the people in the field who fix the cars will be fully educated about all new products before they come out. In fact, they will likely be involved in the basic design process.

As we involve the entire work force in a product s complete life cycle, the better the product will be. And the more educated our workforce is, the safer and more reliable they will be.

On my way to the airport this morning, I looked into the sky as I passed the Capitol. The moon was so bright it reminded me that we haven t been there in decades.

Since I was coming to speak to the dreamers and doers of the automotive industry, I knew you d want to think about the amazing possibilities before us.

The programs and technologies I have mentioned are leading us toward a revolution in personal transportation, including airflight by anyone at anytime from anywhere. It will open access to the nation s 5000 plus airports, even those without control towers. And eventually, we will have runway independent aircraft.

Aircraft will become so safe, flying a plane will be like driving a car. Not only will we have driver s ed, we will have flyer s ed.

Now we re already working on many of these technologies, while others are a little further out.

But when the revolution in personal transportation takes place, everyone in the automotive sector could be well-positioned to take the lead.

Notice I said **could**.

I ve given you the possibilities but the rest is up to you.

It s time to take a deep breath and leap off the cliff.

Don t forget to build your wings, because when you do, you will revolutionize life in the 21st century.

Thank you.