

UNITED STATES DEPARTMENT OF  
TRANSPORTATION

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NATIONAL HIGHWAY TRANSPORTATION  
SAFETY ADMINISTRATION

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MASS-SIZE-SAFETY SYMPOSIUM

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MONDAY,  
MAY 13, 2013

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The Symposium convened in the  
Robert S. Marx Media Center at DOT  
Headquarters, located at 1200 New Jersey  
Avenue, S.E., Washington, D.C., at 9:00 a.m.,  
Christopher Bonanti, Moderator, presiding.  
PRESENT:

CHRISTOPHER BONANTI, Moderator  
DAVID STRICKLAND, NHTSA Administrator  
GREG KOLWICH, FEV  
GREGG PETERSON, Lotus Engineering  
JACKIE REHKOPF, Plasan (via telephone)  
DOUG RICHMAN, The Aluminum Association  
STEPHEN RIDELLA, NHTSA

SCOTT SCHMIDT, Alliance of Automobile  
Manufacturers  
HARRY SINGH, EDAG, Inc.  
JAMES TAMM, NHTSA  
CHUCK THOMAS, Honda  
BLAKE ZUIDEMA, Arcelor Mittal

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P-R-O-C-E-E-D-I-N-G-S

9:05 a.m.

1  
2  
3 MODERATOR BONANTI: Well, good  
4 morning and welcome to NHTSA's Mass-Size-  
5 Safety Workshop. My name is Christopher  
6 Bonanti. I'm the Associate Administrator for  
7 Rulemaking here at NHTSA. We are very -- we  
8 have a very full agenda and the room is  
9 expected to be packed today.

10 Please be courteous and make room  
11 for others by not placing items on the seats  
12 next to you.

13 I would like to thank you all for  
14 coming and we are looking forward to hearing  
15 from all our expert panelists about the  
16 engineering and realities as well as the  
17 statistical evidence of the roles of mass and  
18 size in safety.

19 First, it is my pleasure to  
20 introduce my boss, Administrator David  
21 Strickland. Mr. Strickland was sworn into  
22 office on January 4, 2010. Since then, he has

1       overseen the development of the First National  
2       Fuel Efficiency Program and oversees a broad  
3       range of vehicle safety and policy making  
4       programs, which support NHTSA's mission to  
5       reduce crash-related fatalities and injuries.

6                       Prior to his appointment, Mr.  
7       Strickland served for eight years on the staff  
8       of the U.S. Senate Commerce, Science and  
9       Transportation Committee and Senior Council  
10      for the Consumer Protection Subcommittee.

11                      He originally hails from Atlanta,  
12      Georgia. He received his law degree from  
13      Harvard University and his bachelor's degree  
14      from Northwestern University. Mr. Strickland?

15                      (Applause)

16                      ADMINISTRATOR STRICKLAND: Thank  
17      you, Chris, and good morning, everyone.  
18      Welcome to our second Mass and Size Symposium.  
19      It has always been a very daunting task for me  
20      to get in a room full of people who are  
21      intensely bright and I am intensely not very  
22      bright, well, on these issues. I'll give

1 myself a pat on the back on other things I may  
2 be bright about.

3 But it really is an important work  
4 for us here at NHTSA. We have worked very  
5 hard in establishing the National Program  
6 along with the EPA and also in partnership  
7 with the California Air Resources Board.

8 And part of the work that we had  
9 to think about was how do we get as stringent  
10 a standard as possible, but within the  
11 realities of the costs and benefit,  
12 affordability for the folks that are buying  
13 these vehicles and, of course, never  
14 compromising safety.

15 And the work that went into the  
16 standards that actually began in 2012 and go  
17 out to 2021 are incredibly stiff. Now,  
18 recognizing that the industry right now is  
19 stepping up to meet the challenges of these  
20 standards today. We are now preparing or  
21 actually in full throes getting into our work  
22 for the mid-term review for setting the final

1 standards for 2022 to 2025.

2 Now, there is a lot of technology  
3 pipelines that are going to be used in order  
4 to achieve these standards. And one of these  
5 pathways is clearly usage of the reduction of  
6 mass and size and weight in a safe way.

7 Now, while we have been working  
8 for a very long time on these fuel economy  
9 standards over the past several decades, we  
10 really are sort of at a new part in our future  
11 in looking at CAF<sup>2</sup>.

12 We have the foundation of the Ten-  
13 in-Ten Fuel Economy Act, so even beyond our  
14 fuel -- our current rulemaking, we have a  
15 statutory mandate to establish standards out  
16 to 2030.

17 So clearly, the work in the  
18 foundation that we are looking at today and  
19 our approaches as we look at the midterm  
20 review for 2022-2025 will also be the  
21 foundation of that work in the future as well  
22 going forward.

1                   So we are using an engineering  
2                   approach to investigate how much mass  
3                   reduction can be affordably and feasibly  
4                   achieved while still maintaining vehicle  
5                   safety and reasonable levels of major  
6                   functionality, such as noise, vibration and  
7                   harshness. These factors can have a  
8                   significant impact on drivers' awareness of  
9                   road conditions and on performance.

10                   At the same time, we are studying  
11                   new challenges that lighter vehicles might  
12                   bring to vehicle safety and the potential  
13                   counter-measures to be effectively able to  
14                   manage these challenges.

15                   Today our goal is to present  
16                   results from studies completed so far, obtain  
17                   feedback and solicit ideas about how the  
18                   agencies should be considering these  
19                   questions.

20                   NHTSA will continue to examine  
21                   these issues as we approach the next round of  
22                   rulemaking. We look forward to receiving as



1 much input as possible on the complicated  
2 studies and to help us refine our approach  
3 going forward. Today, we will hear from  
4 researchers who have done this engineering and  
5 statistical analysis.

6 We have invited OEMs, material  
7 suppliers and safety specialists. There will  
8 be a lot of information shared and you will be  
9 hearing more detail about how these studies  
10 are coming together today and tomorrow.

11 The overview is that NHTSA and the  
12 other Government agencies have completed a  
13 number of studies in all major areas of  
14 vehicle mass reduction and safety analysis and  
15 we are excited to receive the input from the  
16 stakeholders and the public.

17 It really is our opportunity to  
18 sort of learn, be incredibly transparent and  
19 share our work, but more importantly be able  
20 to receive the input from all the experts in  
21 the room today. It really is how we can sort  
22 of make sure that we have the best standard

1 possible to address NHTSA's mission, which is  
2 the reduction of the dependence on foreign oil  
3 and for reduction of greenhouse gases, but,  
4 first and foremost, making sure that safety is  
5 always the number one priority.

6 Thank you so much everyone. Have  
7 a fantastic two days worth of information  
8 sharing here at the symposium and looking  
9 forward for the results in the days, months  
10 and weeks ahead. Thank you so much.

11 (Applause)

12 ADMINISTRATOR STRICKLAND: Thank  
13 you.

14 MODERATOR BONANTI: Okay. Before  
15 we continue with our speakers, a few  
16 housekeeping and ground rules for the meeting  
17 to be a success.

18 Now, for those needing to place  
19 your luggage or other materials, we have -- we  
20 reserved Room No. 5, which is across the way.  
21 Also for visitors to the building, all  
22 visitors must be escorted at all times. If

1 you need to leave the conference center area,  
2 please, notify one of our escorts located by  
3 the door of the media center.

4 Please be aware that no food is  
5 allowed in the media center and only drinks  
6 with lids are, basically, allowed.

7 There is a small coffee kiosk in  
8 the front that -- in the atrium just outside  
9 the doors that you can get some coffee or  
10 beverages in that regard.

11 Also, please silence your cell  
12 phones and BlackBerrys. Also, please be aware  
13 that this workshop is being broadcast over the  
14 web and open to the public. There are  
15 microphones in the ceiling and at the same  
16 time, please, be aware that even during  
17 breaks, you may be heard from others around  
18 the country that are logging in through the  
19 web, at this time.

20 Bathrooms are located either  
21 outside towards the left hand side, outside  
22 the media center to the left or you can go out

1 and to the right and it curves around to the  
2 back.

3 Also, in the event of an  
4 emergency, I'll have Lixin from my staff dial  
5 911. Also, if the building alarm system is  
6 activated for a fire or an emergency, please,  
7 exit quickly and do not collect your personal  
8 belongings.

9 We will break for lunch around  
10 11:50. Escorts are available to walk you to  
11 the building exit. You must be escorted at  
12 all time while in the building, so we ask that  
13 you refrain from going to the DOT cafeteria  
14 unless you have lunch with someone from the  
15 DOT that will meet you here.

16 We have provided a map of local  
17 eateries in your agenda. To return to the  
18 conference center area after leaving the  
19 building, escorts will be available at the  
20 front door at 12:45 on.

21 Please return in time to resume  
22 the meeting by 1:20. Please, make sure that

1 when -- you have to account for time going  
2 through security.

3 As you can see, today we have a  
4 very full agenda. Our speakers each have  
5 limited time, so if you could, please, hold  
6 your questions and comments for the end of  
7 each presentation, it is appreciated. I'll be  
8 watching the time closely. I didn't bring my  
9 hook, but, you know, I will signal to every  
10 presenter when your time is getting close to  
11 the end and also when your time is expired.

12 Question cards have been  
13 identified and left on each individual seats.  
14 Please submit your questions to the NHTSA  
15 volunteers who will periodically walk around  
16 the room collecting cards. Do not wait until  
17 the end of the presentation, so that we will  
18 have the questions in hand as soon as the  
19 presentation is finished.

20 I will be asking the questions to  
21 each one of the presenters and also at the end  
22 of the day.

1                   If you are listening to the  
2                   webcast, you may submit questions on-line. At  
3                   the end of the day, as I was indicating, I  
4                   will have a 30 minute presentation for a  
5                   focused discussion with all the panelists.

6                   During that time, we will allow  
7                   the audience to share questions or comments  
8                   which will also be requested to be placed on  
9                   the cards. We realize that there is much to  
10                  contribute and apologize for the time  
11                  constraints. We ask you to, please, submit to  
12                  the docket any questions or comments that we  
13                  were unable to get to.

14                  It is located at NHTSA-2010-0152.  
15                  I'll say it again so for those that are  
16                  writing it down. NHTSA-2010-0152. With that  
17                  said, we are ready to begin.

18                  Our first speaker is James Tamm,  
19                  Division Chief for our CAF<sup>2</sup> Program in my  
20                  office, who will present the assessment of  
21                  vehicle mass reduction feasibility, cost and  
22                  safety effects for CAF<sup>2</sup> and greenhouse gas

1 rulemakings. Thank you.

2 MR. TAMM: Okay. Bear with us as  
3 we are taking care of our technical difficulty  
4 here. We're trying to get the presentation on  
5 the screen.

6 Okay. Thank you, Chris, and  
7 hopefully for everybody who will be  
8 presenting, we will have this all up and  
9 operating when you get up here.

10 So anyway, I just wanted to first  
11 say how pleased we are to have this large  
12 turnout. We also have a number of people who  
13 are monitoring on the web, so welcome to  
14 everybody to today's workshop.

15 The topic that we are discussing  
16 today is, as David Strickland had mentioned,  
17 very important to NHTSA and also to EPA and  
18 CARB and to DOE. As -- particularly as the  
19 agencies move forward to the midterm  
20 evaluation and NHTSA's full rulemaking, which  
21 will be conducted for model years 2022 to  
22 2025.

1 I'm going to be today sharing how  
2 the agencies assess the feasible amount of  
3 mass reduction, the cost for mass reduction  
4 and the safety effects for mass reduction.

5 So I'll first start with -- let's  
6 see, I think we are going back one. I think  
7 I got it here, Lixin, so thanks.

8 So as far as the specific topics  
9 I'm going to run through, it's going to be  
10 very brief. A few comments on the 2017 to  
11 2025 rulemaking that are relevant to mass  
12 reduction and safety. I'm going to talk a  
13 little bit about the midterm evaluation and  
14 the 2022 to 2025 rulemaking. And then focus  
15 mostly on, basically, an overview of how the  
16 agencies have assessed the feasible amount of  
17 mass reduction and cost.

18 I kind of tied together some of  
19 the presentations we will be seeing today.  
20 And also how the agencies look at safety for  
21 mass reduction, again, trying to tie it  
22 together, a perspective on how we have been



1 looking at things in our rulemakings.

2 So as far as the 2017 and beyond  
3 CAFE and Greenhouse Gas Emission Standards,  
4 first, the -- in the last two rulemakings, we  
5 have conducted joint rulemaking with EPA. And  
6 California Air Resources Board has  
7 participated with NHTSA in assessing the  
8 effectiveness and cost of technologies as well  
9 as the infrastructure for distributing  
10 alternative fuels.

11 In the rulemakings, NHTSA is  
12 responsible for and has issued fuel economy  
13 standards. EPA has issued greenhouse gas  
14 emission standards. And the CARB has accepted  
15 compliance with the Federal Greenhouse Gas  
16 Emissions Program as compliance with the CARB  
17 Standards.

18 And the most recent rulemaking for  
19 2017 and beyond was published in October of  
20 2012. In establishing the standards, the  
21 agencies have conducted extensive technical  
22 economic and environmental analyses. And a

1 key part of assessing the technologies that  
2 can prove fuel efficiency, the effectiveness  
3 of technology and cost and also the price --  
4 I'm sorry, the pace at which industry can  
5 implement the technologies that are different  
6 assessments we have done.

7 The analysis that the agencies  
8 have done, we have put forth analysis that  
9 shows pathways that the industry could use to  
10 comply with the standards. And we have used  
11 those pathways that we have analyzed along  
12 with other analyses to establish stringency  
13 for standards as well as to assess what the  
14 cost and the benefits are for the program.

15 It is important to note that the  
16 standards that are issued are performance-  
17 based standards, so we don't mandate any  
18 specific technologies be used to comply with  
19 those standards. And the manufacturers are  
20 really free to choose whatever technologies  
21 they feel are most effective for compliance.

22 Next, I would like to move to the

1 midterm evaluation and NHTSA's Rulemaking for  
2 2022 to 2025. So there is a provision in the  
3 Energy Independence and Security Act of 2007  
4 that limits NHTSA to establishing Fuel Economy  
5 Standards for no more than five years at a  
6 time.

7 So based on that, the standards  
8 that were established for 2017 and beyond for  
9 NHTSA were final for model years 2017 to 2021,  
10 but the standards for 2022 to 2025 are not  
11 final. We went to the dictionary and found  
12 the word augural to describe those standards,  
13 which just means they are not -- well, they  
14 are not final, but they would suggest what  
15 standards would be had we had authority to  
16 finalize them at the point in time that we  
17 issued the standards.

18 So NHTSA will be conducting a new  
19 rulemaking for model years 2022 to 2025. And  
20 that will be based on the best available  
21 information at the time of that rulemaking.  
22 It is going to be comprehensive rulemaking.

1 It will be similar to the rulemaking that we  
2 just recently finalized, so it's going to be  
3 fully comprehensive. It will provide  
4 opportunity for public notice and opportunity  
5 for comment to that rulemaking.

6 The EPA Regulations that were  
7 issued with the standards in October require  
8 EPA in the future to determine whether the  
9 2022 to 2025 standards, Greenhouse Gas  
10 Standards are appropriate under the Clean Air  
11 Act, based on circumstances at the time of the  
12 review.

13 So in regulation, EPA will make  
14 this determination no later than April of  
15 2018. If EPA determines that the standards  
16 are appropriate, then they will issue a final  
17 decision. If EPA determines that they are not  
18 appropriate, then they will initiate a  
19 rulemaking to change them.

20 Also connected is that there is  
21 another element in EPA Regulations is that  
22 there will be a midterm assessment that will

1 be conducted and that will be conducted by  
2 EPA, NHTSA and the California Air Resources  
3 Board. There is a requirement to complete a  
4 joint draft technical assessment report by  
5 October of -- I'm sorry, November of 2017.

6 And on this slide, we took a whack  
7 at trying to put things on a time line for the  
8 rulemaking. The one thing that is important  
9 here is that the regulatory text basically  
10 says no later than dates, so there is a  
11 possibility the agencies could conduct one or  
12 more of the elements ahead of the time frame.

13 But this basically shows that in  
14 2012 we did the Final Rule. We are indicating  
15 up through about 2016 this key time for the  
16 Agency's work and research to inform the  
17 midterm evaluation and the rulemaking for  
18 NHTSA.

19 Okay. So in the agency's  
20 analysis, we identified and believe there are  
21 certainly a wide range of technologies that  
22 manufacturers can use to comply with the new

1 standards. And one of those technologies is  
2 mass reduction and, of course, the focus of  
3 our discussion today.

4 Why is it important? Well,  
5 literature and evaluations support that for  
6 each 10 percent reduction in mass, that the  
7 fuel efficiency of the vehicle can be improved  
8 by 6.5 percent and that's assuming that the  
9 engine is downsized to maintain performance.

10 So based on the effectiveness of  
11 mass reduction, we expect and we have also  
12 heard from manufacturers, though fairly  
13 widely, that mass reduction will be an  
14 important technology in complying with  
15 standards moving forward.

16 So therefore, we are sponsoring  
17 this workshop. We think this is part of an  
18 ongoing effort to, basically, be looking at  
19 developments in projecting what can be done  
20 with mass reduction, what its feasibility and  
21 costs are going forward, as well as to look at  
22 its impacts on safety.

1                   Go back one. Sorry. So on this  
2                   topic, manufacturers, the Government agencies,  
3                   supplier groups, universities and other  
4                   interest groups have been sponsoring studies  
5                   to determine how much mass can be reduced from  
6                   a light-duty vehicle. And the studies have  
7                   really varied very widely.

8                   Some have focused on body-in-  
9                   white, some on closure, some on components,  
10                  some on materials, such as steel-focus, some  
11                  on aluminum and some have considered costs  
12                  very broadly.

13                  In determining how much mass  
14                  reduction is feasible, we really feel it is a  
15                  fairly complicated undertaking. And the study  
16                  results can really vary based on a number of  
17                  factors, including the baseline vehicle that  
18                  the study was starting from, the production  
19                  volume of that vehicle, the mass reduction  
20                  techniques considered, cost constraints and to  
21                  the extent to which vehicle functionality is  
22                  maintained, as well as the time frame for the

1 study, what model years the projections are  
2 for.

3 So in order to assess the feasible  
4 amount of mass reduction and cost, the  
5 agencies, NHTSA, EPA and CARB, have conducted  
6 studies each using holistic vehicle design  
7 approaches.

8 And this slide provides an  
9 overview of the studies that the agencies have  
10 sponsored. At the top is a study based on the  
11 2009 Toyota Venza that CARB sponsored that was  
12 completed in 2010. The study developed two  
13 design concepts, what is so-called low-  
14 development design which had 20 percent mass  
15 reduction and a high-development design that  
16 had over 30 percent mass reduction.

17 And the design concepts from this  
18 so-called Phase 1 work were then studied in  
19 Phase 2 follow-on studies by EPA and CARB.  
20 And the first of those Phase 2 studies was  
21 funded by EPA and ICCT. We will be hearing  
22 about that later this morning.



1                   It started with the low-  
2 development design concept from Phase 1. The  
3 primary contractor was FEV, EDAG served as a  
4 subcontractor. The study used technologies  
5 that were judged to be mature for high-volume  
6 production in 2017, that included detailed  
7 engineering and cost analysis for the whole  
8 vehicle, used material substitution with gauge  
9 and grade optimization for the body structure  
10 and closures. This particular study did not  
11 look at changes in geometry.

12                   Other components used a best-in-  
13 class design approach and then those designs  
14 being rescaled to the Venza application.

15                   The second study was sponsored by  
16 CARB and the ICCT. The work started with a  
17 high-development concept from Phase 1. The  
18 contractor was Lotus Engineering and the study  
19 included additional analysis from the Phase 1  
20 study for the vehicle structure and the  
21 closures. It used an aluminum-intensive body  
22 design and included a new cost analysis for

1       that body structure and the closures.

2                       The third study was sponsored by  
3 NHTSA and the baseline vehicle was a 2011  
4 Honda Accord. The primary contractor was  
5 Electricore and subcontractors were EDAG and  
6 George Washington University.

7                       The study focused on detailed  
8 engineering design and cost analysis for the  
9 whole vehicle. The body structure and  
10 closures were optimized for geometry, grade  
11 and gauge.

12                      That study used technologies that  
13 were judged to be mature for high-volume  
14 production in 2020 and the design criteria was  
15 to maintain the same functional performance as  
16 the baseline vehicle.

17                      As far as future work, the EPA has  
18 a current study on light-duty truck and that  
19 is with FEV as primary contractor and EDAG as  
20 subcontractor. Also, we have, NHTSA, posted  
21 a synopsis on fedbiz.org for a potential study  
22 of a light-duty truck.

1           So one challenge that the agencies  
2           face in rulemaking is determining the feasible  
3           amount and cost of mass reduction for each  
4           year is that the number of data points that we  
5           have to try to determine what is  
6           representative for the overall fleet.

7           Basically, if you look at the  
8           studies that we are representing here, there  
9           is really three studies, so we have got three  
10          point estimates that are covering two vehicle  
11          models and we are really trying to extrapolate  
12          those findings across the entire fleet to  
13          reflect the influence of our regulations.

14          So as part of that, as mentioned  
15          earlier, the assumptions that are used in each  
16          of these studies is important and each of the  
17          presenters today will be talking about what  
18          those assumptions were as well as their  
19          attempts to basically project what the cost  
20          curve would be for the entire fleet based on  
21          the study.

22          So we think this is an inherently

1 difficult task and that's why this dialogue is  
2 a very important element as we go forward. We  
3 are really seeking comments on what, if any,  
4 studies was done right? Are there things that  
5 could be improved going forward? There will  
6 be valuable dialogue.

7           So each of the studies included  
8 simulation modeling to assess the performance  
9 to FMVSS, NCAP and IIHS tests. But  
10 additionally, NHTSA and EPA consider the  
11 effects of mass reduction on societal safety.

12           And what is societal safety?  
13 Basically, it is the safety of the overall  
14 fleet that is on the road and pedestrians.

15           So NHTSA has long-considered the  
16 potential safety effects in determining the  
17 maximum feasible CAFE Standards. If OEMs are  
18 going to be reducing vehicle mass or building  
19 smaller vehicles in response to future CAFE  
20 Standards, we want to, basically, anticipate  
21 whether there will be safety implications and,  
22 if so, what are those safety implications?

1                   So for example, if manufacturers  
2                   make lighter vehicles, stiffer to protect  
3                   against intrusion in a crash making the  
4                   vehicle stiffer will affect both the forces on  
5                   the vehicle's occupants in a crash as well as  
6                   the forces of that stiffer vehicle would exert  
7                   on other vehicles in the fleet that it may  
8                   crash in to. And so these are the  
9                   interactions that we need to understand.

10                   We are also concerned that lighter  
11                   vehicles have a higher change in velocity in  
12                   a crash and that would result in potentially  
13                   higher injury and fatality risks during  
14                   crashes with heavier vehicles. So  
15                   understanding this dynamic is going to be  
16                   important because heavier legacy vehicles will  
17                   persist in the fleet during the transition to  
18                   the lighter and smaller vehicles.

19                   CAFE Standards should be designed  
20                   to encourage manufacturers to pursue a path  
21                   toward compliance that is both safe and cost-  
22                   effective.

1                   NHTSA is assessing the societal  
2 safety using two different approaches. The  
3 first is what we termed as a backward-looking  
4 approach which uses the statistical analysis  
5 of historical crash data to assess the effects  
6 of vehicle mass reduction and size on safety.  
7 That is going to actually be the topic that  
8 will be focused on in tomorrow morning's  
9 portion of the workshop.

10                   The second approach is what we are  
11 terming as a forward-looking approach, which  
12 uses engineering design in analysis models.  
13 It, basically, is performing crash simulations  
14 using these CAE models that I mentioned  
15 earlier. And the results of that will be  
16 discussed, as far as NHTSA's first phase of  
17 that work, later this afternoon.

18                   So I'm just going to talk briefly  
19 about each of those, the forward -- first, the  
20 rearward-looking and then the forward-looking.  
21 So we will start with the statistical analysis  
22 of historical data.

1                   So in the statistical analysis of  
2 historical crash data approach, we believe  
3 that this is useful for several reasons.  
4 First, it shows what the real-world trends are  
5 in crash incidence and severity. It can show  
6 it for smaller versus larger vehicles and it  
7 can show it for lighter versus heavier  
8 vehicles.

9                   This information is really not  
10 available through other methodologies and it  
11 provides the Agency with a pool of data to  
12 analyze as well as enables us to look at  
13 different crash scenarios and exposures.  
14 However, there is also drawbacks that we  
15 recognize.

16                   First, there is a question because  
17 the data is historical, is it -- are we  
18 confident that it represents what is going to  
19 happen in the future?

20                   And also, because the data are  
21 mixed from various crash scenarios and  
22 exposures, some times there is not enough data

1 to pinpoint the exact cause.

2 So researchers have been using a  
3 statistical analysis of the historical crash  
4 data to evaluate trends for over a decade.  
5 NHTSA's doctor Chuck Kahane, Mike Van Auken of  
6 Dynamic Research Incorporated, Tom Wenzel of  
7 Lawrence Berkeley National Lab among others,  
8 have published a number of analyses.

9 The body of research has yielded  
10 in the past conflicting results. Some studies  
11 showing significant increase in fatality with  
12 mass reductions and others finding a decrease  
13 in fatalities. So to -- as far as way of  
14 background, in the past, NHTSA sponsored a  
15 peer review of over 20 studies to assess  
16 methodologies and that was completed in 2011  
17 by Dr. Paul Green from the University of  
18 Michigan.

19 Also in the prior mass reduction  
20 workshop that we had, there was -- it was  
21 postulated that a part of the reason for the  
22 different results stem from the analysis being



1 conducted using different databases and  
2 different statistical methodologies.

3 So since then, NHTSA and DOE with  
4 help from EPA created and published a common  
5 updated database for the statistical analysis  
6 and that consists of fatality data from model  
7 year 2000 to 2007 vehicles in calendar years  
8 2002 to 2008. And anyone that's interested in  
9 doing research has access to that database.  
10 It's on the NHTSA website and can be  
11 downloaded.

12 And we are thinking that having  
13 that has helped with the most recent round of  
14 analyses in at least helping to reduce one of  
15 the sources of variations in the studies. So  
16 using that common database, Dr. Kahane has  
17 updated his 2010 Fatality Study. Also, Mr.  
18 Wenzel has independently replicated Dr.  
19 Kahane's work as well as updated his 2010  
20 Casualty Study.

21 Dynamic Research Incorporated has  
22 also been working with the database and others

1 such as Chrysler have downloaded the database  
2 and done some analysis.

3 So we are really hoping for a good  
4 robust discussion of that issue. Again, that  
5 is going to be tomorrow morning.

6 So moving back to our rulemaking  
7 just to tie this in, what do we do with that  
8 analytical data? We use, basically in our  
9 analysis, mass reduction levels that achieved  
10 a net neutral effect on safety. So therefore,  
11 the analyses that the Agency has conducted for  
12 the 2017 to 2025 rulemaking showed a path that  
13 industry could use that maintains overall  
14 fleet safety while complying with the  
15 standards.

16 The chart at the bottom shows the  
17 -- the section at the bottom shows the --  
18 well, first -- well, second row from the  
19 bottom is the maximum amount of mass reduction  
20 that the analysis allowed for these different  
21 subsegments of the vehicle fleet. And then  
22 the bottom row shows the projected industry

1 average mass reduction by each of these  
2 classes to achieve that result.

3 In these -- go back. I'm sorry.  
4 So just for reference, these mass reduction  
5 levels are referenced to 2010 fleet. And it  
6 is -- one thing that is important to stress is  
7 that all vehicles must meet applicable safety  
8 standards and we have expectation that  
9 manufacturers will continue to build vehicles  
10 that perform well to NCAP and IIHS testing.

11 Okay. So then lastly, I'm going  
12 to just have just a few remarks on NHTSA's  
13 forward-looking assessment of societal safety  
14 effects. And part of this research uses the  
15 finite element models that were developed as  
16 part of the light-weighting studies that were  
17 mentioned earlier and NHTSA is using those  
18 models to evaluate how those proposed designs  
19 perform in a variety of simulated crash  
20 configurations.

21 The -- really what I'm saying is  
22 that, you know, the FMVSS, NCAP and IIHS tests

1 are very important parts of analysis, but they  
2 can't capture all the diversity of types of  
3 crashes that occur in the real-world.

4           So NHTSA sponsored this work. It  
5 has been -- the contractor was George  
6 Washington University. It, basically, is  
7 conducting simulations of vehicle-to-vehicle  
8 and vehicle-to-object crashes. And again, as  
9 mentioned, they are moving beyond the crash  
10 conditions that are used for standards and  
11 voluntary ratings.

12           So we are looking at broader array  
13 of speeds and conditions. We are also -- we  
14 have conducted some compatibility work between  
15 light-weighted and non-light-weighted  
16 vehicles. And we are intending to use the  
17 study in the future to evaluate potential  
18 counter measures which could include different  
19 airbag deployment timing for lightweight  
20 vehicles and potentially adaptive occupant  
21 restraint systems.

22           So the first phase of the study is

1 nearly complete. We are going to hear about  
2 it later today. We expect it to be completed  
3 with a peer review in July of this year.

4 And let's see with that, next  
5 steps. I'm not going to comment on next  
6 steps. There were some that were filtered  
7 into -- were included in what I just remarked  
8 here. But some of the speakers will be,  
9 basically, covering some of the future work  
10 that is intended with studies.

11 So with that, again, in advance I  
12 just want to thank everybody for participating  
13 here today. We look forward to some good  
14 questions from the audience, some good  
15 dialogue among the panelists. So thank you  
16 very much.

17 (Applause)

18 MODERATOR BONANTI: Okay. I  
19 understand that our next speaker needs to flip  
20 out their laptop. Is that correct?

21 MR. TAMM: Yes, that's correct.

22 MODERATOR BONANTI: Okay. Do you

1 have the computer?

2 MR. TAMM: Yes.

3 MODERATOR BONANTI: Oh, Lixin is  
4 getting it. Okay. Great. Okay. While --  
5 the next speaker is actually Gregg Peterson  
6 from Lotus Engineering and is going to be  
7 discussing the analysis of the impact  
8 performance and cost considerations for a low  
9 multi-material body structure.

10 Again, if you have any questions,  
11 please, we will have volunteers going through  
12 the aisles with any questions that you may  
13 have. Please write them down on your -- on  
14 the pads or the cards that we provided and we  
15 will be collecting them and being able to ask  
16 them towards the end of the presentation.

17 Unfortunately, we are having some  
18 technical difficulties here. For those that  
19 are on the webcast, please, just bear with us.  
20 Okay. This is long.

21 Replication of Dr. Kahane's  
22 analysis is done for the ICCT by DRI. It adds

1 an analysis of the separate effects of mass on  
2 crash probability and crash outcome. That  
3 analysis shows that while there are some  
4 opportunities statistically significant  
5 relationships between mass and crash  
6 probabilities, there are no statistically  
7 significant negative effects of the mass on  
8 crash outcomes.

9 Are there any theories consistent  
10 with this result? That's the first question.

11 Does this change NHTSA's  
12 understanding of the mass and safety? That's  
13 the second question.

14 And the word apparently -- oh,  
15 okay. So is that the end of it, the end of  
16 the question? Okay. Okay.

17 So the first question we will go--

18 PARTICIPANT: We have a theory to  
19 explain the follow-up mass crash probability -  
20 - increases crash probability, but does not  
21 bundle the effects of crash outcomes.

22 MR. TAMM: Okay. Those are

1 excellent questions. You know, I think  
2 actually I'm going to defer those though to  
3 one of our experts, Dr. Kahane, because I  
4 think he has taken a closer look. I don't  
5 know if Steve can. Yes, which he just left,  
6 so I don't mean to dodge the question, but I  
7 think we will probably get a little more  
8 informed answer to get his perspectives on it,  
9 which would be tomorrow, yes.

10 Yes, okay, and I guess related to  
11 that, I mean, we will have copies of the  
12 transcripts from this meeting, so we will hold  
13 that question and make sure it gets asked  
14 tomorrow and have discussion on that point.  
15 We will make sure that gets covered.

16 MODERATOR BONANTI: Okay. We are  
17 going to be downloading a -- are there other  
18 questions, at this point? I understand there  
19 is one at least. Okay. And this is for Jim  
20 as well? This question is for Jim Tamm as  
21 well? Oh, he will answer it tomorrow. He  
22 will answer his question tomorrow. Okay.



1                   Actually, if we get this back up  
2                   in a minute, we are still on time. So  
3                   hopefully this will work. We are switching  
4                   out computers. There you go. Okay.

5                   No further ado, Gregg Peterson.

6                   MR. PETERSON: All right. Thanks,  
7                   Chris. All right. I would like to thank  
8                   NHTSA for the opportunity to present today.  
9                   I apologize for the technical difficulties.  
10                  I'm going to be running without animation  
11                  here.

12                  James covered pretty much what I  
13                  wanted to talk about in the first slide here  
14                  in terms of the background. There is a lot of  
15                  information here and I'm not going to go  
16                  through it in any detail.

17                  Suffice it to say, there are a  
18                  number of studies done on what I'm going to be  
19                  talking about today.

20                  All right. So to continue what I  
21                  am going to be talking about today will be the  
22                  continuation of the Phase 1 high-development,

1 which was targeted for a 40 percent mass  
2 reduction. And essentially what happened, we  
3 published a White Paper and predicted roughly  
4 a 40 percent mass reduction was cost-effective  
5 and essentially ARB challenged Lotus to show  
6 that a very lightweight body structure could  
7 meet federal crash requirements as well as  
8 some internal standards for bending and  
9 torsional stiffness.

10 So that's what I'm going to be  
11 talking about. As part of the process, we  
12 shared our early models with NHTSA. They were  
13 crash testing the vehicle independently using  
14 their modeling. George Washington University  
15 was involved as part of the study.

16 We also worked very closely with  
17 the EPA and Department of Energy. The  
18 Department of Energy contributed to the  
19 material science as part of this study. And  
20 this paper was published in 2012.

21 This is the Phase 1 mass and cost  
22 results. And essentially, we found about a 38

1 percent mass reduction and the very surprising  
2 thing was about only a 3 percent cost hit.  
3 And that came about, number one, the body-in-  
4 white cost was about plus 35 percent, but  
5 every other system we found, essentially,  
6 about a 4 percent cost-save.

7           And the reason for that is you  
8 take 30 or 40 percent out of a vehicle and use  
9 pretty similar materials in every area but the  
10 body-in-white structure, you are going to  
11 effectively be able to save some money.

12           And that's really what we  
13 predicted from the Phase 1 study. There was  
14 no analysis as part of this that was beyond  
15 the scope of the project.

16           So what are some of the  
17 fundamental designs/factors affecting vehicles  
18 today? Well, obviously, fuel economy and  
19 emissions. So these are key areas that  
20 everyone is very concerned about, very good  
21 objectives in terms of saving U.S. consumers  
22 money as well as saving billions of tons of

1 emissions.

2           The -- it is important to note  
3 that the 54.5 mile per gallon standard  
4 translates to somewhere around 40 mile per  
5 gallon EPA sticker number. So it's not quite  
6 as severe as what it sounds like to the  
7 general public.

8           Factors that affect fuel economy,  
9 James hit on that. Every 10 percent reduction  
10 gives about 7 percent fuel economy increase.  
11 So about 30 percent results in roughly a 20  
12 percent fuel economy savings, that's with  
13 equivalent powertrains.

14           There are also some other effects  
15 that happen as a result of this. You get into  
16 mass de-compounding effect where you hit a  
17 tipping point and it allows you to redesign  
18 some of the body systems and some of the  
19 chassis systems to help make your vehicle  
20 lighter.

21           There is also a positive effect on  
22 dynamic performance. We found that the tire

1 size doesn't shrink as fast as the mass  
2 reduction, so that effectively you get more  
3 tire contact patch area per pound of vehicle  
4 weight, which can help in emergency situations  
5 and dynamic transitions.

6 Okay. There are other factors  
7 that affect fuel economy besides mass and I'm  
8 just showing some examples here that don't  
9 follow the 10 percent mass-reduced vehicle  
10 that will get you about 7 percent better fuel  
11 economy.

12 The Toyota Scion that is shown at  
13 the end there has about 10 percent less  
14 weight, yet it has 37 percent better fuel  
15 economy than the baseline Nissan Versa that I  
16 show there. A much heavier car, the Chevy  
17 Cruze Eco which weighs almost 30 percent more  
18 than the baseline gets 22 percent better fuel  
19 economy.

20 So there are, obviously, other  
21 factors besides mass that you need to pay  
22 attention to when you are designing a vehicle.

1           In terms of lightweight effect on  
2 performance, there is, obviously, fuel  
3 economy, but there are also an improved  
4 potential for braking, handling, acceleration  
5 times remain the same with a properly designed  
6 engine system to give you the same weight-to-  
7 power ratio as you had with the baseline  
8 vehicle.

9           Also, the center of gravity tends  
10 to come down as the central masses stay low,  
11 but you are reducing the top hat section  
12 weight of the vehicle. And BMW uses carbon  
13 fiber roofs in some of its M variants for that  
14 very reason to help get the center of gravity  
15 lower.

16           Okay. Engineering parameters.  
17 When we looked at the Phase 2 design, which  
18 was targeted for 2020 model year with a 2017  
19 technology readiness level, we looked at every  
20 class of material, steel, aluminum, titanium,  
21 carbon fiber, ductile cast iron, etcetera,  
22 before we made final decision.

1                   One of the key factors was being  
2                   able to utilize proven software. If you got  
3                   a new material that looks great on paper, but  
4                   you don't have the ability to model it, OEMs  
5                   are going to be very reluctant to us that  
6                   material, as there is high risk involved with  
7                   that process.

8                   All right. Use of lightweight  
9                   materials doesn't guarantee a lightweight  
10                  vehicle. This is an example, Lamborghini has  
11                  outstanding engineers and yet despite their  
12                  best efforts, they ended up engineering a  
13                  carbon fiber body, 2-ton, two-seater sports  
14                  car.

15                  The Mustang GT 500, which has a  
16                  steel body is actually lighter by over 200  
17                  pounds. And when you look at it from a  
18                  specific density, meaning the area, the volume  
19                  of the vehicle divided by the weight, you end  
20                  up with a vehicle that is actually about 10  
21                  percent lighter on a specific density-basis.

22                  So again, you need to pay

1 attention to the details. Lightweight doesn't  
2 mean that it is going to -- lightweight  
3 materials don't necessarily translate into a  
4 lighter weight vehicle.

5 All right. Also, what I wanted to  
6 point out here basically is that recycled  
7 materials we think have an opportunity to help  
8 reduce the cost of the lighter weight  
9 materials that are going to be used in  
10 vehicles. Plastics play a large role in  
11 automotive systems today and are showing that  
12 they are -- the very dismal record that the  
13 U.S. has in terms of reclaiming materials.

14 The blue shows the use rate and  
15 the magenta shows the recycled rate. So we  
16 think there is some opportunities for using  
17 recycled materials. And we used recycled PET,  
18 which is from water bottles, in the floor on  
19 the vehicle that I'll be describing.

20 In terms of the manufacturing  
21 process selection, this is also key in terms  
22 of looking at every possible process as part



1 of the design. And really, tooling investment  
2 is also a key consideration.

3 So looking at lightweight  
4 methodologies and looking at low-cost tooling  
5 methodologies contribute to the overall  
6 vehicle cost.

7 The joining process selection,  
8 again, we looked at everything that was out  
9 there. Resistance, spot welds, clinching and  
10 I'll be going into this in more detail. A key  
11 part of a multi-material vehicle is the  
12 galvanic considerations. You have got a big  
13 battery out there and you want to make sure  
14 that you don't get anodic and cathodic  
15 reactions with the various materials.

16 So there is a tremendous amount of  
17 work that is being done by industry. And we  
18 worked with one of the chemical companies,  
19 Henkel, to help make sure that we had the  
20 proper corrosion and galvanic protection as  
21 part of this process. And then we -- the  
22 processes were chosen to meet the cycle time

1 requirements.

2 This vehicle was targeted for  
3 60,000 to 100,000 units per year, body design  
4 methodology. This is a real key point. If  
5 you are using materials, let's say, that  
6 average about four times the cost of the base  
7 materials and you have the weight, you still  
8 have double the piece cost. So going in on  
9 day one, you know that you have to do  
10 something to help offset that.

11 If you use the same processes, the  
12 same forming techniques and the same material  
13 joining processes that you used on the  
14 baseline vehicle, then you aren't going to get  
15 any cost offsets. So you need a different  
16 design approach to help offset the added costs  
17 of the more expensive non-ferrous materials.

18 The design methodology that we  
19 use, essentially, was a total vehicle holistic  
20 approach where not every system was  
21 necessarily down-massed or used lighter  
22 materials. It was a function of the total

1 vehicle system, so that the total contribution  
2 would allow the vehicle to become lighter as  
3 a whole.

4 We used a multi-material approach.  
5 The one material we think is best, so we used  
6 steel, we used aluminum, we used magnesium, we  
7 used composites as part of this design  
8 process. We designed for low-cost tooling.  
9 Extrusions are very inexpensive. We minimized  
10 the scrap process and then we maximized the  
11 structural attributes through continuous  
12 joining techniques. And we also used  
13 electronics and electrical systems to replace  
14 mechanical hardware.

15 A couple of examples, using  
16 solenoids to control transmission gear  
17 selection and parking brake actuation. You  
18 don't think a transmission gearshift lever has  
19 to handle much force, but yet, when a 300  
20 pound person leans across that, you generate  
21 as much torque as a V-6 engine and you have to  
22 offset that not only in the transmission

1 selector lever, but also in the structure  
2 underneath it that supports it.

3 All right. We started with the  
4 Phase 1 design. We did the interior and  
5 exterior. And then we used topology analysis  
6 to essentially develop the skeleton of the  
7 vehicle. And we did a sensitivity analysis  
8 using magnesium, aluminum and steel, each of  
9 those pictures that I show here are 100  
10 percent mag, 100 percent aluminum and 100  
11 percent steel.

12 Load-path determination played a  
13 real key role. On Day 1, you start looking at  
14 how you minimize torque input. The smoother  
15 the surface -- the transition, the better and  
16 lighter weight the solution can be from the  
17 design standpoint.

18 Shape optimization also played a  
19 key role for section inertia is  $BHQ$  divided by  
20 the shape factor, which means every little bit  
21 that you can add, every tenth of a millimeter  
22 you add to the height is an exponential

1 contributor to section inertia increases.

2           And then we -- basically, material  
3 selected after that and then apply thickness  
4 optimization. So this is the vehicle that we  
5 ended up with. Silver is aluminum. The  
6 purple is magnesium. The red is steel. And  
7 then the blue is composites. And we used a  
8 variety of processes to put this together.

9           We used rivets. We used friction  
10 spot joining and we used mechanical fasteners.  
11 It is 100 percent bonded using a structural  
12 adhesive. And what that effectively means is  
13 with a resistant spot weld body, you can  
14 essentially get a gapping during a crush  
15 situation, an impact situation where the  
16 materials separate on a microlevel.

17           With the structural adhesive you  
18 get 100 percent bonding. And what it allows  
19 you to do, we used actually the inverse of  
20 what you do when you are racing. You stitch  
21 weld the entire body-in-white to improve the  
22 stiffness. We used the converse of that where

1 we were able to down-gauge the material  
2 thickness as a result of having a 100 percent  
3 intimate contact throughout the entire flange  
4 length.

5 All right. Is anybody else doing  
6 this? Well, if you look at the 2014 Chevrolet  
7 Corvette chassis, which is a work of art, it's  
8 just a stunning work by the GM Engineering  
9 Team, they use extrusions. They use castings  
10 and they use stampings. This is an aluminum-  
11 intensive body. It does have composite  
12 underbody as well.

13 So this is a step in the  
14 direction. And this isn't the optional  
15 chassis. This is the base chassis for 2014.  
16 The Z06 has an aluminum chassis. This is now  
17 the new base chassis for the Corvette.

18 So the bottom line is we took  
19 about 140 kilograms of weight out of the  
20 baseline vehicle. We didn't quite get to 40  
21 percent, but we got very close. And the real  
22 key here is that we minimize the parts count.

1 We took about 35 percent of the parts out from  
2 the baseline vehicle and we did that by being  
3 able to integrate components using castings  
4 and extrusions.

5 All right. Why structural  
6 adhesive bonding? Well, I talked about one of  
7 the advantages, the 100 percent flange length.  
8 It also helped us reduce the cost of joining  
9 it using friction spot joining. Lotus has had  
10 a long history of using, successfully using,  
11 structural adhesive bonding. And so we had a  
12 lot of background in terms of this technology.

13 Okay. Friction spot joining.  
14 Friction spot joining for those who don't know  
15 what it is, it's basically a small drill motor  
16 with a unique drill bit that comes down and  
17 joins two pieces of aluminum. We couldn't get  
18 it to work with mag. We worked hard to join  
19 mag and aluminum. There is work being done  
20 around the world to try to make that happen.  
21 We are very encouraged by those results.

22 But essentially what you do is you

1       come down and you stand the plastic region of  
2       the material, so you don't degrade the parent  
3       material properties with this. It also has  
4       the advantage of being one-fifth the cost of  
5       resistant spot weld, primarily due to the  
6       energy.

7                       So another key advantage is to  
8       reduce flange width. We see automotive  
9       companies today starting to do scalloping  
10      where you scallop around the material when you  
11      come in with a resistant spot weld and it  
12      saves weight on the protection body, but in  
13      the meantime you are throwing away some of  
14      that steel.

15                      In this case, we are able to go to  
16      a 20 millimeter flange width versus say 26 or  
17      28 resistant spot weld and that is material  
18      that comes off each side. So there is some  
19      material advantages to doing that.

20                      In terms of riveting, there are  
21      single sided and double sided rivets. There  
22      are a wide variety of family of rivets that



1 work well that are out there in production  
2 today.

3 In terms of putting this together,  
4 we used a new assembly plant. It cost \$53  
5 million, which is within a million dollars of  
6 what the -- the new Corvette body-in-white  
7 plant is. This was developed by a European  
8 company that we worked with and essentially  
9 allows you to build an A, B, C, D or E class  
10 vehicle on the same line. So it's a very  
11 versatile plant.

12 In terms of the structure and  
13 crash performance, we basically looked around  
14 the world for the best performing SUV, CUV-  
15 type vehicle that we could find. And the  
16 published information that we got -- that we  
17 found was on a BMW X5, which has a 27,000  
18 nanometer per degree torsional stiffness.  
19 This is a world-class number. It is better  
20 than many super cars, exotic two-play sports  
21 cars that are out there today.

22 And what we ended up with was a

1 number that was in excess of that. Our target  
2 was to use and allow for 10 percent error,  
3 which still put us around 30,000 nanometers  
4 per degree. So it's a very good number. And  
5 remember, this is still modeling. It's not  
6 actuality, but the fidelity of the software to  
7 reality is about 10 percent. So we think that  
8 this is certainly a very solid number.

9 In terms of the crash tests that  
10 we ran, there were front, side, rear and roof  
11 as well as some quasi-static seatbelt-type  
12 pulls.

13 In terms of crash performance, we  
14 had a good background in our latest vehicle,  
15 the Evora, which is an all aluminum structure  
16 with some steel reinforcements. So that car  
17 meets all U.S. requirements. This is a front-  
18 impact. You can see how the aluminum  
19 extrusion basically accordions there. Side-  
20 impact, you can see that's a steel roll hoop  
21 that is in there to help manage roll-over as  
22 well as side-impact. And the car performs

1 very well.

2 One thing I didn't point out in  
3 the first slide here is that there is less  
4 than 10 millimeters of deformation in the  
5 footwell area, which is a very solid number  
6 for a 35 mile an hour full frontal crash.

7 And then fuel tank integrity at  
8 the rear. There is really no deformation in  
9 the tank barrier. So very good indication  
10 that a very lightweight body structure is  
11 certainly capable of handling U.S. Compliance  
12 Regulations.

13 These are the various tests.  
14 These are normally animated. These won't be  
15 animated today. This is the pulse from the  
16 front crash. And we worked with TRW, a safety  
17 system supplier for OEMs. And essentially,  
18 they said this was a conventional-looking  
19 pulse.

20 The time to zero is a little bit  
21 quicker, the body is a little bit stiffer than  
22 the steel body. But essentially, the

1 acceleration levels are conventional. They  
2 said no new invention required for airbag  
3 systems. And we carried over the 10 bag  
4 system from the Venza. We carried over that  
5 mass and because these acceleration levels are  
6 very similar to the Venza, their actual peak  
7 load is about 10 percent less acceleration  
8 than the Venza. We think that there is  
9 certainly high potential that this vehicle can  
10 meet the Federal Regulations.

11 This is the side barrier. And the  
12 intrusion level is quite low, 80 millimeters.  
13 As referenced, the seat index point in  
14 reference to the same base is 300 millimeters,  
15 so it gives you, basically, in this 33.5 mile  
16 an hour impact, you have got a cushion of  
17 about 220 millimeters before you hit the side,  
18 outboard side of the seat.

19 The roof-crush model. The results  
20 of this, we actually used IIHS four times curb  
21 as our target. We exceeded that. We are in  
22 the six times curb weight range. It's not

1 that this vehicle is super engineered and  
2 super strong, it's just that because it's  
3 lightweight, it, essentially, will meet these  
4 requirements.

5 We put the Venza curb weight and  
6 applied that at the federal level, the three  
7 times level and, essentially, passed the test  
8 with the Venza. So it says that our roof  
9 structure is really about the same strength as  
10 the Venza, but because the vehicle is so much  
11 lighter, it gives added protection in terms of  
12 the roll over.

13 And then lastly, the rear barrier,  
14 which is, essentially, the fuel tank integrity  
15 test. In this case, the magenta that you see  
16 in the upper right hand corner is the fuel  
17 tank and then the blue is a small battery  
18 pack. In this test, there was no deformation  
19 to either of those.

20 And we looked at fuel tank strains  
21 and we are in the 10 percent fuel tank strain  
22 range, which is an acceptable number. So

1 bottom line is that you could say that this  
2 body-in-white certainly has the potential to  
3 meet the performance of a steel body, not only  
4 in bending and torsional stiffness, but also  
5 in federal crash requirements.

6 Noise, vibration and harshness  
7 management. This is a key issue that comes up  
8 again and again. I just wanted to show some  
9 of the current information.

10 This is from the Chevy Corvette.  
11 This is from a GM site that is listed below,  
12 but, essentially, unwanted noise is reduced  
13 and ride and handling has improved, thanks to  
14 the structures greater torsion or rigidity, so  
15 they are saying that essentially, this very  
16 stiff body is 57 percent stiffer than the  
17 steel body it replaced and is contributing to  
18 NVH improvement.

19 This is from a Great Designs in  
20 Steel presentation given and that is a  
21 terrific event in terms of contributing to  
22 industry, showing what everyone is doing in

1 terms of steel. And the steel industry is  
2 doing a great job in terms of providing  
3 materials that are absolutely at the forefront  
4 of technology.

5           What this slide is saying is  
6 essentially that he increased the use of  
7 structural adhesive. Structural adhesives are  
8 not limited to aluminum bodies or magnesium  
9 parts. And they also found a 44 percent  
10 reduction in airborne noise and that makes  
11 sense because you are sealing essentially the  
12 cracks in between the bonding areas.

13           And then lastly, again from Great  
14 Designs in Steel, the Hyundai i40, which is  
15 called the Sonata in some areas of the  
16 country, they looked at the impact of  
17 aerodynamics at NVH and again, if you have got  
18 an air dam down below the car, you are going  
19 to be generating turbulence, which is noise.  
20 So smoothing the air flow has a positive  
21 effect on an NVH.

22           So we are -- really, the bottom

1 line is you can say that increasing the body  
2 stiffness, improving aerodynamics and  
3 improving sealing can all contribute to  
4 reduced NVH levels and that those fundamental  
5 principles are applicable to ferrous as well  
6 as non-ferrous body design.

7 In terms of cost analysis, this is  
8 really key. We ended up with over a \$700 hit  
9 for the body-in-white. And if you had used  
10 existing technologies for forming and joining,  
11 that cost would have stayed at that level and  
12 probably be higher than that, which would be  
13 a very high number.

14 But because we are able to get  
15 offsets from the tooling and from the assembly  
16 process, we are able to offset a good deal of  
17 that, roughly \$480.00 went away. So we ended  
18 up having a piece cost-hit of about \$250 after  
19 those offsets.

20 And then once we amortized the \$52  
21 million plant in to that scenario, we ended up  
22 with a plus 118 percent cost or 18 percent



1 higher than the baseline. And once we fully  
2 amortized the plant, that dropped to 108  
3 percent cost penalty.

4 And then when you do the same  
5 weighting scheme that I showed you from the  
6 Phase 1 report, we essentially used the 118  
7 percent cost factor for the body. Then from  
8 the chart, the pie chart on the right, the 18  
9 percent projected cost contribution of that  
10 body to the total vehicle multiply those, you  
11 get a weight of cost factor of 21 percent.

12 For all non-body items, as I  
13 mentioned very early in the presentation, that  
14 number was 96 percent. I was more  
15 conservative here showing 100 percent, so  
16 effectively, the weighted cost factor comes  
17 down to about 3 percent, plus 3 percent when  
18 you do -- go through all of these numbers.  
19 And then once you fully amortize the plant,  
20 that drops to above 1.5 percent.

21 So there are other considerations  
22 that we wanted to look at, but one of them

1 that really jumped out at me when I started  
2 looking at some C Class vehicles is that the  
3 Hyundai Elantra, which is a very similar size  
4 to the competitors, I show the Cruze, the Dart  
5 and the Focus, it is 400 pounds lighter on  
6 average than these vehicles. That is 15  
7 percent lighter.

8           And when you look at the Elantra,  
9 it is an unremarkable vehicle. It has got  
10 steel body, steel closures. There is no  
11 titanium, no carbon fiber. And yet, it is  
12 essentially 15 percent lighter.

13           So how did they do it? Well, if  
14 you look at the cost, you will see that the  
15 cost is also reduced. These vehicles all have  
16 automatic transmissions, alloy wheels and  
17 four-wheel disc brakes. So some cars I had to  
18 take money out, some cars I had to add money  
19 to get those features in, but the bottom line  
20 is it is 10 percent less costly on average  
21 versus the other three vehicles.

22           And if you do a further analysis

1 and say well, it's really not fair to penalize  
2 a car that is using the same materials, why  
3 does it come out with a higher cost per pound?  
4 So I said well, let's look at averaging the  
5 cost from the other three vehicles and then  
6 apply that cost per pound to the weight of the  
7 Elantra and you find that there is another 4  
8 percent potential.

9           So you could say Hyundai Elantra  
10 today is producing a car that is similar size  
11 to its competitors. You know it is physically  
12 smaller. It has the same interior volume and  
13 a comparable trunk volume. That car is  
14 roughly 14 percent, you could say 10 to 14  
15 percent less expensive than its competitors  
16 and that may explain why it has some of the  
17 best warranties in the business.

18           So what happens if you take the 30  
19 percent mass reduction and apply it to the  
20 Dodge Dart that I showed earlier in this  
21 slide? Well, a couple of very interesting  
22 things happen. The first is that a 30 percent

1 weight reduction means that you are going to  
2 go down to almost take almost 1,000 pounds out  
3 of this vehicle.

4 If you look at the EPA Combined  
5 Mile Per Gallon at the bottom, you will see  
6 that that never jumps up to 39 miles per  
7 gallon, which is starting to get into the  
8 range for the 2025 Regulations.

9 And this is with a vehicle using  
10 current technologies. This doesn't have  
11 start/stop. This doesn't have increased aero  
12 and it doesn't have better tires for lower  
13 rolling resistance.

14 Another very interesting thing  
15 happens when you do this analysis is that you  
16 see the cost per pound goes up to over a 40  
17 percent advantage. In other words, you can  
18 spend another 40 percent per pound because you  
19 made the vehicle lighter. So that right off  
20 the bat, you get an advantage in this case, of  
21 about, at a manufacturer level, \$1.65 a pound  
22 or about \$3.50 per kilogram more money to

1 spend on this lightweight vehicle.

2 But the only way you can do that  
3 is if you do the total vehicle holistically  
4 and simultaneously and make that happen. If  
5 people -- if subsystems don't get lighter and  
6 systems don't get lighter as a whole, then  
7 this doesn't happen.

8 So in summary, there is certainly  
9 potential for a lightweight multi-material  
10 body to perform as well as a steel body in not  
11 only bending and torsional stiffness, but also  
12 in craft situations. And again, remember this  
13 is modeling. This isn't an actual vehicle  
14 yet.

15 There is also potential for a  
16 substantially mass-reduced body to meet  
17 federal crash requirements and then it's also,  
18 we think and are showing that, possible to  
19 manufacture a high-volume lightweight vehicle  
20 at an MSRP competitive with much heavier  
21 vehicles.

22 And then lastly, by using a

1 holistic total vehicle mass reduction  
2 approach, there is potential to utilize more  
3 expensive materials, lighter weight materials  
4 in volume production automobile and truck body  
5 structures while maintaining competitive  
6 vehicle pricing.

7           Some next steps. We think there  
8 have been a lot of very good paper studies  
9 that have been done. We certainly recommend  
10 building one of these lightweight vehicles and  
11 running it through tests. So to build an  
12 entire body-in-white that we show here would  
13 be very expensive.

14           We think there are options in  
15 terms of building say the front structure or  
16 the roof structure and then testing that and  
17 modeling and then providing that information  
18 to industry.

19           So that concludes my remarks. I  
20 would be happy to answer any questions. Thank  
21 you.

22           (Applause)

1                   MODERATOR BONANTI: Did we get any  
2 questions? Thank you. Anyone else? Okay.  
3 First question. You noted improved emphasis--  
4 no, excuse me.

5                   You improved -- you noted improved  
6 evasive capability reduced braking distance  
7 and lowered center of gravity as effects the  
8 light-weighting. Are you saying that  
9 everything else equal light-weighting vehicles  
10 should be less likely to be involved in a  
11 crash?

12                  MR. PETERSON: No, I'm not saying  
13 that at all. That is very driver-dependent  
14 and some of the studies that the NHTSA Team  
15 have done show that the driver is one of the  
16 key -- has a key role in the vehicle. I mean,  
17 so it just means that there is -- for a given  
18 situation, that a lighter weight vehicle in an  
19 identical situation with a heavier vehicle  
20 that has less tire contact patch area per  
21 pound of vehicle that the lighter weight  
22 vehicle could be more maneuverable.

1                   MODERATOR BONANTI: Okay. Another  
2 question. Your conclusions call for increased  
3 use of adhesives. Automotive adhesives are  
4 subject to EPA Clean Air Act Max Standards.  
5 Was the cost of compliance with these  
6 standards taken into account when calculating  
7 down-weighting costs?

8                   MR. PETERSON: No, they were not.  
9 We are relying on the chemical companies to  
10 handle that aspect of the production of the  
11 material. I should point out that the number  
12 of -- the amount of material that we did use  
13 in this was about 1.5 kilograms, so it's a  
14 relatively small amount, but certainly that's  
15 a very good point to make in terms of well to  
16 wheel. That was not part of the study in  
17 terms of looking at total emissions as a  
18 result of this entire process.

19                   MODERATOR BONANTI: Thank you.  
20 Another question. Please explain how a  
21 "totally holistic approach" fits with today's  
22 practice of sharing platforms across multiple



1 models, for example sharing platforms.

2 That's the first question. The  
3 second question has Lotus performed any  
4 analysis of investment required to revamp  
5 facilities?

6 I need to be able to read the  
7 questions first.

8 MR. PETERSON: I'll answer the  
9 last question first and the revamped facility  
10 that I talked about was \$52 million for this  
11 new body-in-white plant. And as I showed from  
12 earlier data, the Corvette plant, which uses  
13 similar types of components that are  
14 extrusions, stampings and castings was about  
15 \$51 million. So that is in the ballpark, so  
16 certainly we did that.

17 And then the first question, what  
18 was the question again? I think it related to  
19 the architecture?

20 MODERATOR BONANTI: The first  
21 question said -- yes, please, explain how the--  
22 - a totally holistic approach fits with

1 today's practice of sharing platforms across  
2 multiple models.

3 MR. PETERSON: Yes. I'll give an  
4 example. The Lotus has developed what we call  
5 our VVA or Versatile Vehicle Architecture and  
6 it is aluminum-intensive. And what we  
7 essentially did was design a vehicle that has  
8 the ability to be stretched and widened very  
9 easily in the plant.

10 So that is something that as part  
11 of this process certainly needs to be taken  
12 into account on Day 1 of the design.

13 MODERATOR BONANTI: Can you  
14 comment on reliability of joining assumptions  
15 made in CAE models, specifically failure  
16 incorporated.

17 MR. PETERSON: Yes, that's a very  
18 good question. I didn't point this out, but  
19 what we did, we worked with our suppliers,  
20 which included Alcoa for the aluminum. We  
21 used Meridian for the magnesium. We used  
22 Henkel for the structural adhesive and

1 Kawasaki for the joining process.

2 And what we did was we developed  
3 lab coupons and tested those to destruction  
4 and then input that data into our FEA model.  
5 So all of the data that we used was  
6 essentially created in the lab testing for  
7 failure.

8 MODERATOR BONANTI: Okay. Thank  
9 you. Next question. How much do you trust  
10 the result without the testing from the -- I'm  
11 sorry.

12 MR. PETERSON: I think the --

13 MODERATOR BONANTI: From the  
14 vehicle, what is the -- I'm sorry. What is  
15 the best to be answered?

16 MR. PETERSON: Well, we used a  
17 software called LS-DYNA for all of our craft  
18 testing and it is used around the world by  
19 OEMs. It is a well-respected software and the  
20 fidelity is typically within about 10 percent.  
21 Some companies are claiming even better than  
22 that.

1                   And the bottom line is that we  
2 know of at least one OEM that no longer builds  
3 mules in crash tests and they rely on the  
4 software itself as their starting point. So  
5 it has, in our opinion, about a 10 percent  
6 modeling error.

7                   MODERATOR BONANTI: Okay. Thank  
8 you. Are there any other questions? Sure.  
9 Yes, one more coming. The clearer the  
10 writing, the easier it is to ask the question,  
11 so I apologize.

12                   Okay. Here is a question that I  
13 would like to have the answer myself as well.

14                   Do you believe in this software  
15 used for simulation?

16                   MR. PETERSON: Well, as I just  
17 mentioned, not only does Lotus believe in it,  
18 but OEMs around the world use it as part of  
19 their process development.

20                   MODERATOR BONANTI: Okay. Well,  
21 this is a question specifically for you. Will  
22 the OEMs be able to use this software to avoid

1 actual crash tests?

2 MR. PETERSON: That is dependent  
3 on how much risk OEM management is willing to  
4 take. Certainly for the early development, as  
5 I mentioned, companies are already foregoing  
6 some of the very early mules and going more  
7 into their, basically, prototype development  
8 models.

9 MODERATOR BONANTI: Okay. I think  
10 we have time for a few more questions if there  
11 are any. Yes? This is an excellent study in  
12 the application of a multi-material solution.  
13 Aren't OEMs more receptive to this type of  
14 approach using a mono-material holistic  
15 approach?

16 PARTICIPANT: Versus a mono.

17 MODERATOR BONANTI: Versus a mono.  
18 Excuse me. Versus a mono-material approach.

19 MR. PETERSON: Yes. It's a very  
20 good question and the answer is yes. We have  
21 been working with OEMs from around the world  
22 and every company that we are working with is

1 really starting to say that this is the way  
2 that they are heading in this direction.

3 I think the use of steel as I  
4 showed you, even though this is a very  
5 lightweight vehicle with aluminum, a lot of  
6 aluminum, steel played a key role in not only  
7 side-impact, but also in roll over protection.

8 So we simply don't think that  
9 there is a good reason to use just single  
10 material for any vehicle. We think that the  
11 use of multi-materials allows you to make your  
12 selection not only in process, but also in  
13 joining based on cost, allows you to be much  
14 more effective than just picking a single  
15 material and sticking with that and forcing  
16 that material into all the different stresses  
17 and strains that it needs to meet the various  
18 regulations and internal targets.

19 MODERATOR BONANTI: Okay. Thank  
20 you. I have two last questions, unless there  
21 is any further, that are very similar in  
22 nature. However, I'll ask them both at the

1 same time that way you can answer them.

2 How is aging considered for the  
3 adhesive joint? That's the first one. And  
4 second, what is the contribution of an  
5 adhesive bonding for crash and safety?

6 MR. PETERSON: Repeat the second  
7 question.

8 MODERATOR BONANTI: What is the  
9 contribution of adhesive bonding for crash  
10 safety?

11 MR. PETERSON: Oh, okay. All  
12 right. First of all, relative to the aging,  
13 that's always a big concern when you have got  
14 new materials that haven't had 20 or 30 years  
15 of history.

16 What we do is look at our previous  
17 vehicles. We have been producing adhesively  
18 bonded aluminum structures since the early  
19 '90s. And those vehicles, Lotus vehicles,  
20 spend a lot of their time at racetracks and  
21 are driven near their dynamic limits very  
22 frequently.

1                   And at this point in time, we have  
2 not had a single issue relative to  
3 delamination of the parent material and the  
4 structural adhesive. We do use on these  
5 vehicles rivets. We use friction spot joints  
6 here and the reason is to prevent a peel  
7 condition.

8                   Structural adhesive is very good  
9 in terms of joining of materials, but once you  
10 get a peel condition, then it starts  
11 unzipping. So we have to be very protective  
12 of that and that's why we friction spot joints  
13 or rivets or mechanical fasteners to kind of  
14 prevent this zipping action from happening.

15                   So again, 20 years of experience  
16 and we have not had a single issue related to  
17 delamination of structural adhesive.

18                   MODERATOR BONANTI: Okay. This  
19 card has three questions. What is Lotus  
20 Engineering's relationship to Lotus vehicles?

21                   MR. PETERSON: We have the same  
22 parent and we work together joined at the hip.



1 But just to give a brief overview, Lotus has,  
2 basically, 70 percent of its engineers doing  
3 automotive and transportation industry  
4 consultancy, 30 percent of our engineers  
5 actually design our cars.

6 So we are underground. We do a  
7 lot of work that nobody knows about, because  
8 we don't put the Lotus brand on customer work,  
9 obviously.

10 MODERATOR BONANTI: Okay. The  
11 second question I think you already answered,  
12 is have you produced any vehicles?

13 MR. PETERSON: Yes. Lotus has  
14 been building vehicles since 1952.

15 MODERATOR BONANTI: Okay. The  
16 third question. I'm doing this for the court  
17 reporter. Lotus vehicles do not perform well  
18 on a footprint versus fuel economy basis. Why  
19 is that taking into consideration what you --  
20 what you have presented this far?

21 MR. PETERSON: Well, I can say,  
22 from personal experience, that I have gotten

1 over 35 miles per gallon on highway in a car  
2 that does zero to 60 in under 4 seconds. I  
3 think that is a pretty good number.

4 In terms of the fuel economy  
5 numbers that are actually obtained by our  
6 owners, I think most of our owners are very  
7 pleased with the fuel economy that they do  
8 get.

9 When you are designing a car --  
10 our current car that is sold in Europe is the  
11 Exige S, which has almost 400 horsepower. It  
12 has the same power-to-weight ratio as a  
13 Porsche 911, and it certainly gets comparable  
14 fuel economy to that competition, as well as  
15 being about half the cost.

16 MODERATOR BONANTI: Okay. Do we  
17 have any further questions? If not, okay, we  
18 are going to get ready to go to our next  
19 speaker, but in the meantime, I wanted to ask,  
20 does everyone need a five minute break? Yes.  
21 Five minute break. Okay. Please be back here  
22 in the next five minutes. Thank you.

1 (Whereupon, the above-entitled  
2 matter went off the record at 10:29 a.m. and  
3 resumed at 10:35 a.m.)

4 MODERATOR BONANTI: Okay. Our  
5 next speaker will be Greg Kolwich from FEV.  
6 He is going to be talking about NHTSA's mass-  
7 size-safety workshop light-duty vehicle  
8 technology cost and mass analysis. So I would  
9 like to give him a warm welcome to Greg.  
10 Thanks, Greg.

11 (Applause.)

12 MR. KOLWICH: Good morning,  
13 everyone. My name is Greg Kolwich. I work  
14 for FEV. A little bit of background on me  
15 first, I guess. I have been in automotive  
16 roughly 20 years, both on the production/  
17 design side as well as production  
18 implementation, both for chassis and  
19 powertrain components.

20 The group that I work with or in  
21 at FEV is called Production Development and we  
22 do basically all the manufacturing and costing

1 within FEV. So it's everything from new  
2 innovative designs, be it hybrid design  
3 technology, new engine design technology, new  
4 transmissions, whatever, our group is kind of  
5 in charge of the costing side of it. And the,  
6 you know, B-to-business case study or design  
7 trade-offs or whatever that may be.

8           So to jump into the presentation.  
9 For those that don't know, we basically did a  
10 2010 Venza study ourselves. It was kind of a  
11 continuation of the Phase 1 Lotus work. So  
12 you will hear the word or the terminology  
13 Phase 1, Phase 2.

14           The original work done by Lotus  
15 Engineering had two parts. It had a low  
16 development or 20 percent mass reduction  
17 target, and a high-development, which was  
18 roughly 40 percent. And so our work really  
19 took to 20 percent low-development work and  
20 kind of continued on with it.

21           So the things we will talk about  
22 today are project objectives, the vehicle

1 attributes and analysis assumptions, a kind of  
2 a run through of the methodology, the costing  
3 methodology, some of the mass reduction  
4 results, cost results, and then conclusions  
5 and recommendations.

6 So as I mentioned, there is kind  
7 of three key objectives for the work we did  
8 based on the previously completed Lotus work.  
9 And the first was that there was no CAE  
10 analysis done in the first phase of the Lotus  
11 work, so EPA requested that we take the Lotus  
12 work and do CAE analysis on it, both from an  
13 NVH and crash perspective to kind of validate  
14 the changes.

15 And if for any reason there were  
16 issues with that, basically, take that model  
17 and add in changes to make it sure, so it does  
18 match up relative to stiffness in crash to the  
19 baseline model.

20 And then we also were to take --  
21 in the Lotus study, originally there was not  
22 powertrain stuff done, so engine transmission

1 light-weighting. So we expanded that section  
2 plus reviewed some of their ideas and kind of  
3 -- and basically brainstormed on those ideas  
4 to create new ideas.

5 And then the last part of it was  
6 detailed costing. So we are probably all  
7 sitting in this room and we probably all would  
8 -- if I said, you know, do we think you could  
9 achieve 20 percent mass reduction in the  
10 vehicle, we would all probably stick our hand  
11 up.

12 If we said, at what cost factor,  
13 we would probably write it down on a card and  
14 we would probably have about 20 different  
15 answers coming from everybody.

16 So a lot of the work we did for  
17 EPA on the powertrain stuff was really digging  
18 into that part of the analysis, and I'll get  
19 more to it in a minute, but it was really  
20 trying to work out a detailed cost methodology  
21 that was transparent and flexible that  
22 everyone could understand the numbers. And if

1       there were 20 different answers out there,  
2       people can go to the sheets and see why their  
3       answer was right or wrong or indifferent.

4                So that's kind of the three  
5       objectives we tried to accomplish in this  
6       study.

7                So, again, it was a 2010 Venza, is  
8       what we tore apart. Our goal was a 20 percent  
9       mass reduction, similar to the first phase.  
10      The vehicle weighed roughly 1711 kilograms.  
11      Relative to a cost target, our goal was to get  
12      a 10 percent maximum increase for mass  
13      reduction. That's all in. That's direct  
14      manufacturing costs, indirect cost, all those  
15      costs are in there. I'll kind of break that  
16      out here in a minute as well.

17               And then our volume assumption was  
18      the vehicle roughly sells 60 to 75k per year,  
19      and our program assumed that we would produce  
20      200,000 custom components, like the body-in-  
21      white components, that weren't cross-platform  
22      shared. Anything that was cross-platform

1 shared, like an engine or transmission or so  
2 on, it would be 450,000 units a year.

3 So those were the boundary  
4 conditions going into the assumption. Some  
5 other cost assumptions were, everything was  
6 produced in North America, it was 2011/2012  
7 rates for material, labor, overhead and such.  
8 And I'll highlight some of that here as well  
9 in a minute.

10 So the process -- I guess one step  
11 here was we had three people participate in  
12 this project. It was ourselves, FEV, Monroe  
13 & Associates, who does benchmarking and  
14 costing, and then EDAG, who focused on the  
15 body-in-white section of this analysis.

16 So three of us participated. For  
17 the most part, the five steps were the same,  
18 though there was a little bit of differences  
19 because the EDAG work was more CAE-based, so  
20 there was more automation relative to mass  
21 reduction in some of the costing stuff.

22 But the five primary steps were



1 taking the baseline vehicle, tearing it down  
2 and getting a fingerprint of that vehicle.  
3 Then the second phase was kind of doing the  
4 detailed idea generation. The third step was  
5 our preliminary mass and cost estimates. And  
6 then the fourth step was then going through an  
7 optimization process, which I'll get to in a  
8 minute here. And then lastly we get into the  
9 detailed costing and the mass reduction.

10 So the vehicle was purchased. The  
11 first line there. Tore down the vehicle,  
12 scanned in the vehicle level. So key  
13 measurements were made at the vehicle level,  
14 ride heights and such. The whole vehicle was  
15 scanned in and then the tear-down started.

16 So every piece was pulled off the  
17 vehicle chunk-by-chunk, doors, seats, exhaust  
18 system, fuel tanks and so on. As those parts  
19 came off, they were put into a BOM. They were  
20 categorized, quantities, weights, photos and  
21 such. And then along the same process, as  
22 the body was coming apart in bits and pieces,

1 the scanning continued on, both for the body-  
2 in-white pieces that were involved in the  
3 crash in NVH as well as some of the components  
4 that would be involved in the crash later on,  
5 like the engine, transmission and fuel tank  
6 and such.

7 The last part of the process was  
8 then to basically get all the stuff into a  
9 BOM, an organized BOM. So it's 21 different  
10 vehicle systems we broke it down into, and  
11 then each person within our team took on one  
12 of those vehicle systems, one or several of  
13 those systems.

14 The other part of the baseline was  
15 to establish a CEA model that was  
16 representative of the baseline Venza. So as  
17 part of this analysis, EDAG worked on taking  
18 the scanned in data, white-light scanned data,  
19 basically then correlating it to actual NVH  
20 data. So we had an actual Venza that was  
21 taken apart and tested for NVH, torsional  
22 stiffness, bending stiffness and such. And

1 then the model was tuned to that actual data.

2 As well, there was NHTSA crash  
3 data that was used to then correlate the crash  
4 results or compare it to relative to the NHTSA  
5 crash results to make sure that the vehicle  
6 was crashing like it did in the model.

7 So the next step was the -- step  
8 two was the idea generation. So using the  
9 Lotus ideas from their report as the starting  
10 point, what we did is our team then started  
11 brainstorming each of the different systems,  
12 be the it interior, body, you know, fuel  
13 system, engines, transmissions, exhaust, all  
14 that good stuff.

15 And to do that, you can imagine,  
16 we have thousands of ideas going on in these  
17 lists and you have to somewhat start to boil  
18 these ideas down into workable ideas. You  
19 know, you have got your titanium and carbon  
20 fiber on one end of it, and you have got  
21 standard aluminum, maybe some higher-end  
22 aluminum mag on the other end of it.

1                   How do you start to rank which of  
2                   those ideas seem to be feasible than others?  
3                   So we come up with a five grade -- a five kind  
4                   of factor rating system. It looks at  
5                   manufacturing feasibility. It looks at  
6                   functional risk performance degradation. It  
7                   looks at estimated percent mass reduction,  
8                   estimated cost impact and estimated tooling  
9                   impact.

10                   So for those that are familiar  
11                   with kind of a DFMEA concept, the idea is you  
12                   are factorizing these parameters and  
13                   eventually you will factor them out and you  
14                   get a net value. And that helps us assess if  
15                   that idea is better than the next idea and if  
16                   that's an idea we should include in the study.

17                   On the other end of it, EDAG then  
18                   takes the base model that is now established  
19                   from a CAD perspective, and they brought in  
20                   the Lotus mass reduction ideas from the Phase  
21                   1 study and did their preliminary analysis.

22                   From that analysis, the NVH wasn't

1 the same as the baseline, so the team said we  
2 would need to, basically, take some of the  
3 Lotus ideas, pull those in to the basket that  
4 stays with mass reduction, and some of those  
5 ideas that weren't panning out we pushed off  
6 the table, and that was kind of the starting  
7 point for the body-in-white analysis at that  
8 point.

9 So in the next phase, what we are  
10 doing now, we are doing the -- we have these--  
11 all these ideas that are ranked out. What we  
12 have to do is start the down-selection  
13 process. So, again, thousands of ideas need  
14 to be boiled down into different component  
15 ideas. So what we do is we have a score of 50  
16 in the first step there. And anything that is  
17 greater than 50 falls off the table at the  
18 get-go.

19 And now what you are left with is  
20 potentially three 49 ideas for the same  
21 component and you have to pick, well, which  
22 idea again is better.

1           So in this phase what we are doing  
2           is now starting to put mass and cost to each  
3           idea. The goal was to get a cost per  
4           kilogram. And what we want to do is then take  
5           those ideas and bin them in the respective  
6           cost group.

7           We created five cost groups, as  
8           you can see on the right hand side there. So  
9           anything that was a mass reduction and a cost-  
10          save, anything that was zero to a dollar in a  
11          mass save, and so on and so on. And the 4.88  
12          is representative of the 10 percent increase  
13          in price at a mass reduction.

14          So anything that was over 4.88  
15          was, essentially, greater than a 10 percent  
16          cost-hit from the mass reduction.

17          So now we have these five bins,  
18          all these ideas loaded in for each system, and  
19          now what we have to do is start grouping those  
20          ideas. So you can imagine, this is an example  
21          of kind of the flow of how the vehicle is  
22          broken out from a BOM perspective.

1           So what we are doing is if you are  
2 starting on the far right on the conrod, you  
3 have a cap, a conrod and two bolts. On any  
4 one of those components, you might have two or  
5 three ideas to pick from. You could take  
6 those ideas, roll them up in different  
7 combinations that get you a conrod assembly.  
8 You can then take that conrod assembly, and  
9 there might be three different versions of a  
10 conrod assembly that are mass-reduced, and  
11 roll them up into a crank-drive system.

12           So now you have got a crank,  
13 you've got a piston, you've got a conrod  
14 assembly and, again, mixing and matching you  
15 can have different combinations based on mass  
16 reduction and cost impact.

17           Eventually those get rolled into  
18 various engine combinations and eventually you  
19 can get a vehicle. You take all these  
20 different systems and you can roll them into  
21 different vehicle solutions.

22           The approach we use, we started

1 off -- when we first started this, all our  
2 engineers were all thinking big, thinking  
3 carbon fiber, titanium this, titanium that,  
4 and we had a couple of team meetings and we  
5 quickly realized that we shouldn't necessarily  
6 be taking these very expensive ideas, that the  
7 OEMs more than like will not implement out of  
8 the gate, and was them down with low cheap  
9 ideas.

10 So if I take a plastic trim panel  
11 and I MuCell everything, does that allow me to  
12 take titanium and bring it in now and I could  
13 pay for the titanium, because I've got this  
14 cheap MuCell?

15 Well, we agreed that probably  
16 wasn't the right approach and we created two  
17 kind of pathways. One pathway was for the  
18 conservative engineer. We call it the low  
19 cost solution, which was only ideas that save  
20 money, ideally, and save weight, or the ones  
21 that the OEMs would more than likely jump at.

22 The ideas that were bringing in



1 and mixing and matching titanium with MuCell  
2 were ideas that would be considered more of an  
3 engineer solution. Those are the guys that  
4 are stretching the boundaries with carbon  
5 fiber, metal matrix composites and so on. We  
6 called that the engineered solution.

7 Then the ground rules for that are  
8 kind of shown with this brake example. So we  
9 have a brake rotor as our example. You could  
10 reduce the rotor thickness. You can change  
11 the diameter, again, with the assumption that  
12 the whole vehicle is going to get 20 percent  
13 lighter. You can do additional venting and  
14 cross drilling on the rotors. You can go to  
15 a two-piece rotor. You can do scalloping, OD  
16 scalloping and so on.

17 So if you look at all the red  
18 boxes on the chart, they have -- they are  
19 using ideas that are coming from A, B and C.  
20 When all those ideas come together, they  
21 create a \$1.35 hit per kilogram, which falls  
22 into the C category because all the ideas are

1 in that C category, unless that's a low cost  
2 solution in our eyes.

3 If you now stretch it and you pull  
4 in a two-piece rotor design, which is a lot  
5 more expensive, and you mix that with the  
6 other ideas there, you end up with \$3.56 a  
7 kilogram. That actually puts it in a D  
8 category. And, again, because it has ideas on  
9 the more expensive side of what the final idea  
10 fell in, and on the cheaper side, it becomes  
11 an engineered solution.

12 It was really just some ground  
13 rules for our guys to help sort through the  
14 bins of different cost reductions -- or,  
15 sorry, different mass reductions and cost  
16 impact.

17 The same process then followed  
18 through again, if you look at the previous  
19 slide where I showed you the conrod, the crank  
20 assembly and so on getting built up, we now  
21 take this to the next layer.

22 So the next subsystem is the front

1 rotor and shield subsystem. And now we are  
2 looking at rotors, dust shields, brake  
3 calipers, pad kits and so on, and now we have  
4 got to do the same process. We have got to  
5 kind of go in these bins, pick and choose, mix  
6 and match and try to build up an optimized  
7 brake subsystem.

8 And then we go to the next level,  
9 same idea. Now we are going to the brake  
10 system level. We have got the front rotor  
11 drum and shield subsystem, the rear rotor drum  
12 and shield system, parking brake, brake  
13 actuation. Exact same process, we are just  
14 going up to the next step.

15 Essentially, what we are doing is  
16 working our way up in each system to a final  
17 solution or final solutions and then  
18 eventually to a vehicle solution.

19 So now we have all these systems  
20 evaluated and we put these into a vehicle  
21 optimization. So we've got low cost vehicle  
22 solutions, we've got engineered vehicle

1 solutions. And these are represented by the  
2 points on the curve there.

3 And our goal was 20 percent mass  
4 reduction at the best value. So our starting  
5 point was the little blue triangle off to the  
6 right there, which was roughly -- I think it  
7 was like 19.7 percent at roughly an .83 cent  
8 hit per kilogram, was our initial assessment  
9 based on what the team did in their initial  
10 evaluation.

11 So we all agreed here is all the  
12 ideas they are going to fall into that point.  
13 Do we all agree as a team that the risk level  
14 is right for 2017/2020? And, if so, let's  
15 then start the detailed analysis now and start  
16 going through these in a more engineering  
17 perspective.

18 So the next step now, the team is  
19 now starting to pull in more and more data and  
20 more and more resources. From an engineering  
21 perspective, they kind of validate that these  
22 ideas are real. The mass reduction

1 assumptions that we are going to take are  
2 actually kind of fine-tuned. And then we  
3 start working on the detailed cost model as  
4 well.

5 Through this process, we probably  
6 lost 2 to 3 percent of our ideas that were  
7 originally on the list, but then pulled in,  
8 you know, 2 or 3 percent of new ideas. So it  
9 is kind of an iterative process.

10 Our study is really on all the  
11 systems, but body-in-white was really more  
12 based on published literature. So it includes  
13 support from raw material suppliers, many in  
14 the room that we have dealt with on these  
15 studies in looking at alternative industry  
16 technologies, looking at performance vehicle  
17 benchmark data, published literature, all  
18 these different areas are what our guys use to  
19 kind of come up with these ideas. Because it  
20 had to be 2017, we really couldn't go out  
21 there and stretch the barriers on carbon fiber  
22 and some more of the exotic materials, but had

1 to kind of stay with what was kind of in the  
2 production pipeline either today at low-  
3 volumes or at some level.

4 And then what our engineers would  
5 do is take those ideas, work with the  
6 suppliers and then boil those ideas down into  
7 the change. So we had a steel fuel tank. We  
8 took those ideas, established what the  
9 material specs were, you know, what the  
10 engineering design differences were. Because  
11 we are comparing it from part A to part B, we  
12 have got to kind of make those two parts  
13 normalized. And then eventually take any  
14 secondary mass savings due to the whole  
15 vehicle getting 20 percent smaller and we end  
16 up with our plastic fuel tank on the bottom,  
17 basically.

18 So a lot of participation from  
19 suppliers. This is just a small list of the  
20 guys that participated. A lot of  
21 organizations: AISI, Aluminum Org, Magnesium  
22 Meridian and so on. I could put pages and

1 pages here, but we really tried to leverage  
2 the industry experts, because all the guys on  
3 our team are maybe an expert in one particular  
4 field, but by getting everybody's input, it  
5 really helped out a lot in the study.

6 On the EDAG portion, again, they  
7 are taking it to a whole other level, kind of  
8 similar to what Lotus did in their -- you  
9 know, going shooting for 40 percent mass  
10 reduction. So just quickly to summarize the  
11 nine steps kind of in the process.

12 So, body-in-white was torn down,  
13 scanned in. We took over 150 material samples  
14 that AISI got data for us. So they were sent  
15 out, chemically evaluated, tensile tested and  
16 all that so we could get the right material  
17 cards into the study.

18 All the parts in Step 2 there were  
19 scanned in that were involved in the crash  
20 study. And eventually, the model, as you can  
21 see in the top right, was tuned to the model  
22 before the actual NVH data. And then the

1 crash data from NHTSA compared to the actual  
2 crash data in Step 5 there are from the CAE  
3 analysis, that created the baseline.

4 Any change that was now brought in  
5 to create a light mass reduction was always  
6 compared back to that baseline model. And  
7 they always had to have, basically, similar  
8 stiffness, similar crash performance to get  
9 the thumbs up for mass reduction.

10 So looking at NVH, crash pulse,  
11 dynamic crush, intrusion and so on, those were  
12 the parameters we kept comparing back to.  
13 Ideally, you would like to do this on every  
14 component and the next step eventually comes  
15 a full vehicle, but due to, you know, resource  
16 limitations, we can only do so much on this.

17 So the cost side, again, I think,  
18 in my eyes, is probably the most controversial  
19 topic on this, is what is the real cost for  
20 mass reduction? We all again probably agree  
21 that you can get 10, 15, 20 percent on most  
22 vehicles if you really went to the limits.



1           So what our team does is we have--  
2           we basically build up custom models for  
3           everything we cost. It's not just, hey, the  
4           material went from steel to plastic, we are  
5           going to change it and take the cost of  
6           plastic at \$1 a pound, times it by 2, and  
7           that's the price of the new part plastic.

8           But rather what we do is we build  
9           up a comprehensive manufacturing model, most  
10          of our team is basically all manufacturing  
11          engineers, and the model, you know, tracks  
12          material costs, labor contributions, it's  
13          direct labor, indirect, maintenance repair and  
14          other -- all those costs that are associated  
15          with labor.

16          The overhead rates are built up  
17          from scratch, so if it is a line to put  
18          together an engine, there is a complete layout  
19          of that engine line. We bring in a guy that  
20          has 30 years plus making engines and he will  
21          put that line together. We will cost out the  
22          equipment, the utility usage, the floor space

1 and basically build up comprehensive cost  
2 models.

3 And then for each of the mark-up  
4 levels, what we do is we have different  
5 levels. So if you are a Tier 1 system  
6 integrator, like a Bosch or Delphi, you get a  
7 certain percentage and we break those open and  
8 report. You may disagree with our values that  
9 we chose, based on our boundary condition  
10 assumptions, but the models are there and they  
11 could be easily tweaked and you can change  
12 those.

13 So, for example, a Tier 1 high-  
14 system impact guy makes 21 percent mark-up.  
15 A low-end guy might make 9, 10, 11 percent.  
16 Those are kind of the ranges we would kind of  
17 work within. And, again, all our assumptions  
18 are based on mass production, you know, mature  
19 market, competitive market, because we are  
20 really looking out in the future.

21 And that kind of ties into this  
22 next slide in this whole, what I see as this

1 controversy around costing methodologies and  
2 what methodology is the best methodology, and  
3 how do we know the right prices, this price  
4 versus that price?

5 In our eyes, the devil is in the  
6 details, like everything. So if you are  
7 getting prices from all over, from different  
8 suppliers, OEMs, you are pulling stuff off the  
9 Internet, you are reading it into SAE paper,  
10 you've got a snippet of information over here  
11 and you try to put that all together, you are  
12 left with a mess, essentially.

13 So you are left with this big  
14 circle here of all these points of what it  
15 could be. Now, if you had spent a lot of  
16 time, you could probably continue to boil that  
17 down and eventually get to a price that you  
18 think is reasonable.

19 On the base technology,  
20 represented by the orange lines, you might  
21 say, hey, this technology has been around  
22 forever, I know a six-speed transmission goes

1 for \$1,200 all day long, I don't even need to  
2 look at it any further. So that one you are  
3 pretty comfortable with.

4 But depending on what point you  
5 pick here, the answer at the bottom of it  
6 could be considerably different. So the goal  
7 is what is the right point to pick? You know,  
8 I'll give you an example on seats.

9 You can talk to a Lear or JCI who  
10 welds seat frames all day long and said, hey,  
11 if you want to convert to mag, it's a huge  
12 premium, we don't recommend it. Well, sure,  
13 sure they're not going to recommend it,  
14 because they got all this capital investment  
15 in the facilities.

16 You can go talk to the guy maybe  
17 that wants to get into making mag seat bases,  
18 and he is going to undersell it, because he  
19 might be an automotive supplier and he might  
20 say, yes, I can make those. How much harder  
21 can it be, right? Welcome to automotive.

22 So the bottom line is you've got

1       these two dramatically different price points  
2       and they are all out of whack.  And so our  
3       methodology is to try to not understand the  
4       end result, but all the bits and pieces that  
5       go into it and work with those bits and pieces  
6       to try to get the right answer.

7                   And by understanding that, people  
8       can scrutinize and look at it and say, well,  
9       your process time looks too long ,or the price  
10      of mag looks too high, or the price of steel  
11      looks too low or whatever it may be, all that  
12      data is kind of sitting there.

13                   And the goal is in -- much to the  
14      credit of EPA, I think -- is put the details  
15      in front of everybody and let them scrutinize  
16      it.  And then we will have these meetings  
17      hopefully and walk away and we say we all  
18      agree that that pricing is right or, no, that  
19      price doesn't seem right, let's go back and  
20      look at the numbers again.

21                   So that's kind of the approach we  
22      take.  No matter what the baseline technology

1 is in the new technology, I'm a new OEM, I'm  
2 going to start making stuff from scratch. I  
3 can make a heavier vehicle or a lightweight  
4 vehicle. I can make a six-speed automatic  
5 transmission or a six-speed DCT, dual clutch  
6 transmission.

7 All my assumptions are going to be  
8 the same. My material costs are going to be  
9 the same. My labor rates are going to be the  
10 same. How I make them, obviously, will be  
11 different, but all those factors. So same  
12 cost, same technology maturity, which affects  
13 the mark-ups, same manufacturing volumes, and  
14 then you get a real true apples-to-apples  
15 comparison on those two technologies.

16 And then eventually what you can  
17 do is you can take to those two points, and we  
18 all agree, well, these technologies aren't  
19 really mature right now. We are going to  
20 slide them out to where we think they are  
21 mature, and that is going to be kind of our  
22 ground point or our neutral point where our

1 learning factor is one, say. And that may be  
2 2020.

3 Now when you go and you apply your  
4 reverse learning to figure out what the cost  
5 is at the low-volume, or you go the other way  
6 and you say, well, the technology we tore down  
7 and evaluated was pretty young. It is  
8 probably going to grow a lot as the years go  
9 on. It will probably realistically get a  
10 little cheaper.

11 Now, you are kind of cutting that  
12 error. So even though you are going to have  
13 potentially error in that learning factor, you  
14 have sliced it considerably. So that's kind  
15 of the approach that we have taken on many of  
16 the powertrain studies as well as the mass  
17 reduction study.

18 So, the results. This kind of  
19 graph is kind of a bar chart of all the  
20 systems we evaluated and the mass reduction we  
21 got for each. So the blue is representative  
22 of the Venza starting point. And then the

1 yellowish-green is the new mass-reduced  
2 systems.

3 So you can see engine,  
4 transmission, body group A, brakes,  
5 suspension, interior body, were the major  
6 contributors to mass reduction, basically.

7 I'll just quickly go through. I'm  
8 not sure how many of you have had a chance to  
9 look at the report or read through some of  
10 these sections. I'm going to just high-level  
11 each system, some of the key factors.

12 So on the body-in-white structure  
13 that EDAG did, the focus was on high-strength  
14 steel. And so a lot of the design was  
15 basically material substitutions, adding back  
16 in some new stampings here and there to get  
17 support. They used tailor-rolled blanks in  
18 some areas, and then on some of the closures,  
19 like the hood and fenders and rear hatch,  
20 there was aluminum introduction as well.

21 The steels they chose were  
22 relatively, kind of not your stretches, so to



1 speak. They are more applicable to this near  
2 time frame. So it wasn't really a stretch at  
3 all.

4 And, anyway, long story short,  
5 they came up with roughly 70 kilograms, I  
6 think it was a little bit more once you add in  
7 some of the other stuff, approximately 70  
8 kilograms on the body-in-white structure  
9 enclosures.

10 On the suspension components, a  
11 lot of aluminum change-overs. We do a lot of  
12 benchmarking of full vehicles at FEV. And any  
13 given day, if you walk through our shop and  
14 look at the Audis, the BMWs, that's all you  
15 see, pure aluminum control arms, knuckles,  
16 everywhere. It is rare you will see a cast  
17 knuckle on anything nowadays, to be quite  
18 honest.

19 So the amount of aluminum that was  
20 pulled into the Venza was considerable. As  
21 well, we looked at the stuff like pull-forming  
22 the springs differently. Some tire changes,

1       which were changing the aluminum alloy rims to  
2       be a different shape and different size.  Some  
3       of the original Lotus work that kind of  
4       contributed to that.

5                   On the interior side, it was  
6       basically taking steel-welded frames and going  
7       to Thixomolded frames.  The back seats were  
8       very archaic, to be quite honest, so those  
9       were very low hanging fruit, easy to pick  
10      from.  A lot of the new stuff that a lot of  
11      the OEMs are picking out nowadays are higher  
12      density PUs for seat structure, less wiring.

13                   Anyway, there was a huge weight-  
14      save in the back and a cost-save that made up  
15      for the cost-hit on the front seats, which  
16      were converted to magnesium, basically.

17                   As well, there are some other  
18      changes in technology.  The chevron, which was  
19      the mechanism that helps keep the driver's  
20      head closer to the seat rest eliminating -- or  
21      the head rest, sorry, eliminating the need for  
22      a retractable head rest essentially.

1                   So again, some trade-offs on  
2 design and materials that washed one another  
3 out resulting in a net save. A lot of MuCell-  
4 ing was introduced as well, as far as the  
5 interior components.

6                   Brake system, same deal. A lot of  
7 aluminum was used in the caliper brackets. It  
8 went to a two-piece rotor, you know, aluminum  
9 hub and an outer cast piece, lots of drilling  
10 and scalloping and trying to get out as much  
11 mass as possible. And then. again, a 20  
12 percent mass reduction on the vehicle as a  
13 whole affords you to do a lot of downsizing on  
14 the brakes as well.

15                  Engine system. It was a mag  
16 block, a little controversial. You know,  
17 there is different takes on magnesium used in  
18 the block application. It was used by BMW.  
19 They have since discontinued that purely  
20 because of wanting to commonize their diesel  
21 line between gas and diesel.

22                  Hollow camshafts. They have, you

1 know, plastic covers, all those kind of good  
2 things. Again, the report kind of details all  
3 that information. The transmission was  
4 magnesium case from aluminum. The use of  
5 micro-alloy, higher micro-alloy steel gears  
6 that allow you a little bit of a downsizing of  
7 the gears.

8 Aluminum torque converter  
9 structure. There is a metal matrix composite  
10 that was integrated into that aluminum torque  
11 converter. So, again, some different  
12 technologies there.

13 So, at the end of the day, we came  
14 up with roughly an 18.3 percent mass  
15 reduction. All the ideas that we came up  
16 with, obviously, weren't implemented into  
17 this. There were things that we kind of threw  
18 into the mix at the last minute that would  
19 have took it well over 20 percent, like the  
20 aluminum doors and run-flat tires and some  
21 other ideas, but we kind of stopped at  
22 essentially the 18.3 percent mass reduction.

1           So, the cost, don't fall out of  
2           your chairs, but the cost, direct  
3           manufacturing cost, what we see the cost to be  
4           if you took away the indirect OEM cost, and  
5           you take away any learning, into the future,  
6           we are seeing that at the end of the day you  
7           will save money or you will be -- in my eyes,  
8           when you are talking \$100, you are pretty much  
9           cost-neutral give or take.

10           So we are saying that in the long  
11           haul, saving 20 percent of the vehicle should  
12           save you cost. The amount of mass reduction  
13           we achieved was 312 kilograms and it works out  
14           to basically a .47 cent kilogram save. Again,  
15           direct manufacturing cost-save. That was,  
16           again, 18.3 percent vehicle mass reduction.

17           What we did then is take all of  
18           our ideas and we kind of ranked them in order  
19           of best value to least value to create the  
20           blue line you are looking at there. So we had  
21           a lot of those ideas.

22           So a lot of those ideas had

1 secondary mass savings into them. So what we  
2 had to do is pull at the secondary mass  
3 savings so we could add ideas together that  
4 include secondary mass savings and that's how  
5 we kind of created that blue line. And then  
6 what we did is had our -- our blue line, I  
7 think, went up to roughly -- or the non-  
8 compounding line went up to about 14 to 15  
9 percent.

10 So the blue line then was our kind  
11 of trend line going through the green point,  
12 which is the point we achieved, which was the  
13 18.3 percent mass reduction at a .47 cent  
14 cost-save.

15 So what we did is we had the blue  
16 line that had no compounding on it, and you  
17 will see in a minute here the red line is the  
18 line that when we peel out the compound, the  
19 secondary mass savings, what the impact of  
20 that is.

21 And, unfortunately, it's just a  
22 single point that we didn't interpolate

1 between zero back up to 20 percent, but it's  
2 what our prediction line is basically on what  
3 mass would be if you did it solely on a  
4 component-by-component basis and you didn't  
5 really look at kind of the holistic vehicle  
6 approach.

7 So you get up to roughly, what is  
8 it, \$3 a kilogram hit. Again, just direct  
9 manufacturing cost at about a 20 percent mass  
10 reduction is what we are seeing on the Venza.

11 The purple X is -- what we did is  
12 we threw in aluminum closures at the end and  
13 run-flat tires, which took it down or got us  
14 to the 20 percent mark and it lowered the  
15 savings from the 47 to the .11 cent cost per  
16 kilogram.

17 So, again, this last slide just  
18 shows you, to kind of put you in perspective  
19 on short-term versus long-term, learning  
20 versus non-learning, ICMs versus non-learning  
21 -- or ICMs.

22 So we all acknowledge that, coming

1 out of the gate, on vehicles that aren't using  
2 a lot of aluminum, aren't using a lot of mag  
3 right today, you will pay a premium. There is  
4 no doubt. And you could argue it's one times,  
5 two times or whatever it may be. I don't want  
6 to not promote any given material, but there  
7 is just going to be that learning curve  
8 associated with these new materials.

9 Europe has gone through it. We  
10 will go through it in North America as well.  
11 But the bottom line is that over time the  
12 purple line representing the net incremental  
13 direct manufacturing costs, you over time will  
14 approach that line. And again, getting --  
15 when you look at purely from a direct  
16 manufacturing perspective, you will approach  
17 that line and this mass reduction over long-  
18 term should be very cost-effective.

19 Again, in our eyes it is -- it  
20 approaches essentially a neutral or a save.

21 So our recommendation, obviously,  
22 is there is a lot more work to be done here.



1 It is, in our eyes, picking up 10-fold in the  
2 industry. A lot of suppliers want to get  
3 involved. They have all these great ideas and  
4 there is a lot of great technology out there,  
5 so we are, you know, through these continued  
6 studies and these kind of meetings, it's a  
7 great way of sharing ideas and building on  
8 what is being developed to date.

9 Our studies, you can see at the  
10 links there if you haven't caught them  
11 already, I'm not sure I'm assuming this  
12 presentation material will be sent out, but  
13 feel free to go to those links and if you have  
14 any questions, feel free to follow-up with  
15 myself.

16 I'm assuming they will send out  
17 the contact information after the meeting and  
18 give me a call if you have any questions on  
19 anything. That's it.

20 (Applause)

21 MODERATOR BONANTI: Thank you,  
22 Greg.

1 MR. KOLWICH: Yes.

2 MODERATOR BONANTI: Real quick.

3 Okay. We have volunteers going around picking  
4 up the questions. In the meantime, I just  
5 wanted to make everyone aware, those of you  
6 that have wi-fi-enabled devices that are  
7 trying -- have been trying to potentially  
8 access the network, I would like to give you  
9 the network itself.

10 It is not on the agenda, so the  
11 select -- you need to select the network dot--  
12 oh, excuse me, d8011t.g. and the user name  
13 would be -- these are all lowercase,  
14 mss\_symposium, S-Y-M-P-O-S-I-U-M. The  
15 password, if you are familiar with it, it  
16 would be Summertime01. But the s in  
17 summertime would be capitalized.  
18 Summertime09, excuse me. Okay.

19 We have time for a few questions.  
20 We -- our five minute break turned into more  
21 like a 10 or a 12 minute break, so hopefully  
22 we will be able to get through these. Thank

1       you.

2                       Okay.  Greg, what materials would  
3       be suitable for light-weighting the drive  
4       shaft?

5                       MR. KOLWICH:  The half-shafts,  
6       yes, there is the half-shafts.  There is not--  
7       this is a front-wheel drive, so there was not  
8       a rear or a prop-shaft in the back.  So I'm  
9       assuming we are talking about half-shafts.  
10      And things we have looked at are there is a US  
11      Manufacturing, there is a couple of guys that  
12      do this.  It's kind of a cold-forming, cold  
13      extrusion process where you basically take a  
14      hunk of bar or a tube and you form it in.  You  
15      can pull out a lot of weight.  I think it is  
16      up to 30 percent, I think, is what we are  
17      finding, by taking weight out of the shafts by  
18      basically putting the section where you need  
19      it and taking it away where you don't need it.

20                      There are carbon fiber shafts out  
21      there as well.  Tejon does, I think, a million  
22      carbon fiber shafts in production today as

1 well. So I would recommend both. If you are  
2 in the short-term, I see this kind of -- not--  
3 I'm not here to represent suppliers, the guys  
4 that we worked with. I would suggest kind of  
5 a US Manufacturing-type process where you are  
6 streamlining the material usage in the shaft.

7 MODERATOR BONANTI: Okay. And  
8 following up to that, how much reduction could  
9 be achieved by replacing the currently used  
10 steel with an equally durable lightweight  
11 material?

12 MR. KOLWICH: Well, I know for  
13 sure the US Manufacturing process touts, I  
14 think, 20 to 30 percent. Closer to 30, I  
15 believe. And carbon fiber, when we looked at  
16 it, when you start adding the ends back on, it  
17 wasn't all that big. When you start putting  
18 the cost for carbon fiber and you are trading  
19 out putting the metal ends in, it wasn't  
20 really that big of a save. I can't remember  
21 the number.

22 MODERATOR BONANTI: Okay. FEV

1 report shares cost-down 30 -- \$3.51 with  
2 lightweight for body-in-white enclosure. You  
3 are proposing many aluminum applications. Can  
4 you make a comment about this?

5 MR. KOLWICH: I think body weight  
6 was actually not a cost-down. It was a cost-  
7 hit. We were up three. So yes, just maybe to  
8 -- due to the way we add and subtract numbers  
9 in our spreadsheets, it is always base minus  
10 new. So the three -- what you are looking at  
11 on the screen there is the \$3.33, that's  
12 actually a cost-hit.

13 The blue is the save and a red is  
14 a cost or the negative number is actually a  
15 cost-hit in our sheet. So probably the  
16 question would be different, I suppose,  
17 knowing that.

18 MODERATOR BONANTI: All right.  
19 The next question. As you did mass reduction,  
20 did you consider front/back/sides? Would  
21 vehicle functions change?

22 MR. KOLWICH: When you say

1 front/back/sides function change --

2 MODERATOR BONANTI: When it comes  
3 to weight and balance.

4 MR. KOLWICH: No, we did not. So  
5 it was put into the crash model, but there was  
6 no vehicle dynamic modeling done on the Venza.

7 MODERATOR BONANTI: Okay. I don't  
8 know who asked this question, but I'll ask it.  
9 Thanks. Interesting presentation.

10 I completely agree with your  
11 comment "The cost of the given action depends  
12 on if you are a buyer or a seller." Can you,  
13 please, talk about why you would ignore  
14 indirect costs, such as BMW and others cannot  
15 avoid these costs?

16 MR. KOLWICH: Yes. So we don't --  
17 the indirect costs eventually get applied, so  
18 we don't apply them, so in all our costs, what  
19 we do is we develop a direct manufacturing  
20 cost number and then the indirect. So in our  
21 number, you will have the Tier 1 mark-ups and  
22 ED&T.

1                   So the mark-up in our numbers  
2 include supplier ED&T, engineering design and  
3 testing. It includes profit, SG&A and any in-  
4 process type scrap. But what we don't apply  
5 is the OEM mark-up and that is done through  
6 EPA's indirect cost multiplier.

7                   So we recognize that it is a real  
8 number. In all the studies we have done to  
9 date, FEV has never applied that portion of  
10 it.

11                   MODERATOR BONANTI: Okay. In  
12 order to reach the point on the cost curve  
13 where costs are neutral, you must pass through  
14 a period where costs are high.

15                   MR. KOLWICH: Yes.

16                   MODERATOR BONANTI: Who do we ask  
17 to buy the expensive early vehicles at volume?  
18 Who will spend money on weight reduction,  
19 rather than comfort features?

20                   MR. KOLWICH: Good question. I  
21 think it is like everything else. It's the  
22 same guy, you know, that buys an iPhone, I

1       suppose, for \$500 knowing that there are going  
2       to be guys out there buying them and  
3       eventually that price is going to come down  
4       rapidly.

5                    You know, you look at the vehicles  
6       in Europe, the Audis and the BMWs, there is  
7       people that buy -- make those vehicles. They  
8       are great vehicles. They cost more money, but  
9       eventually that will drive the cost down for  
10      some of the other vehicles.

11                   I suppose it is no different than  
12      what Cadillac does, what Lincoln does where  
13      those new technologies go into these luxury  
14      cars first. People pay the premium and  
15      eventually that gets transferred to the lower  
16      models.

17                   MODERATOR BONANTI: Okay. What  
18      learning factor is used to estimate cost? Is  
19      this 20 percent by five years? Is this  
20      industry practice used?

21                   MR. KOLWICH: Yes. We, FEV,  
22      doesn't get so much into that. I'll be



1 honest. So there are all types of different  
2 learning practices out there. I guess I  
3 wouldn't know if 20 percent is the right  
4 number to be quite honest without looking into  
5 it.

6 I think what we tried to promote  
7 in the -- going forward is that each  
8 technology will have a different learning  
9 curve depending on where it sits on that curve  
10 and it may be not just a position on one  
11 curve, but there might be different curves for  
12 different technologies. So we haven't dove  
13 into that part of this assignment, so I would  
14 rather not, I guess, add much to that.

15 MODERATOR BONANTI: Okay. And the  
16 last question, unless there is any other  
17 questions out there. What is known about  
18 cost-effective mass reduction as a function of  
19 vehicle mass and/or size? Different or  
20 similar percentage with regard to reduction?

21 MR. KOLWICH: Repeat that one more  
22 time.

1                   MODERATOR BONANTI: What is known  
2 about cost-effective mass reduction as a  
3 function of vehicle mass or size? Is it --  
4 does it take into consideration different or  
5 similar percentage in reduction?

6                   MR. KOLWICH: Yes. So we did a --  
7 we kind of did that assignment for another  
8 person. We took mass reduction on the Venza  
9 and actually applied it to different vehicle  
10 segments. Now, these vehicle segments were in  
11 Europe. So what we did is we took the Venza  
12 ideas and we looked at them in two ways.

13                   One, are those ideas already  
14 implemented in Europe and if so, we can't  
15 include them in the A segment, B segment and  
16 so on. And then (B) is the technology so much  
17 different in Europe that that -- that those  
18 ideas don't even exist?

19                   For example, we use mechanical  
20 water pumps. They have electric water pumps  
21 everywhere already. So the stuff you might  
22 have taken on a mechanical water pump, we

1       couldn't apply. But the reality of it is it  
2       is probably -- you know, we are taking one  
3       snippet of information.

4                 We are taking the Venza, so even  
5       within the Venza vehicle segment, you could  
6       probably argue that that mass reduction won't  
7       be the same for all those vehicles. And then  
8       when you drop to different segments, it is  
9       going to be different as well.

10                And then some of the European  
11       stuff, I think we were getting roughly around  
12       10 percent. Speaking on say A and B segments,  
13       and maybe a little bit higher like 13, 12 or  
14       13 on some of the larger vehicle segments.

15                MODERATOR BONANTI: Okay. Thank  
16       you. Are there any further questions? No.  
17       Okay.

18                MR. KOLWICH: Thank you.

19                MODERATOR BONANTI: Great. Thank  
20       you.

21                (Applause)

22                MODERATOR BONANTI: Okay. Our

1 next speaker is Harry Singh from EDAG  
2 Incorporated. He is going to be speaking  
3 about the feasibility, amount of mass  
4 reduction for lightweight vehicles for models  
5 years 2017 to 2025.

6 Remember at the end of the day, we  
7 are going to have an overall moderated panel  
8 and so if there are specific questions that  
9 you want to ask these individual panelists,  
10 speakers, as a collective, it would be very  
11 beneficial for -- if you would like to submit  
12 those questions now and just indicate that it  
13 is for the panel and we can hold them until  
14 the afternoon, if you would like. Thank you.  
15 Thank you.

16 MR. SINGH: Thank you, Chris.  
17 Good morning, everybody, and thank you NHTSA  
18 for the opportunity. This particular project  
19 was funded by NHTSA and we had to identify  
20 mass savings for year 2017 to 2025. The work  
21 has been written up in the report. It is  
22 about 500 pages. I recommend all of you print

1 a copy and keep it under your pillow. And it  
2 is a great cure for insomnia.

3 Okay. Okay. I am going to be  
4 talking materials and manufacturing processes  
5 for high-volume production, about vehicle  
6 system weights, light-weighting options and  
7 costs, also all the engineering work which we  
8 did, the combination of which was very  
9 detailed, finite element models and the  
10 results from those models.

11 And since this work has been done,  
12 we have been getting a lot of feedback from  
13 OEMs. We had a very good meeting with Honda  
14 engineers, Honda team and I want to go over  
15 some of that feedback and conclusions.

16 But very quickly, EDAG, we  
17 specialize in automotive design and  
18 engineering. We offer our services worldwide  
19 to the OEMs. With our sister company, sort of  
20 FFT, we also provide production solutions and  
21 plant construction.

22 We are worldwide and the team who

1 did this work, we were based in Detroit in  
2 Auburn Hills. And we have about 6,000  
3 employees worldwide.

4 We are two-partner companies sort  
5 of in this program, George Washington  
6 University and National Crash Analysis Center  
7 and Electrical. And the way the team was set  
8 up, electrical basically did all of the  
9 communication between NHTSA and us and really  
10 kept the engineering team in line, so we were  
11 meeting all the deadlines and everything.

12 And George Washington University  
13 provided crashworthiness support and make sure  
14 that all the models which were being generated  
15 they were actually up to the standards, you  
16 know, which are required and as well as  
17 directly correlating the results.

18 But overall, the boundary  
19 conditions for this program, our baseline  
20 vehicle was Honda Accord, 2011 Honda Accord.  
21 And we had to design the vehicle keeping the  
22 overall cost in mind, the cost had to stay

1 within 10 percent of the manufacturing MSRP  
2 cost. And the vehicle had to meet all of the  
3 functional and performance requirement as the  
4 current vehicle.

5 And the engineering team, we had  
6 the freedom to, basically, choose any light-  
7 weighting technology as long as it met the  
8 cost constraint and the high-volume production  
9 constraint which for this class of vehicle was  
10 set at 200,000 vehicles a year to run over  
11 five years at 1,000,000 vehicles in total.

12 And our deliverable very detailed  
13 CAE models which NHTSA used in additional  
14 safety studies. But of course, before you can  
15 construct a detailed FE model, you really have  
16 to do very detailed design first.

17 The program started with  
18 benchmarking exercise. We actually purchased  
19 a 2011 Honda Accord, four-door LX model, which  
20 was that particular, you know, sort of  
21 vehicle. We really took all of the data from  
22 that in terms of all the surfaces on the

1 outside as well as the sort of interior.

2 The vehicle was actually torn down  
3 and all the components were weighed and we  
4 sort of, you know, created a complete  
5 development material of the current vehicle,  
6 which was also costed out.

7 Also the body structure, the  
8 stripped down body structure, we actually did  
9 some stiffness tests and normal vibration  
10 tests. And the numbers which I'm going to be  
11 showing on some of these, you know, slides,  
12 they all came from the tear-down vehicle.

13 And when we look at the mid-size  
14 sedan, it is really a very popular package in  
15 the U.S. market. 20 percent of the vehicles  
16 which we buy are mid-size cars. And when you  
17 look at the package, it is really the very  
18 comprehensive package. It can carry five  
19 adults, you know, comfortably with reasonable  
20 leg room and stuff for the occupants in the  
21 back. It can carry so much luggage and  
22 occasional towing.



1                   And if you sort of, you know, look  
2                   at the payload, we are looking at 470  
3                   kilograms, which is almost a quarter of the  
4                   gross vehicle mass. That is what we are  
5                   designing the vehicle for as well as the  
6                   performance it has to meet.

7                   The vehicle have to carry the  
8                   payload over 500 miles with a single filling  
9                   in comfort, safety, entertainment, day or  
10                  night, rain or shine, and then also achieve  
11                  vehicle maximum speed of the order of 112  
12                  miles per hour, naught to 60 times, you know,  
13                  acceleration.

14                  So it's a really very  
15                  comprehensive, you know, package. And in my  
16                  opinion, this really is a very important  
17                  slide. This is what the customer wants. And  
18                  we have to actually design for this. And then  
19                  looking at the other masses, when you look at  
20                  -- you have to keep, you know, five occupants  
21                  sort of, you know, comfortable and safe.

22                  We end up adding the sort of --

1 you know, quite a bit of mass to these  
2 systems, airbags, interior trim, instrument  
3 panel, all the sort of entertainment, heating  
4 and, you know, air conditioning. That's  
5 another quarter of the weight, which, you  
6 know, the vehicle is not moving yet.

7           And then for the chassis, which is  
8 about 15 percent of the weight, there is your,  
9 you know, suspension components and wheels,  
10 brake systems and then the powertrain.

11           In order to achieve the  
12 performance we would be looking at engine  
13 transmission, driveshafts, exhaust systems and  
14 also the fuel system, which is required.  
15 That's another 20 percent of the mass.

16           And then the body structure almost  
17 344 kilograms, 18 percent. And I have those  
18 three numbers in red. Those numbers, the mass  
19 of those numbers is kind of directly  
20 determined by your payload, all the non-  
21 structural masses and even the mass of those  
22 systems by themselves.

1           So if the vehicle gets lighter by  
2           1 kilogram, that means some of those systems  
3           can also get lighter. Not the payload, not  
4           the non-structural masses but at least those  
5           three red numbers. And we use the term sort  
6           of a mass compounding for every one kilogram  
7           you can save, there is a secondary mass-saving  
8           advantage of half to .7 of a kilogram on those  
9           red systems.

10           And the approach which we took in  
11           our project was to really holistically look at  
12           the entire vehicle and try to get the mass out  
13           as much as we could out of all of the systems.

14           And I'm going to talk a little bit  
15           more about, you know, some of the options  
16           which we considered.

17           We started with kind of a  
18           comprehensive assessment of materials and  
19           manufacturing technologies. The materials  
20           which are kind of, you know, readily available  
21           or which are over the horizon which are going  
22           to be available in the near future and also

1 the manufacturing process and we rated each  
2 technology either as mature, if it's already  
3 in high-volume production or -- and midterm  
4 would be if the technology is available on  
5 kind of low-volume, up to 50,000 vehicles a  
6 year production and long-term which is really  
7 kind of, you know, exotic sports car, you  
8 know, type, maybe up to about 10,000 a year.

9 And we looked at steel with the  
10 corresponding manufacturing techniques, which  
11 include stamping, hydroforming, forging and  
12 that sort of thing. Same thing with aluminum.  
13 We looked at other materials magnesium,  
14 plastics, composites.

15 And if you look at composites, we  
16 -- I mean, just about all the categories,  
17 application for body structure, closures or  
18 for the powertrain, we kind of -- they're all  
19 long-term. And we also looked at the assembly  
20 technologies once you made all these parts,  
21 they have to be put together, either like spot  
22 welding which is very common in the automotive

1 industry than laser welding, big welding,  
2 laser braising, adhesive bonding, those  
3 technologies were also rated.

4           And for this particular project,  
5 we basically chose only the mature and limited  
6 number of midterm technologies, because we are  
7 looking at time frame 2017 to 2025 and it's  
8 very high-volume, 200,000 a year. If you have  
9 to make anything of 200,000 a year, you  
10 basically have to make one a minute, two  
11 shifts, two eight hour shifts in 24 hours all  
12 the year, that's how you get 200,000 a year.

13           So you really have to keep that in  
14 mind when choosing the materials and the  
15 technologies that we connect and implement  
16 those in high-volume, you know, production  
17 environment.

18           And then the approach which we  
19 took, we basically ended up dividing the  
20 entire vehicle into a number of systems. And  
21 I'm going to talk about, you know, a couple of  
22 these systems in detail, you know, like the

1 body structure, because that's a major system.

2 And for each system, we actually  
3 had -- we actually sort of -- what are our  
4 possibilities in terms of mass reduction as  
5 well as the cost increase? And then we  
6 actually, you know, chose the technologies  
7 which kind of made sense in terms of dollars  
8 per kilogram of mass saving.

9 If you look at the body structure,  
10 we basically looked at four options. We could  
11 make the body, you know, structure entirely  
12 out of advance size strength steels or it  
13 could be we can use advance size strength  
14 steel and selectively some of the panels can  
15 be other materials like the roof panel  
16 possibly could be aluminum or part of the  
17 floor panels could be plastic, that's Option  
18 2.

19 And Option 3 all aluminum, sort  
20 of, you know, aluminum-intensive. And Option  
21 4 possibly going to composites, although it is  
22 -- you know, it has its limitations but at

1 least we did some numbers. And after looking  
2 at the, you know, cost numbers, our  
3 recommendation was for the body structure go  
4 with advanced high strength steel.

5 And all this is fully discussed  
6 why we chose some of these options, you know,  
7 in the report.

8 And then the next, you know, major  
9 item the closures, which is your doors and  
10 hoods, deck lid, the parts, you know, which  
11 you see on the screen in green. When you look  
12 at the assemblies of all those parts, they  
13 weigh up to, you know, 144 kilograms. And out  
14 of those 144, 92 kilograms is the actual steel  
15 frames. So there is, you know, opportunity  
16 there.

17 And we looked at each one of those  
18 assemblies and if you look at the door, we  
19 looked at three options for the doors. Option  
20 1, use advanced high strength steel where we  
21 would get -- I think if we optimize the design  
22 in steel, we can achieve about 15 percent mass

1 savings.

2 Or if you go with the aluminum  
3 sort of stampings, and we chose aluminum, you  
4 know, aluminum stamping because some of the  
5 infrastructure which were -- you know, which  
6 is out there for stamping steel, those presses  
7 can still be used for stamping aluminum.

8 And Option 3 was there are some of  
9 those in low-volume production. Magnesium  
10 casting for the door and we also looked at  
11 that option. But here our recommendation was  
12 to go with aluminum stamped solution.

13 And the -- so what you see here,  
14 this is sort of all of the body panels, the  
15 door panels and every single panel was  
16 redesigned. We basically kept the Honda  
17 Accord external surface, kept all the interior  
18 sort of, you know, clearances, things like,  
19 which are required for the occupant's, you  
20 know, leg room and so forth.

21 But every single sort of, you  
22 know, panel was redesigned and here we're



1 looking at that kind of material map, what  
2 materials we chose for each of, you know, the  
3 panels.

4 And in the body structure, the  
5 manufacturing processes which were chosen  
6 really most of them are already in high-volume  
7 production. Sort of, you know, hot stamping  
8 which is, you know, graining ground. It is  
9 being used more and more. We used hot  
10 stamping, you know, roll-form section. We  
11 took advantage of the roll-form section.

12 So we feel that in terms of what  
13 we selected, there is nothing really to  
14 invent. I think, yes, it needs engineering  
15 improvements to make those designs work, but  
16 really no new technology.

17 And this slide kind of, you know,  
18 shows where the mass saving came from. About  
19 73 kilograms from the body structure and then  
20 the closures all the way around from the hood,  
21 you know, 7.7 kilograms.

22 The bumper beam is a steel design

1 in, you know, hot stamping. So all together  
2 about 28 percent saving in mass on account of  
3 your typical body structures by taking this  
4 approach.

5 And then on the chassis  
6 components, one of the areas where we ended up  
7 getting significant mass saving which you  
8 won't necessarily achieve on every single mid-  
9 size sedan, was the front suspension on the  
10 2011 Honda Accord, it was a double wishbone  
11 and then we felt that there are a number of  
12 mid-size cars with the MacPherson Strut for  
13 going from double wishbone to MacPherson  
14 Strut. That was almost about 30 kilogram  
15 saving and also, you know, significant cost  
16 saving as well.

17 And then that was our  
18 recommendation. In fact, Honda's new Accord  
19 they have gone from double wishbone to  
20 MacPherson strut as well. But that sort of --  
21 results like this, which was kind of the low-  
22 hanging fruit, you know, which we were -- that

1 mass-saving necessarily, you won't be able to  
2 apply to other mid-size cars if they already  
3 have the MacPherson Strut.

4 But in this case, I think we had a  
5 good mixture on the -- on a lot of the brake  
6 components. As Greg mentioned earlier on, I  
7 think if it is cast iron, we went with either  
8 cast or forged aluminum. The only cast iron  
9 parts we kept were the brake rotors. We feel  
10 that they are really -- that's the best  
11 solution, the brake rotors and, you know, with  
12 current technology.

13 And then other systems on the  
14 powertrain, we -- sort of our belief was  
15 really just downsize the powertrain keeping  
16 the same technology. With the lighter  
17 vehicle, we didn't -- we -- instead of 177 odd  
18 horsepower for the lighter vehicle, we needed  
19 140 horse power.

20 And that, in fact, there is a  
21 Honda engine available which is in the Honda  
22 Civic which is, you know, 1.8 liter, so we

1 basically substituted the powertrain and these  
2 weights you are seeing are for the 1.8 liter  
3 powertrain from the Honda Civic and then, you  
4 know, some of the other systems.

5 On the interior, the mass saving  
6 about 30 percent on the trim, on the  
7 instrument panel beam and the seats. Again,  
8 each of these systems is fully discussed in  
9 the report, why we chose what we chose and  
10 what other alternatives were in those areas.

11 And so, you know, overall, we were  
12 able to achieve about 22 percent mass saving  
13 and we did -- we also did a very detailed cost  
14 model of the first baseline vehicle and then  
15 the new design which we did, so we can, you  
16 know, calculate the delta increase in cost.

17 So for 22 percent mass saving, the  
18 cost increase in MSRP was just over 2 percent.  
19 We didn't make use of the full 10 percent,  
20 because it just didn't make sense to. I mean,  
21 that additional cost can go towards more  
22 advanced powertrain, you know, stop/start and

1 other technologies.

2 And just looking at the overall,  
3 you know, material usage, the chosen material  
4 if you look at the steel, although the steel  
5 content goes down, but it's sort of regular  
6 steel are being replaced by more advanced sort  
7 of high strength steel and ultra high strength  
8 steel.

9 Just an example, if you look at  
10 the current Honda Accord, the 2011 Honda  
11 Accord, not the current one, for the body  
12 structure, the average tensile strength was of  
13 the order of just over 400 megapascals. This  
14 is for the engineers there. Where the design  
15 which we did, we pushed that average up to  
16 over 700.

17 So taking advantage of the highest  
18 strengths which are available from new ultra  
19 high strength steel and techniques like hot  
20 stamping. And most of the other materials  
21 are, you know, cast iron as I mentioned.  
22 That, you know, went down and replaced by cast

1 aluminum, which has gone up a little bit.

2 And then sort of additional  
3 aluminum sheet for the closures, you know,  
4 which was our recommendation. And at the  
5 moment, Alcoa, I believe, they are building or  
6 they are investing in two plants to provide  
7 additional sheet. They obviously see the  
8 demand going up there.

9 But all the other materials, the  
10 material has gone down. And the previous peak  
11 was they defined if you are buying less  
12 material, your cost will also go down as well.  
13 Then that's one of the reasons why when we do  
14 our cost calculation, we do put more cost in  
15 say aluminum doors and in some of these parts,  
16 because some of these other systems are going  
17 down, that cost is offset. The increase is  
18 offset by the reduction.

19 And now, we -- all together the  
20 vehicle was broken into about, you know, 40  
21 subsystem and each subsystem we had number of  
22 options. So we kind of, you know, put sort of

1 options together of increasing mass reduction,  
2 so we basically end up with -- I don't expect  
3 you to read the numbers, but Options 1, 2, 4  
4 is basically going from all steel solution all  
5 the way up to Option 4 using more exotic, you  
6 know, composite type of material achieving a  
7 mass saving from about 19 percent all the way  
8 up to 28 percent.

9           And looking at the cost curve, if  
10 you ignore some of the early points, but those  
11 four options all steel solution, additional  
12 manufacturing direct cost of \$111 increase the  
13 solution which we did detailed design work  
14 Option 2 to, you know, \$319 sort of additional  
15 sort of cost.

16           And then all aluminum solution  
17 Option 3, I will calculate the number,  
18 additional manufacturing cost of \$927. Then  
19 for composites really it blows our target of,  
20 you know, plus or minus 10 percent.

21           And we did a very detailed sort  
22 of, you know, design and computer

1 optimization. We started with topology  
2 optimization, which is basically you take the  
3 outside shape of the vehicle, then you take  
4 out the volumes where the engine is going to  
5 go, where people are going to sit, where you  
6 are going to put your luggage and you take  
7 that out and what is left behind is where we  
8 can put the structure.

9                   And with this topology  
10 optimization, you apply the various loads and  
11 the, you know, computer basically kind of, you  
12 know, gives you an indication where the  
13 natural load parts needs to go. And then so  
14 the engineers, who do the design work, we  
15 basically try to follow some of those sort of  
16 -- you know, follow that direction and then  
17 make the design more manufacturable.

18                   And now, in this picture, you see  
19 the results from the topology in kind of a  
20 pink color. And the way we follow that design  
21 is it's the, sort of you know in the  
22 background, darker gray color.



1                   And so, you know, straight away  
2                   you start seeing differences. You know,  
3                   normally, this front rail structure on a lot  
4                   of the cars is continued underneath the floor,  
5                   but here from the topology optimization, it is  
6                   kind of indicating, you know, start feeding  
7                   the loads into the body side structure.

8                   So we did follow, you know, some  
9                   of this and made the designs, obviously, more  
10                  manufacturable. And then the sort of, you  
11                  know, another method of optimization which we  
12                  would be applying now, you know, as an  
13                  engineer when you start designing your  
14                  vehicle, here is the body structure design.

15                  And I've got to make a decision.  
16                  What should I make this part of the structure  
17                  from? And you have choices of all these  
18                  grades of steel and equally you have the  
19                  choice of, you know, maybe aluminum grades and  
20                  other material grades. And then the material  
21                  is available in various forms and coils or  
22                  extrusions or rolled-foam sections.

1                   Then we have the manufacturing  
2 processes of hot stamping, regular sort of  
3 stamping, hydroforming. As an engineer, you  
4 have to make a decision which part, which  
5 material I choose, which path I follow to make  
6 that part so it's the most efficient cost-  
7 effective design?

8                   Not an easy choice. Up until now,  
9 I think a lot of these decisions had been made  
10 based on experience, but experience is not  
11 always, I feel, the best guide when you are  
12 looking into the future. I think again, we  
13 kind of developed the -- we use optimization  
14 technology where we are looking at not just  
15 the, you know, thickness of the panels or the  
16 grade of the panels, what grade of material to  
17 use, but also the geometry sort of, you know,  
18 shape and then put this into a computer  
19 simulation and let the computer come out with  
20 what sort of shape would be required for a  
21 section through here.

22                   And using this approach, I mean,

1 going through a computer loop where you do,  
2 you know, a number of simulations, you look at  
3 the results, compare the results with the  
4 target we are trying to achieve and then you  
5 say is this my minimum mass solution?

6           If not, you keep on, you know,  
7 going over this sort of loop over and over  
8 until you find the minimum mass solution, you  
9 know, for the -- and meeting all the targets.  
10 And there is a lot of detail when you look at  
11 the body structure. You know, this is just  
12 the body side. This is the panel you see,  
13 there is the opening for the door.

14           But on the inside, we have to  
15 design a lot of panels which have to be welded  
16 together or spot welded together. And in this  
17 type of simulation, we are actually optimizing  
18 these sections. We are optimizing what grade  
19 of steel to use and also the shape as well.

20           And again, using this approach,  
21 the solution you end up, you know, getting are  
22 a little bit unconventional.

1                   Here we are looking at when you  
2 walk into the sort of car and you open the  
3 door, you have that, you know, big section.  
4 This is the section, you know, through that.  
5 The red line is what is on the baseline  
6 vehicle. And this kind of, you know, blue  
7 line is the shape which was developed through  
8 this computer simulation. And we did have a  
9 very interesting discussion on this with the  
10 Honda engineers, so it was good.

11                   And then I just want to go over,  
12 you know, the results. We -- the approach we  
13 -- you know, up front we do the optimization,  
14 but still you have to make certain decisions  
15 up front, you know. Was there -- you know,  
16 what strategy you going to use, especially for  
17 the front end.

18                   And then the strategy which was  
19 used really for the -- this is the front of  
20 the vehicle. When you are involved in a  
21 crash, all these members come into play and  
22 start absorbing energy. And we sort of

1 really, you know, kept these same sort of, you  
2 know, strategies as Honda ACE concept. They  
3 use the term, you know, sort of ACE concept  
4 for the structure.

5 For the load parts 1, 2 and 3, but  
6 load part 4 which is the engine cradle  
7 underneath, that's where we did not use the  
8 same approach. And here you see the  
9 underneath of the vehicle when it is going  
10 through, you know, frontal crash.

11 This, the engine cradle, and that  
12 mount sort of, you know, it is designed to,  
13 you know, fail at a controlled sort of, you  
14 know, load. This is the, you know, strategy  
15 which Honda uses and there is some other  
16 companies use the same approach.

17 But we did not. We went away from  
18 this approach. We did not allow this mount to  
19 fail. With this approach, we feel it is just  
20 a little bit more inefficient in terms of  
21 mass. And you have to design that engine  
22 cradle section really very, very strong, so

1 you reach that failure load.

2 But if you don't want to rely on  
3 that mechanism, we can design the engine  
4 cradle to actually absorb energy during  
5 impact. That was our reasoning. And so based  
6 on the design, we did a very detailed, you  
7 know, finite element model, about 1.5, you  
8 know, million elements.

9 One thing I want to point out, the  
10 external shape is the 2011 Honda Accord. But  
11 we are not claiming this vehicle which we have  
12 designed is a Honda Accord. It is a  
13 lightweight vehicle with similar size and  
14 similar performance, but I think only Honda  
15 can design the Honda Accord with the Honda  
16 DNA. What makes Honda different is why people  
17 buy Honda as opposed to, you know, other  
18 vehicles.

19 And this model, we did simulation  
20 for all the load cases, which is used for the  
21 NCAP rating plus the IIHS load cases. We did  
22 add the rear impact for, you know, fuel tank,

1 you know, integrity and then also the  
2 torsional bending/stiffness and normal modes  
3 of vibration.

4 And looking at the results, on top  
5 you have the animation of the Honda Accord  
6 test and underneath we have the lightweight  
7 version of the, you know, structure which we  
8 designed. And I think that, you know, overall  
9 behavior can see it's, you know, similar.

10 And looking at the acceleration  
11 path, that's what -- the occupancy of the  
12 occupant compartment area. If you look at  
13 this particular part, it's the acceleration  
14 path. The dark line is the Honda Accord test.  
15 And the dotted line is the FEA simulation of  
16 the lightweight vehicle.

17 And this drop in peak is that  
18 engine mount failing, you know, which I was  
19 talking about. When that mount fails, then  
20 the rest of the structure takes -- overload  
21 has to build up, so you do see that. But we  
22 haven't got that because we didn't take

1 advantage of that.

2 This is the acceleration path on  
3 the driver side, that's the acceleration path  
4 on the passenger side. And then also the  
5 important area is front of the dash where  
6 driver's feet are, the passenger's feet are.  
7 How much is this area going to come in?

8 I normally tell people that when a  
9 vehicle is involved in an accident, it's like  
10 your feet are there and on the other side is,  
11 you know, hit with a sledge hammer, that's  
12 kind of what's happening, that is what your  
13 feet end up seeing. And more intrusion there  
14 is at the feet level, more lower leg injury  
15 there is going to be.

16 So measurements are taken in this  
17 area relative to the seat. These are the test  
18 numbers in millimeters, which is really very  
19 tiny. And these are the FEA numbers which,  
20 again, you know, are quite small.

21 And we also looked at the offset  
22 barrier. Here the results were not available



1 for the Honda Accord, so we compared it with  
2 the Crosstour, which have similar structure  
3 sort of in the front end. And looking at the  
4 paths here, we have similar paths.

5 Looking at sort of underneath the  
6 vehicle our engine cradle is not failing at  
7 the back. This is the footwell area where  
8 people's feet are. And when we held the  
9 discussions with Honda engineers, you know,  
10 they point -- they felt uncomfortable with the  
11 amount of intrusion we were getting here.

12 And you can sort of see it here.  
13 These are the various points in this area.  
14 The blue line is the FEA for the lightweight,  
15 but the actual test is this line here.  
16 Although, according to IIHS rating, we are  
17 still in the good area, but Honda engineers  
18 felt very uncomfortable about this increased,  
19 you know, sort of deformation in this area,  
20 which I'm going to talk about a little bit  
21 later on.

22 We did side impact. Here you are

1 looking at the images. The FEA model versus  
2 the test. Also, you take measurements. We  
3 are comparing the amount of intrusions sort  
4 of, you know, in to the area and the impact  
5 velocity. I'm kind of, you know, hoping you  
6 understand all this and there is going to be  
7 a test later on.

8           And then there is a pole impact  
9 which is kind of equivalent of a vehicle going  
10 out of control and hitting a lamp post. Here  
11 are the test pictures and this is the FEA  
12 simulation. You know, the amount of  
13 intrusions which are predicted on the FEA are  
14 in line with, you know, the test numbers and  
15 that was in our brief.

16           A roof crush test, again, the same  
17 thing. Here the dark line is the FEA model  
18 and this is, you know, one of the test curves.

19           So again as I said, we did a very  
20 interesting meeting with the Honda team. They  
21 did a lot of work. They actually didn't just  
22 download the report, they downloaded all the

1 FEA model which they kind of, you know, ran  
2 and their experts looked at it.

3           They identified areas of, you  
4 know, shortfall in performance of that offset  
5 barrier, additional intrusion, side impact.  
6 We actually simulated material failure. There  
7 were areas where the material was a little bit  
8 failing and they were concerned about that.  
9 And on the rear impact, clearance with the  
10 fuel filler line on drivability, sort of, you  
11 know, handling response due to ground  
12 clearance on a lightweight vehicle torsional  
13 stiffness, riding comfort on certain surfaces  
14 and also noise.

15           And then also, you know, we would  
16 talk a little bit about sort of, you know,  
17 commonality effect with other vehicles,  
18 because each vehicle is really a family and  
19 you have to take that into account.

20           I only need another 20 minutes.  
21 Okay. I'll quickly go through this.

22           MODERATOR BONANTI: Okay.

1 MR. SINGH: All right. So we  
2 actually did some additional work where we,  
3 you know, modified the body structure in those  
4 areas. And this is the -- you know, what I  
5 showed you, but the improved. We actually,  
6 you know, made changes and reduced the amount  
7 of deformation, you know, in this area.

8 And here I think, you know, Honda  
9 engineers will, you know, like this. This is  
10 our improved design compared with the test  
11 results.

12 And also the concern which was  
13 with, you know, the side impact by some, you  
14 know, material failure, we made changes there.  
15 Actually increased the thickness of the  
16 gauges, reduced the strength of the material  
17 with more elongation, so those failures will  
18 not account -- would happen. And so again,  
19 you know, we have an improvement.

20 You know, for the rear impact, we  
21 feel the concern which was we will be able to,  
22 you know, reroute, you know, some of the

1 components. There should be no mass impact.  
2 So, you know, sort of torsional/stiffness,  
3 there was a discrepancy which we have  
4 corrected. This was the test number, the way  
5 the test was done. This is the lightweight.  
6 This is the lightweight improved. And the  
7 other way of testing, these are the FEA  
8 numbers.

9                   And so it's really not -- I mean,  
10 you know, there is a difference, but I think  
11 we have improved the structure and these are  
12 the results for -- again, for bending  
13 stiffness, for normal modes, you know, for  
14 vibration.

15                   We did look at the, you know, sort  
16 of engine clearance issue, which was the red  
17 line is the Honda Accord geometry in the  
18 front. The blue is what we had designed. So  
19 we ended up encroaching into the ground  
20 clearance, but this we were able to correct or  
21 really solve just by turning the flanges the  
22 other way on the section.

1                   And if you redesign the engine  
2                   cradle to take into account that -- that was  
3                   kind of a mass hit off by the kilogram. And  
4                   so we felt that in order to meet the  
5                   performance in these areas, there would be a  
6                   total mass impact of about 23 kilograms.

7                   But I think we also identified new  
8                   areas where mass could be saved. One of the  
9                   areas is use of tailor-rolled blanks which we  
10                  didn't use, but that technology is really  
11                  being used now on high-volume production.  
12                  There is potential for 13 kilogram mass saving  
13                  there.

14                  We used a minimum thickness in our  
15                  lightweight design of .6 millimeters. And a  
16                  number of steel companies are beginning to  
17                  roll materials at about .55 or even .5 and the  
18                  .60 are already in production. By 2020, we  
19                  can possibly go down to .55, that's an  
20                  additional 4.5 kilogram mass saving.

21                  And also just general packaging,  
22                  because we are using, you know, a smaller

1 engine in the front, we could save some mass  
2 by, you know, better packaging in the front  
3 and the rest of the vehicle. But the net  
4 effect, even, you know, for improving the  
5 performance would take a material hit off,  
6 which is shown in red, but the other  
7 opportunities, I think there is an additional  
8 20 kilogram.

9 So we feel that the overall  
10 conclusion of our report is still, I think,  
11 about 22 percent mass saving, you know, is  
12 possible. And I just wanted to show we had  
13 also estimated that for a compact vehicle,  
14 mass saving would be about 240 kilograms.

15 And a vehicle which VW have  
16 announced, Golf Mark VII, they are achieving  
17 a mass saving of 100 kilogram and it's  
18 slightly a larger vehicle across three  
19 platforms. So we feel that the vehicles which  
20 are coming out now, they are already meeting  
21 part of that mass saving, but, you know, 100  
22 kilograms out of 245, another two generations,

1 Golf will be able to save another 145  
2 kilograms.

3 On platform sharing, this is my  
4 last one, if you look at the sales of  
5 vehicles, these are the Honda vehicles based  
6 on their UV platform. Honda Accord with the  
7 four-cylinder engine is the highest seller,  
8 200,000 a year for 2010 and these are the  
9 siblings which all share the same platform,  
10 much lower sales.

11 And I think they -- maybe a  
12 changing strategy may be required. And this  
13 is a comment from GM from Mary Barra. "We are  
14 maniacal about, you know, mass."

15 On the new Cadillac ATS, Dave  
16 Masch, the chief engineer, I think the comment  
17 he made is sort of very interesting. And the  
18 biggest break from past practice, "GM  
19 engineers built the ATS platform with only one  
20 highest volume model in mind. Initially, they  
21 didn't incorporate weight here, more durable  
22 parts for say V-6 engine or rear drive



1 version."

2                   So I think a change in strategy  
3 here for these vehicles make those sort of  
4 additions rather than, you know, penalizing  
5 the vehicle, but adds the economic decisions  
6 with the OEM. And our conclusions, you know,  
7 overall, I think we were able to achieve 22  
8 percent mass saving using conventional, sort  
9 of most of the, technologies which are  
10 available now or will be shortly available.

11                   And most of the techniques -- yes,  
12 they will require engineering effort, but I  
13 think all new vehicles require engineering  
14 effort. I think this can be implemented.  
15 Thank you.

16                   (Applause)

17                   MODERATOR BONANTI: Thank you,  
18 Harry. Okay. So we have gone over our time,  
19 at this point. We do -- I want to offer up a  
20 number of questions, if you do have them to  
21 Harry, but at the same time, the first three  
22 speakers besides Jim Tamm from my staff at

1 NHTSA discussed both CARB's perspective from  
2 studies, EPA's studies as well as Harry just  
3 discussed what NHTSA asked him to do and his  
4 team.

5 This afternoon, we will be able to  
6 have the OEMs respond to that and others on a  
7 mass-safety basis with their expertise. And  
8 I just wanted to at least make you all aware  
9 that the interaction here is very important to  
10 establish what we have learned and what the  
11 industry is focused on and what you hope to  
12 achieve as well.

13 So at the same time, after I ask  
14 the last question, we are planning on being  
15 back here and starting at 1:20. So it is  
16 12:00 now. If you want to hear the questions  
17 and the answers in response, feel free to  
18 stay, but I'm going to start at 1:20. Thank  
19 you.

20 Okay. What manufacturing process  
21 did you assume for the composites? Assuming  
22 CFRP prepreg, okay? Did you consider RTM

1 process or polyamide thermoplastic laminate?

2 MR. SINGH: Boy. That's kind of a  
3 technical question, which I will not be able  
4 to answer. But when you look at composites,  
5 the -- when you look at what BMW are doing  
6 with the I-3, that we kind of took some of the  
7 cues and ideas from that. They are claiming  
8 about 50 percent mass saving and that was the  
9 assumption we used in our calculation.

10 But I think very early on, we kind  
11 of ruled composites out because of we are  
12 looking at high-volume production, one part,  
13 you know, one vehicle coming off the line a  
14 minute. And in order to make a high-volume  
15 production kind of cost-effective, you really  
16 need to have one of these parts coming up,  
17 single sets of tools wherever possible.

18 If you have to look at composite  
19 cycle times, the best possible cycle times are  
20 down to about maybe seven minutes now per  
21 part. So in order to reach that one a minute,  
22 you would probably need seven sets of tooling.

1                   So sorry I can't answer that, sort  
2 of detailed question, but because we did not  
3 really exactly design the body structure in a  
4 lot of detail in composites.

5                   MODERATOR BONANTI: All right.  
6 Okay. With your mass reduction, were you able  
7 to judge how much fuel economy improvement you  
8 could get? That's the first question.

9                   The second question, what safety  
10 standards did you evaluate for NHTSA? Did you  
11 include Honda's internal requirements as part  
12 of that?

13                   And they also want to thank you  
14 for a good presentation.

15                   MR. SINGH: Oh, thank you. Okay.  
16 We used all of the NCAP, you know, testing and  
17 the list is in the report and I showed which  
18 is mainly all of the occupant safety. We did  
19 do sort of additional stiffness of the  
20 vehicle, normal modes, which is vibrations of  
21 the vehicle, but we did not consider any  
22 Honda's internal, you know, kind of tests.

1                   We did do -- you know, other load  
2 cases, you know, say for durability, a vehicle  
3 hitting a pothole, vehicle going around a  
4 corner and what sort of loads are generated in  
5 those maneuvers. Those loads were used to  
6 make sure the vehicle, you know, the stress  
7 levels are going to be low enough.

8                   But there are right now -- when  
9 you design a vehicle, there are basically  
10 hundreds of load cases, but a lot of those  
11 load cases are very, very localized. And then  
12 in those areas, we basically used good  
13 engineering design lines principles like where  
14 the seatbelts are attached. There has to be  
15 reinforcement back there. We make sure there  
16 is reinforcement in our design.

17                   Besides the bolts which is used,  
18 we make sure we use the standard size of bolt.  
19 So we did take account all of the mass which  
20 would go into it, but the actual test was not  
21 done.

22                   And then when you do the actual

1 test, sometimes you end up actually taking  
2 some material out, because you are optimizing  
3 for that test. Other times you end up adding  
4 a little bit of material in under those sort  
5 of, you know, localized load cases. But we  
6 feel overall impact of those -- that type of  
7 detailed testing it should weigh out the mass  
8 saving versus mass you may have to put in  
9 certain areas.

10 MODERATOR BONANTI: The first  
11 question, which I don't recall you actually  
12 answering was with your mass reduction, were  
13 you able to judge how much fuel efficiency  
14 improvement you could get?

15 MR. SINGH: We did detailed models  
16 in PSAT, which is a performance simulation  
17 program in which you can put your powertrain,  
18 you know, type of parameters and you can  
19 predict what miles per gallon you would get.  
20 And we did -- had a PSAT model which we ran  
21 and the results which came out of the PSET  
22 model were very close to the guidelines, you

1 know, which we generally use, which is for 10  
2 percent mass saving, you get about 6.5 to 7  
3 percent increase in fuel economy if you resize  
4 the engine.

5 And the PSAT results were very  
6 close to that rule, but we did have a detailed  
7 PSAT model which we used for NULL to 60, you  
8 know, performance prediction as well as miles  
9 per gallon and maximum speed and that sort of  
10 thing.

11 MODERATOR BONANTI: Okay. I  
12 believe this is the last question, unless  
13 there are any others.

14 Okay. What were the joining  
15 optimization performed? How does optimum  
16 joining compare to baselining?

17 MR. SINGH: When it comes to, you  
18 know, joining, the strategy which we used was  
19 about half the flanges we are using laser  
20 welding. The other half we are using spot  
21 welding with increased amount of adhesives,  
22 which is, I think, we are using a little bit

1 more laser welding, which does give you a mass  
2 advantage.

3           You need smaller flanges and in  
4 the report there is an entire chapter  
5 comparing laser welding versus spot welding.  
6 And a lot of the joint -- as soon as you start  
7 using more adhesive in the joint area or laser  
8 welding, your joint stiffness also improves.

9           So in and around key joint areas,  
10 we have adhesive bonding and possibly a little  
11 bit more laser welding, but that is fully  
12 discussed in the report in more detail.

13           MODERATOR BONANTI: Okay. Thank  
14 you, Harry.

15           (Applause)

16           MODERATOR BONANTI: Okay. We have  
17 escorts outside for those that are going to be  
18 leaving the building for lunch. Hopefully, if  
19 you have any questions, any of my staff or any  
20 of the guides will be able to assist you. And  
21 we look forward to getting you back here at  
22 1:20, so please take into consideration -- you



1 can leave -- yes, if you want to leave your  
2 stuff here, you can leave your stuff here.

3 (Whereupon, the Symposium was  
4 recessed at 12:09 p.m. to reconvene at 1:22  
5 p.m. this same day.)

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1:22 p.m.

MODERATOR BONANTI: Thank you. It looks like the majority of everyone heeded my warning that we were going to start at 1:20, so I'm glad you all are back in attendance.

The next speaker to start the afternoon as we discussed this morning most of what you received when it came to presentations was looking at the three agencies, both CARB, EPA and NHTSA's perspectives on the type of research that each one of the agencies has developed and put forward.

This afternoon, we are fortunate enough to have OEMs as well as technical representatives from other areas that will be able to provide perspectives on what has been discussed this morning, as well as initiatives on their own.

So first and foremost, I would like to have Chuck Thomas from Honda come up

1 and give his presentation. He is going to be  
2 discussing the Honda study and report that was  
3 commissioned by NHTSA that you just received  
4 a lengthy presentation before lunch and I'm  
5 looking forward to hearing Chuck's response to  
6 that. So thank you, Chuck.

7 MR. THOMAS: Hello, everyone. I'm  
8 Chuck Thomas with Honda R&D and I do really  
9 want to thank NHTSA for inviting us here today  
10 to discuss the study that was conducted by  
11 EDAG.

12 Harry stole a little bit of my  
13 thunder today, so hopefully -- that is good,  
14 he covered some of the material, so that way  
15 it saves me a little bit of time.

16 So I want to start out with a few  
17 observations about the lightweight vehicle  
18 study that was conducted by EDAG. You know,  
19 our position is that we think the report  
20 really is a pretty good study of light-  
21 weighting possibilities and has -- identifies  
22 a lot of technologies that we think have a lot

1 of potential to reduce vehicle weight. And I  
2 think everybody can agree on that.

3 You know, many of the technologies  
4 and the approaches that they discuss in the  
5 study reflect in sort of parallel our own  
6 activities, our own research into vehicle  
7 light-weighting.

8 Honda arranged to have this  
9 presentation initially with NHTSA and with  
10 EDAG to really kind of share some of our  
11 observations of the study that was conducted  
12 and a few corrections we think are really  
13 important, both in the details of the study  
14 and in some of the conclusions that it  
15 reached.

16 And really, we think it is  
17 important as a manufacturer in the automotive  
18 industry to work with NHTSA and kind of  
19 collaborate. So they understand what our  
20 perspectives are, what our concerns are. And  
21 you know, we bring a lot to the table, I  
22 think, when it comes to the actual potential

1 of some of these light-weighting ideas.

2 As a manufacturer, these are the  
3 things we cope with and struggle with every  
4 day.

5 So kind of like I think to touch  
6 on what Harry said, you know, we looked at the  
7 lightweight vehicle study and if you look  
8 underneath the chair over there, there is a  
9 copy of it printed out that I don't keep under  
10 my pillow, but I did read it. And I think it  
11 was very well-done.

12 But there were some areas, I  
13 think, that we had concerns with. One of the  
14 assumptions of the study is the lightweight  
15 vehicle that they created would match the  
16 performance of the 2011 Honda Accord. We  
17 looked at it and we thought in some areas it  
18 doesn't, we believe, meet that level of  
19 performance, particularly in the area of  
20 crashworthiness, performance and drivability  
21 and also related to some ground clearance  
22 issues.

1                   So also there were some business  
2                   conditions that we think weren't really  
3                   discussed or explored by EDAG in the study and  
4                   those are related primarily to platform  
5                   commonality and Harry touched on that a little  
6                   bit and I'll expand on it.

7                   And then, you know, one of the  
8                   things that occurs is when you look at these  
9                   light-weighting studies, because you can take  
10                  weight out of the vehicle, then you have this  
11                  sort of multiplier effect where people begin  
12                  to downsize other components of drivetrain and  
13                  chassis.

14                  Of course, the problem is when you  
15                  have to put some of that weight back in to  
16                  correct for that, that effect reverses itself.  
17                  So there is some weight that has to be added  
18                  that we kind of call the mass rebound and I'll  
19                  try to cover some of that as well.

20                  So if you look at this chart, this  
21                  is what we call at Honda, a Yamataka, which is  
22                  just kind of a fancy name for a stair step

1 kind of weight analysis. And this looks at  
2 the change that the lightweight vehicle  
3 proposed compared to the 2011 baseline Accord.

4 And you can kind of see the  
5 different categories and weight reduction that  
6 they proposed. And they, from their study,  
7 achieved a 332 kilogram weight reduction, so  
8 which is about 22 percent of the vehicle  
9 weight.

10 So when we looked at this, you  
11 know, as I had already mentioned, we observed  
12 that there are certain areas of performance  
13 that we feel the lightweight vehicle didn't  
14 achieve parity with the 2011 Accord,  
15 particularly crashworthiness, some drivability  
16 issues. And to correct for that, you know,  
17 some weight is going to have to be added back  
18 in.

19 So when we think about like what  
20 is the lightweight vehicle adjusted weight  
21 based on the performance, what we started to  
22 look at were the finite element models and the

1 other data that was available from EDAG to  
2 make some assumptions and some rough  
3 calculations on what we think would be a more  
4 reasonable level of weight.

5 So I think maybe you saw this  
6 chart in Harry's presentation. This is at our  
7 common radar chart that looks at sort of  
8 performance mapping. And, of course, the  
9 study of the 2011 Accord was attempting to  
10 achieve a vehicle that met all the performance  
11 criteria of the 2011 except in one area and  
12 that is fuel economy.

13 So the idea was they would be  
14 improving the fuel economy of the vehicle  
15 while maintaining its performance.

16 I think when -- you saw this chart  
17 in Harry's presentation as well. And this,  
18 you know, our chart that sort of shows what we  
19 believe to be the performance of the  
20 lightweight vehicle. Of course, this is a  
21 qualitative chart. This isn't a quantitative  
22 radar chart.



1                   But in the area of safety and some  
2 handling response, ride, comfort and noise and  
3 vibration, we feel that the lightweight  
4 vehicle's design would be degraded compared to  
5 the 2011 Honda Accord. And I'll touch on  
6 these.

7                   First, I want to kind of explain a  
8 few things in define a few assumptions that we  
9 made in the work that we did with the  
10 lightweight vehicle. As Harry had mentioned,  
11 I think there is kind of a misconception for  
12 a lot of people in this study that the  
13 lightweight vehicle is the 2011 Honda Accord  
14 with some weight removed from it.

15                   But like Harry pointed out, really  
16 the lightweight vehicle is a completely new  
17 vehicle. The vehicle platform architecture  
18 was redesigned by EDAG. Really the only thing  
19 that is sort of the same is the exterior  
20 shell.

21                   So two of the assumptions that we  
22 worked with when we did this study, one was

1 the sub-frame design. So Harry had mentioned  
2 that the sub-frame design for the lightweight  
3 vehicle is a fixed sub-frame that is not  
4 designed to separate from the body the way the  
5 Accord's sub-frame is designed to.

6 And then the second thing is we  
7 didn't change the geometry of the platform.  
8 So you can kind of see these components in the  
9 lower picture that are identified in red.  
10 This was construction that was developed by  
11 EDAG for this lightweight vehicle.

12 We didn't -- it was beyond the  
13 scope of what we were going to do to go back  
14 and redesign all the components, so the  
15 countermeasures that we have applied are  
16 primarily looking at either changing the  
17 material or the thickness of the components  
18 that already exist. And in some areas, adding  
19 some additional components to reinforce  
20 different components of the structure.

21 So I want to start with front  
22 crash testing, particularly the Insurance

1 Institute's moderate overlap crash test, which  
2 I think probably many of you are familiar  
3 with.

4           And Harry had touched on this that  
5 we had discussed this when we had met with  
6 them previously. The design of the  
7 lightweight vehicle had increased levels of  
8 dashboard lower intrusion which we saw. And  
9 also what we saw in some of the -- in our  
10 initial runs was that the dashboard upper  
11 intrusion was increased as well.

12           So these are areas that are of  
13 concern, because even though the Insurance  
14 Institute defines these regions as, you know,  
15 good acceptable, marginal and poor, what we do  
16 know is increased intrusion in these areas  
17 increase the risk of injury, particularly to  
18 lower extremity injury.

19           So even though the values in the  
20 lightweight vehicle were not excessive, the  
21 increase in those values to us would be an  
22 indicator that we probably need to do

1 something to prevent that from occurring,  
2 because it is increasing the risk of injury.

3 So when we looked at the model, we  
4 came up with four different things that we  
5 changed to improve the front crashworthiness  
6 of the vehicle. There was a patch that was  
7 added to the toe board right area to help  
8 reinforce that area to prevent intrusion. The  
9 front rail-end or the front side for rail-ends  
10 buckle very quickly in the analysis, in the  
11 structure. So those areas are reinforced to  
12 try to prevent that buckling early in the  
13 crash and to drive the front side into a more  
14 column-type crush behavior.

15 The upper wheel house members and  
16 the pillar areas were reinforced to try to  
17 help rebalance that load going into the cabin  
18 to reduce the pillar intrusion.

19 And then also what we saw in the  
20 model, there is a lot of seat pitching in the  
21 model that was designed. Now, this model  
22 didn't have an occupant in it, but there were

1 masses that were added to try to create some  
2 of the inertia loading, so it appears.

3 So we reinforced areas of the  
4 seat, because that seat pitching pushes the  
5 occupant closer to the instrument panel and we  
6 wouldn't want that to happen. So when we  
7 applied all of these countermeasures to the  
8 vehicle, it adds up to be around 25 kilograms  
9 of mass.

10 Now, some people could argue maybe  
11 we could do this with a little bit less mass.  
12 As I mentioned, you know, we made certain  
13 assumptions. We weren't going to redesign all  
14 the geometry, but I think that it is fair to  
15 say that mass would be -- have to be added to  
16 improve the front crash performance of the  
17 vehicle to match the 2011 Accord. And I don't  
18 think 25 kilograms is an unreasonable amount  
19 of the mass.

20 The next thing I want to talk  
21 about is side crash performance. So we looked  
22 at the size model, because the size has a

1 tendency to be a very demanding side crash  
2 model of the structure. There is a lot of  
3 energy that goes into the vehicle.

4 One thing we notice when we looked  
5 at the EDAG analysis of the lightweight  
6 vehicle, there was a lot of fracture that was  
7 occurring in the side impact areas of the  
8 vehicle. The cabin structure is, you know,  
9 designed primarily to maintain the integrity  
10 of the space around the occupant and protect  
11 them from intrusion, which is one of the kind  
12 of the key mechanisms that cause injury in  
13 side impact events.

14 The cabin in a side impact event  
15 is not intended to absorb energy, because  
16 there is very little stroke in the cabin  
17 structure. So you can imagine unlike the  
18 front crash, the side crash -- our intention  
19 as a manufacturer is to maintain the integrity  
20 of the space around the occupant.

21 So since EDAG went to new types of  
22 materials, particularly these hot stamp

1 materials, which, you know, we are very fond  
2 of and we are beginning to use in our vehicles  
3 as well, one thing that has a tendency to  
4 happen with these materials, they have the  
5 tendency to fracture when they fail.

6           Unlike traditional materials that  
7 are milder that have longer levels of  
8 elongation, when these materials fail, they  
9 fracture and you see catastrophic failure in  
10 the structure. So we can't tolerate that type  
11 of behavior in the structure, because it  
12 destroys the integrity of the protective cage  
13 around the occupant. So we have to design the  
14 vehicle such that these types of fractures  
15 aren't going to occur in these types of  
16 crashes.

17           When we looked into the EDAG  
18 model, it was predicting quite a few fractures  
19 in the side impact structure. You can see a  
20 few of them that are highlighted in these  
21 figures. You can see fractures at the base of  
22 the B Pillar, some fractures in the roof arch.

1       These types of fractures would indicate a very  
2       high risk of sudden increases in intrusion in  
3       real-world crashes. And we wouldn't tolerate  
4       these types of fractures in our vehicles.

5               So we went back and looked at it  
6       and much like Harry just explained, what we  
7       did was we left it go into materials with  
8       higher elongations and with lower yield  
9       strengths for these certain areas where you  
10       have inner pillar structures, which are placed  
11       in tension during side impact events, because  
12       tension loading is what has a tendency to  
13       cause them to fracture and kind of fail  
14       catastrophically. And that adds up to about  
15       10 kilograms.

16               And then lastly from a crash mode,  
17       we looked at rear crash. So I think we are  
18       all -- probably most of us are familiar with  
19       the 301 crash mode. In the model that was  
20       developed by George Washington in a  
21       lightweight vehicle study, they didn't have a  
22       fuel tank, but the lines and particularly the



1 filler neck were missing out of the  
2 simulation.

3 So what we did was we added those  
4 back in. And what we found is if you kind of  
5 see the filler neck which is shown there in  
6 red, the filler neck is contacted in the  
7 simulation by the upper control arm of the  
8 rear suspension structures. That is something  
9 that we wouldn't tolerate in our design.

10 While FMVSS 301 has allowances for  
11 certain amounts of fuel to leak during a  
12 crash, we don't allow any fuel to leak by our  
13 own internal requirements. We actually don't  
14 allow for the potential of fuel leak. So we  
15 try to avoid contact if at all possible with  
16 the fuel system and certainly minimize any  
17 contact with hard steel components that could  
18 damage the fuel system.

19 While not by design, it's  
20 certainly possible the filler neck could have  
21 fluid gas in it, because customers overfill it  
22 and, of course, the vehicle can turn.

1                   So we made modifications to the  
2 rear frame rails of the vehicle as well as the  
3 rear sub-frame to increase the strength of  
4 those areas to help prevent that contact.

5                   Now, I think Harry mentioned in  
6 his presentation that we could redesign the  
7 fuel system and we could try to route the  
8 filler neck somewhere else. That is certainly  
9 a possibility. The problem is the real estate  
10 in the rear area of the vehicle is very tight  
11 and, you know, already we struggle with how to  
12 route that fuel filler neck.

13                   So we think we have probably found  
14 a pretty optimal position for it. And it was  
15 something that needed to be protected. So  
16 this adds up to about 15 kilograms.

17                   So if you go back to our fancy  
18 word Yamataka and you look at sort of where we  
19 are right now, so if we started at 1148 with  
20 25 kilograms for front collision, 10 kilograms  
21 for side collision and 15 kilograms for rear  
22 collision, that gets us to 1198 kilograms,

1 which is still a pretty big reduction in mass.

2 There are a few other areas I  
3 wanted to look at and next I'll get into  
4 drivability and performance and we can see  
5 what kind of weight increases we think might  
6 be necessary there.

7 So when we talk about driving and  
8 performance, we are really kind of talking  
9 about handling. And probably the most  
10 representative characteristics of the vehicle  
11 related to this is what we think of as body  
12 rigidity.

13 So this affects how the vehicles  
14 turning response is going to be affected and  
15 also its stability as it recovers from a  
16 steering maneuver. If you look at this chart,  
17 you know, we are estimating right now that you  
18 are going to see a significant drop in  
19 performance of the lightweight vehicle against  
20 what we think is the 2011 Accord's  
21 performance.

22 Harry had touched on this, too,

1 and I'll just go over this quickly, but the  
2 target for body rigidity for the lightweight  
3 vehicle was derived from the performance of  
4 the 2011 Accord that was tested by DEFIANCE.

5 From looking at the study, we  
6 think that DEFIANCE used a boundary condition  
7 that was different than what was intended by  
8 EDAG, because when we looked at their data we  
9 saw that their results seemed very different  
10 than ours. And it looks like, from the  
11 photograph, they had supported the vehicle in  
12 different locations than the shock tower.

13 When we looked at it, and the  
14 numbers I'm sorry, I had to remove for  
15 confidentiality reasons, our physical test and  
16 our CEA results are much similar. And they  
17 are significantly higher than what was  
18 measured either by EDAG or what is predicted  
19 in the lightweight vehicle.

20 So really the target for the  
21 lightweight vehicle's torsional rigidity, I  
22 think, is low compared to what the 2011 Accord

1 already achieves. The good news is though  
2 when you looked at the weight we had added for  
3 crashworthiness, it increased the overall  
4 torsion of the vehicle.

5 So those changes alone seem to  
6 address a lot of the torsional concerns. So  
7 we really didn't need to add any additional  
8 weight for body rigidity. It was addressed  
9 through the crash countermeasures.

10 Another area that I want to touch  
11 on is noise. I think everybody who drives a  
12 car wants their car to be quiet and  
13 understands, you know, that from a competition  
14 factor today, road noise and vehicle quietness  
15 is a very important consideration for the  
16 customer.

17 Some of the things that was looked  
18 at in the EDAG report to reduce weight, for  
19 example, was reducing the thickness of the  
20 wheel rim for the steel wheel and going to a  
21 stronger material. Our concern with that is  
22 thinning that wheel, we think, would increase

1 road noise, transmission into the cabin.

2 We have looked at these types of  
3 things before and we don't think that's a very  
4 good idea. So we suggested putting that  
5 weight back into the wheels, which is about  
6 4.5 kilograms.

7 Also EDAG looked at aluminum  
8 closures for the vehicle. We have some  
9 experience with aluminum. We have developed  
10 the old NSX. The inside -- we understand  
11 that, you know, there is certainly big weight  
12 advantages to aluminum closures. However, the  
13 noise transmissibility through aluminum is  
14 higher than steel.

15 So probably some additional  
16 soundproofing or insulation material would be  
17 required, so we estimated 1.2 kilograms would  
18 be added. And then there is some additional  
19 noise countermeasures and it all sort of adds  
20 up to about 5.8 kilograms.

21 Another issue that came up was the  
22 ground clearance. So I know Harry had

1 mentioned this, but what we looked at when we  
2 looked at the sub-frame design that EDAG had  
3 come up with with their new sub-frame, one  
4 thing they removed was the curved rear beam  
5 area of the sub-frame that the Honda Accord  
6 has.

7 One of the reasons for this curved  
8 rear beam is the exhaust A pipe runs  
9 underneath the engine and that curve creates  
10 an escape space for the exhaust pipe to fit up  
11 underneath the engine to reduce the likelihood  
12 it is going to strike the ground.

13 With the sub-frame that was  
14 developed in the lightweight vehicle, that A  
15 pipe is closer to the ground and there is  
16 potential impact of that relatively fragile  
17 exhaust system component to the ground.

18 So we would recommend that be  
19 raised back up. We tried to look at their  
20 sub-frame and make some estimates of what we  
21 think would be necessary to change as the rear  
22 beam, but to maintain the kind of design

1 concept of their sub-frame. And we thought  
2 about somewhere around 8.5 kilograms would be  
3 necessary in additional weight.

4 So now if we look at sort of these  
5 drivability and performance weights, if we  
6 start with the 1148 and we add in the 50  
7 kilograms of crashworthiness, the 18 kilograms  
8 of drivability and performance and then about  
9 another 7 kilograms that we found, mainly  
10 because we think there were some mistakes in  
11 the baseline weight. It didn't add up to be  
12 a lot, but a few things that we found, that  
13 puts us back up to around 1223.

14 So then so that weight going from  
15 1148 to 1223, we think is a pretty reasonable  
16 amount of weight to adjust what we think are  
17 some of the performance parity issues between  
18 the 2011 Accord and the lightweight vehicle.

19 But there are some other areas we  
20 need to think about as well and that is some  
21 business consideration in what we call kind of  
22 this mass rebound effect.



1           So when we talk about the business  
2           condition, one thing we want to talk about is  
3           platform commonality. And Harry kind of  
4           touched on this. We discussed it earlier.

5           You know, the Accord is a vehicle  
6           that has a lot of sort of children that go in  
7           its family. Besides the four-cylinder and  
8           six-cylinder version of the Accord, the Honda  
9           Crosstour and the Acura TL are actually both  
10          in the same platform as the Honda Accord. And  
11          both of these vehicles are significantly  
12          heavier than the Honda Accord.

13          So our strategy is, and I think  
14          many auto makers are, that we look at how that  
15          platform is going to be used throughout a  
16          family of vehicles and we have to make certain  
17          decision on the design of components to  
18          accommodate the different types of mass that  
19          these different vehicle configurations are  
20          going to bring.

21          So when you look at the  
22          lightweight vehicle, what you really have is

1 a four-cylinder vehicle that has no family.  
2 It is a vehicle in and of itself and it really  
3 is just one design, but when you think about  
4 the Accord, you know, the Accord has multiple  
5 engine configurations as well as larger  
6 vehicles that are derived from the same  
7 platform.

8 So again, I'm sorry, due to  
9 confidentiality reasons, there was some data  
10 we had to remove here that we had shared with  
11 NHTSA, but, you know, Harry had touched on the  
12 idea that maybe some auto makers are  
13 rethinking this strategy. And, you know, for  
14 some vehicles maybe it makes sense. Like the  
15 ATS volumes are significantly lower than the  
16 Honda Accord, so maybe for the ATS that  
17 General Motors is talking about, it makes more  
18 sense.

19 But one of the things that becomes  
20 a problem is if you do that, a lot of these  
21 other vehicles that are derived from the  
22 common platform have much smaller amortization

1 volumes than the Accord does. So by sharing a  
2 part, even though that part may be a little  
3 over designed for the L4 Accord across the  
4 entire family, our amortization values are  
5 much more reasonable.

6 But if you have to take a vehicle  
7 that only has 10 or 15,000 units that are sold  
8 and have to design exclusive parts for it, the  
9 amortization numbers become very difficult.  
10 So there are complicated kind of situations  
11 that have to be managed when you think about  
12 this sort of business compatibility structure,  
13 because as the manufacturer, you know, we do  
14 want to create a family of vehicles that we  
15 can sell to customers that sort of are  
16 designed to meet their needs depending on the  
17 type of vehicle that they want to buy.

18 And then I guess to kind of hit  
19 the last point is that based on this  
20 commonality and those sort of family of  
21 vehicle issues, we think that would add about  
22 40 kilograms back into the vehicle.

1                   So if you go back to our Yamataka,  
2                   if we add 40 kilograms in for business  
3                   considerations, we are now back up to about  
4                   1263 from the original 1148.

5                   So the last thing we want to talk  
6                   about is what we call mass rebound effect. So  
7                   in the EDAG study and in like many of the  
8                   studies we have seen this morning, as we  
9                   reduce weight from the vehicle, other systems  
10                  related to vehicle weight can be changed,  
11                  because the performance that's necessary based  
12                  on lighter vehicles is now more than we  
13                  originally requested, particularly areas like  
14                  the drivetrains and the braking systems and  
15                  chassis systems we have discussed can be  
16                  downsized or have some weight reduced without  
17                  impacting performance.

18                  The problem is if we go the other  
19                  way, if we wind up having to put some of this  
20                  weight back in, we have to kind of back off  
21                  some of those things. So when we looked at  
22                  it, originally the 332 kilograms of mass

1 production, about 90 kilograms of that from  
2 the EDAG study were related to sort of like  
3 being able to reduce weight based on the  
4 weight that they had already reduced.

5 We had our power train group look  
6 at it and based on the weight that we added  
7 back in, the EDAG proposal of going to 140  
8 horsepower probably wouldn't really meet the  
9 performance targets that we have for the  
10 vehicle.

11 We didn't want to end up going all  
12 the way back up to 177, which is the Accord,  
13 but they estimated that they needed to go up  
14 to about 160 horsepower. And we asked them to  
15 make some estimates of what that weight would  
16 cost. They said that, you know, 30 kilograms  
17 they thought was a reasonable target based on  
18 some changes they may have to make to the  
19 transmission or different types of engine  
20 configurations to achieve that.

21 Some other systems added up to be  
22 about 12 kilograms. So totally from this sort

1 of weight rebound effect or mass rebound, we  
2 were looking at about 42 kilograms.

3 So if you add in the 42 kilograms,  
4 that brings us all the way back up to around  
5 1305. So if you look at the total weight that  
6 was adjusted, you know, we started at 1148 or  
7 1480. The lightweight vehicle went down to  
8 1148. From our investigation of it going back  
9 up, we come back to about 1305.

10 You know, so I think 1305 is still  
11 a pretty significant weight reduction, but,  
12 you know, kind of they conclude there are a  
13 few things we wanted to kind of point out to  
14 EDAG and Harry and I have talked about this.

15 Certainly, we think that the  
16 original lightweight vehicle model while it  
17 really looks at a lot of good ideas, it sort  
18 of over-emphasizes the potential for some of  
19 the weight reduction, primarily because it  
20 doesn't necessarily match the performance  
21 requirements of the 2011 Accord, particularly  
22 in the area of crashworthiness, drivability,

1 and NVH.

2 And then when we add those in in  
3 the business kind of conditions, you know, we  
4 think an achievement of 175 kilograms for the  
5 lightweight vehicle project is probably more  
6 reasonable than the 332 kilograms that were  
7 reported. You know, of course, this is a  
8 difference of opinion and I haven't built this  
9 vehicle, so the exact amount of weight that  
10 this would actually be if we designed this  
11 car, you know, I can't prove it, but  
12 identifying some of the things that we were  
13 concerned with in the lightweight vehicle, I  
14 think would definitely require additional mass  
15 to address.

16 You know another thing, too, which  
17 is a really important factor that I haven't  
18 heard anyone really talk about today yet is  
19 the manufacturer -- what we have to think  
20 about is what our customers are going to want  
21 in the future.

22 So most of these studies have

1 looked at, you know, two generations of  
2 vehicles and sort of the time lines. So we  
3 are thinking about, you know, 2020 to 2025.

4 I would ask all of you to think  
5 back to the car that you owned in 2002 and  
6 think about what that car is like versus the  
7 car that you may be on today, assuming it's  
8 not the same car. And you know, over two  
9 generations, vehicles have changed quite a  
10 bit.

11 And I think it is unreasonable to  
12 think that over the next two generations, the  
13 vehicles won't change again. You know, the  
14 one thing I have learned in the automotive  
15 industry over the past 20 years is that the  
16 customers are really unreasonable and they  
17 want a lot for their dollar.

18 And as a manufacturer, you know,  
19 we are constantly trying to find ways to  
20 satisfy that customer, but still provide a  
21 vehicle at a price that they are willing to  
22 buy.



1                   So, you know, in crashworthiness,  
2                   I think in the past 10 years and how much  
3                   things have changed in crashworthiness in the  
4                   design of the structure and the protection  
5                   that we offer people today, I don't think that  
6                   is going to stop. I think that is going to  
7                   continue in the -- moving forward in the  
8                   future.

9                   But the Insurance Institute, Small  
10                  Overlap test, and the Oblique test that is  
11                  being developed by NHTSA currently are tests  
12                  that are going to be more demanding of the  
13                  vehicle for crashworthiness. It is going to  
14                  make it harder for us, you know, to achieve a  
15                  level of performance and continuously work to  
16                  reduce the weight of the vehicle.

17                  So these are things manufacturers  
18                  I think really are thinking about and are  
19                  concerned about. And I think this is an issue  
20                  that sometimes is overlooked by some of these  
21                  studies.

22                  But I want to end though, I want

1 to say that, you know, EDAG really had, I  
2 think, a good study. It was very thorough.  
3 I think that a lot of the technologies and a  
4 lot of the approaches that they highlighted  
5 are very valuable to kind of bring out and  
6 discuss.

7 As a manufacturer, many of the  
8 things that they identified in their study we  
9 have begun introducing to our vehicles and  
10 some of them are already in our vehicles. The  
11 new NDX will go on sale very shortly and it  
12 has many of the attributes that were shown in  
13 the EDAG study, many of the technologies.

14 So things like these advance high  
15 strength steels and hot stamp steels have  
16 become widely used in vehicles today and  
17 that's going to continue to grow. The next  
18 NDX has a cast magnesium steering hanger beam,  
19 which is significantly lighter than previous  
20 generations.

21 And we are looking at, you know,  
22 reinforced plastics and even new types of

1 carbon fiber composites that we are going to  
2 introduce over the next couple of generations.

3 So I think everybody in the  
4 automotive industry is moving in this  
5 direction as quickly as we can, but, you know,  
6 we are trying to balance all the challenges  
7 that we face. And I think these studies are  
8 good. They help, you know, look at these  
9 technologies and kind of bring some of them to  
10 light.

11 But I think that, you know, there  
12 are a lot of assumptions that get made in the  
13 studies, I think, that maybe kind of  
14 simplified or kind of overlooked some factors  
15 and as a manufacturer we have to deal with.

16 So that's really all I had to say  
17 about that. And I want to thank Harry and his  
18 work and I think that was a good study. And  
19 I would be happy to try to answer any  
20 questions if I can.

21 (Applause)

22 MODERATOR BONANTI: Okay. Thanks,

1 Chuck. Appreciate it. Questions? Does  
2 anybody -- well, you have to write them down,  
3 please.

4 PARTICIPANT: Oh.

5 MODERATOR BONANTI: Do you have  
6 the cards?

7 PARTICIPANT: Yes.

8 MODERATOR BONANTI: Thank you.  
9 The first question with Honda's technical and  
10 design expertise, could Honda achieve a  
11 similar mass reduction as the FEV and EDAG  
12 design without the loss in crashworthiness  
13 comfort or handling properties if Honda  
14 performed the same exercise?

15 MR. THOMAS: Well, I think that  
16 just like I said in the study, if we had  
17 performed the same exercise, I think what we  
18 would expect is maybe about 175 kilograms of  
19 mass reduction is what we think we could  
20 achieve reasonably. So I guess that's what we  
21 think.

22 MODERATOR BONANTI: Okay. Others?

1 I'm sure there is a few. There is a few.  
2 Okay. Okay. Honda's analysis is 12 percent  
3 mass reduction at what cost?

4 MR. THOMAS: I didn't go back  
5 through all the cost numbers in this. I'm not  
6 really a cost expert, so it was hard for me to  
7 try to come up with it. Certainly, some of  
8 the cost that was removed from the study, I  
9 think, would show back up, because I remember  
10 from the EDAG study a significant amount of  
11 sort of the cost rebalancing came from the  
12 downsizing of the powertrain. That helped  
13 offset the cost for the structure.

14 That would -- some of that would  
15 certainly come back, so that would impact  
16 their cost. I think, too, you know, we didn't  
17 mess around with the aluminum that they added  
18 to the vehicle. From an engineering  
19 perspective, I think, you know, aluminum  
20 closures are completely feasible and  
21 completely meet the performance targets that  
22 are necessary, but they are expensive.

1                   So I think that, you know,  
2                   probably the 175 kilograms we have in this  
3                   vehicle would actually probably be at a higher  
4                   cost than what EDAG achieved at their weight  
5                   reduction, because some of the weight -- or  
6                   some of the cost that they took out of the  
7                   downsizing would have to go back in.

8                   MODERATOR BONANTI: Okay. The  
9                   next question. With a turbo direct injection  
10                  four-cylinder engine, it now puts nearly 150  
11                  horsepower per liter. Is Honda considering  
12                  replacing a normally aspirated V-6 with a  
13                  similar output 300 horsepower from a 2 point  
14                  liter four-cylinder to help reduce vehicle  
15                  mass and build complexity?

16                  MR. THOMAS: I'm not really much  
17                  of an expert when it comes to powertrains.  
18                  I'm a steel-bender kind of guy myself.

19                  I know Honda is introducing direct  
20                  injection engines now and most of the  
21                  technologies we have looked through the  
22                  turbocharging and direct injection as well as

1 more advanced transmissions are working  
2 themselves into our product cycles right now.

3 So I guess that's really all I can  
4 say.

5 MODERATOR BONANTI: Okay. Great.  
6 We have our first question of the day from the  
7 web. So we are listening. Do you think the  
8 challenge -- excuse me. Do you think the  
9 change Honda made based on your business  
10 constraints and performance parity would add  
11 additional cost to EDAG's design?

12 Roughly speaking, how much would  
13 be the overall cost increase?

14 MR. THOMAS: Well, I mean, other  
15 than the cost increase due to the mass  
16 rebound, it's hard to say. You know, my own  
17 experiences in use of certain materials, such  
18 as some of the advanced high strength steels  
19 and some of the hot press materials, you can  
20 really avoid much of the cost impact of those  
21 through better design.

22 So short of going back and

1       redesigning the geometry in the lightweight  
2       vehicle, it is really hard to say how much it  
3       would add to the cost of the white-body. But  
4       with these advanced steels, I mean, the cost  
5       impacts are not that particularly large. Most  
6       of the cost impact and the structural changes  
7       that EDAG made, I think would really, like I  
8       said before, come about because of the  
9       aluminum that they introduced into the closure  
10      systems.

11                   MODERATOR BONANTI: Okay. A few--  
12      a number of questions, which is good. Another  
13      one from the web. Okay. Okay. Let me get to  
14      these first. Since you produce a fleet, would  
15      you have started with the Accord? Can you  
16      comment on the reduction by segment?

17                   MR. THOMAS: Well, I mean, I guess  
18      they are talking about sort of the family of  
19      vehicles for the Accord platform. We start  
20      with the Accord, because, of course, the  
21      Accord is the largest volume production out of  
22      that particular family.



1           So in a lot of ways, the Accord is  
2           what controls that overall platform  
3           development. And then other vehicles that are  
4           going to be developed are reflected into it,  
5           particularly some of the larger vehicles.

6           So when we develop a platform,  
7           what will happen is that, you know, groups  
8           that represent different vehicles will be  
9           designed off that platform meet to discuss  
10          what their needs are. But because the  
11          Accord's volume is so large and it is produced  
12          in multiple countries, it really is where we  
13          start when it comes to trying to size and  
14          select those structures.

15          I don't know if that answers their  
16          question or not, but it's probably the best I  
17          can do.

18                 MODERATOR BONANTI: Okay. This is  
19                 a question from the web, our second one. When  
20                 mass was added to -- for IIHS frontal offset  
21                 as well as side impact, were countermeasures  
22                 added to both driver and passenger sides of

1 the vehicle?

2 MR. THOMAS: Yes. So for the  
3 Accord configuration -- well, of course, the  
4 Accord in certain countries are sold with a  
5 right hand side configuration as well.

6 Side impact, of course, it would  
7 be necessary to apply these structure changes  
8 to both sides of the vehicles, because, of  
9 course, the vehicle is symmetric for side  
10 impact performance.

11 But we definitely try to maintain  
12 symmetry in the structural performance for  
13 crashworthiness. You know, because, of  
14 course, we -- in the real-world we really  
15 don't know what type of crash you are going to  
16 have. So we need to make sure that the  
17 structure can deal with impacts from any  
18 direction.

19 MODERATOR BONANTI: Okay. This  
20 adds to it as well, this question. After you  
21 add additional mass, do you think there might  
22 be more mass-up? What is your prediction for

1 2025 mass-up in vehicle based on consumer  
2 need?

3 MR. THOMAS: Well, I don't really  
4 have a good prediction for a 2025 mass-up  
5 number. I mean, our intention is to try to  
6 reduce the mass of the vehicle. One of the  
7 things I think sometimes people don't  
8 recognize is that in automobiles, like we  
9 talked about with performance improvements  
10 over time, whether it is driving performance  
11 or whether it is comfort performance, sort of  
12 the natural inclination of every vehicle is to  
13 add more features and more technology, which  
14 has a tendency to push its mass up.

15 Often people like me who design  
16 the structures of the car are the ones that  
17 are kind of looked to to try to help offset  
18 those additional features. So often times,  
19 unfortunately, the numbers -- the curb weight  
20 numbers don't necessarily reflect the amount  
21 of mass reduction that has occurred in the  
22 structure, it's on the engineered components

1 in the vehicle, because things like new  
2 entertainment systems and power ventilated  
3 seats and, you know, eight-way power seats for  
4 the passenger side kind of eat up some of that  
5 additional mass reduction.

6 So when you look at the curb  
7 weight over a couple of generations, it may go  
8 down just a small amount or it may even go up  
9 a few kilograms, but you don't recognize  
10 necessarily how much mass overall has been  
11 reduced from certain areas of the vehicle.

12 So I don't know if I have a great  
13 answer for 2020 or 2025, but, you know,  
14 probably the number that we -- came out of  
15 this at around 175 kilograms is probably not  
16 an unreasonable target that we would like to  
17 try to achieve within two generations of the  
18 Accord.

19 But again, you know, that is just  
20 sort of our estimate, at this point.

21 MODERATOR BONANTI: Okay. How  
22 should OEM support future NHTSA, EPA and other

1 studies to make outputs relevant and adaptable  
2 for use?

3 MR. THOMAS: Well, I mean, I think  
4 it is important as a manufacturer to certainly  
5 be involved with the study. It was a really  
6 nice opportunity, you know, we got a chance to  
7 meet with EDAG and review their study and  
8 discuss it with them. We got a chance to meet  
9 with NHTSA.

10 I think it is important to do  
11 that, because I think like I mentioned there  
12 is a lot of things that manufacturers know  
13 when it comes to vehicle design that maybe  
14 aren't quite so obvious. And particularly,  
15 when you talk about large volume design. I  
16 don't want to take anything away from Lotus or  
17 EDAG or other companies who have a lot of  
18 design capability, but, you know, there aren't  
19 that many companies out there that are, you  
20 know, designing and selling millions of  
21 automobiles a year.

22 And there definitely is a

1 difference in trying to cope with a vehicle  
2 that is, you know, going to be produced in  
3 multiple factories in multiple continents and,  
4 as like Harry said, has to be built in one  
5 minute compared to say, you know, some  
6 specialty vehicles or some more exotic  
7 vehicles.

8                   So I think that, you know, NHTSA  
9 by working with the manufacturers and having  
10 a really good dialogue with us allows us to  
11 help inform them of some of these issues that  
12 maybe they are not aware of or maybe things  
13 they haven't really thought about the way we  
14 have.

15                   MODERATOR BONANTI: Good. There  
16 is another question from the web. What are  
17 some of the other business constraints that  
18 might hinder the adaptation of light-weighting  
19 technologies?

20                   MR. THOMAS: Well, you know, one  
21 thing that we have run into is that often  
22 vehicles that are the same are produced in

1 multiple factories across multiple countries.  
2 And that can be a problem because not all  
3 materials are available in all countries.

4           So, for example, if we are going  
5 to produce a vehicle in Japan and the United  
6 States, it is pretty similar, but I mean, we  
7 are producing vehicles in Asia, in China, in  
8 other destinations and certain materials and  
9 certain types of technologies are difficult to  
10 procure in those markets.

11           So you know, we don't want to have  
12 to design multiple different vehicles to be  
13 sold in different countries. So because of  
14 that type of situation, sometimes constrains  
15 how quickly new types of materials and new  
16 technologies can be introduced into a vehicle.

17           You know, first, we have to build  
18 up a supplier base in a country that is  
19 capable of providing like certain types of  
20 material before we can begin using those in  
21 the vehicle, even though maybe in a different  
22 country that supplier base is already

1 established.

2 MODERATOR BONANTI: Okay. In  
3 Honda's reevaluation, 40 kilograms is added to  
4 the platform. What is the breakdown of the 40  
5 kilograms?

6 MR. THOMAS: I really don't have  
7 the breakdown to give you guys. I would have  
8 to go back through it and look at it. I don't  
9 have it prepared today.

10 MODERATOR BONANTI: Okay. Are  
11 there other questions? No? Okay. Thank you.

12 MR. THOMAS: All right. Thank  
13 you.

14 (Applause)

15 MODERATOR BONANTI: Okay. Our  
16 next speaker is Scott Schmidt from the  
17 Alliance of Automobile Manufacturers. And he  
18 will be discussing engineering and market  
19 realities. So I'm looking forward to hearing  
20 this. Thank you, Scott.

21 MR. SCHMIDT: All right. Let me  
22 find my way back to the beginning of the --



1 first off, I'm extremely fortunate to have  
2 followed the Honda guy, because I'm going to  
3 be talking more big picture, platitude type  
4 stuff. It was nice to have a very detailed  
5 technical description of a lot of things I'll  
6 probably be bringing out in my presentation.

7 One of the things that we are, as  
8 participants here, really trying to do is to  
9 sort of provide some feedback recommendations  
10 to try to assure that the midterm review will  
11 be based on the most current, up-to-date  
12 information and also especially accommodating  
13 some of the safety analyses and mass  
14 reduction.

15 And even when I say midterm  
16 review, I know we are -- kind of have this  
17 tendency that it is -- there is a review. I  
18 think what we would like to suggest is while  
19 there may be a review, but the job is not over  
20 once you do that review or even leading up to  
21 it. It really should be more of a continuous  
22 review process.

1                   And just like an aircraft pilot is  
2                   trying to land a big jet, he doesn't halfway  
3                   through check his altitude and say oh, I'm  
4                   good and just cruise on in. He is constantly  
5                   monitoring all the things going on, so that he  
6                   can successfully land it.

7                   And I think reaching the fuel  
8                   economy goals, which are very ambitious, it's  
9                   just as hard as landing a 747.

10                  So I would like to kind of keep --  
11                  raise the idea that we applaud NHTSA's work on  
12                  all their studies. I think even after the  
13                  review, they probably will be not done. There  
14                  probably will be more additional updates.  
15                  There will be more data. And as you look at  
16                  some of the costs and some of the things that  
17                  come in for some of the ultra powertrains, I  
18                  think those are all very important things to  
19                  try to include.

20                  I keep hitting the wrong button.  
21                  The other thing, of course, is as you heard  
22                  from Honda and other people is that being an

1 OEM is a huge undertaking that is always  
2 balancing and it's balancing very competing  
3 business case, technical issues, availability,  
4 you can't -- you know, getting the materials.

5 So I think it is again important  
6 to balance the safety considerations, not too  
7 far too fast. Not getting ahead of the fleet.  
8 Keeping those mass differentials at a  
9 manageable rate. And at the same time, trying  
10 to balance the realities of procuring some  
11 advance materials, understanding the advance  
12 materials and utilizing them.

13 And so, again, you know, we kind  
14 of talked here about that. You know, it is  
15 every time you try to go to a substantial mass  
16 reduction, it's not a matter of just carving  
17 out mass out of a certain area. As the Honda  
18 presentation and the EDAG, they have all  
19 acknowledged that you make a change over here,  
20 you have the abilities to make change if we  
21 are here and you need to balance everything.  
22 So it's an important thing to keep in mind.

1           The other thing here, and again  
2           the Honda people talked about trying -- they  
3           have internal standards. Our manufacturers  
4           have those, too, because they are competitive.  
5           We don't necessarily publish them on the web.

6           So I understand the EDAGs and the  
7           NHTSA people might have a hard time trying to  
8           say, yes, this meets OEM specifications when  
9           they don't know what those specifications are.  
10          But we work very hard just as the Agency does  
11          to protect the current safety trend. We are  
12          always trying to get it down.

13          And so one of the things we are  
14          very interested in is making sure that we can  
15          look at what the mass reduction from a safety  
16          standpoint is and try to maintain that current  
17          safety trend.

18          Again, we think we are anxious to  
19          see what the fleet safety evaluation study  
20          that is due out, I think, in July -- we are  
21          very anxious to see that. And we also have  
22          some recommendations later on to maybe expand

1 or give more depth to the statistical analysis  
2 that Chuck Kahane and others have done.

3           Again, the periodic reviews and I  
4 do this as plural. We should really look at  
5 the potential mass associated with future  
6 safety requirements and voluntary provided  
7 equipment. As the Honda guy brought out, you  
8 know, IIHS and well, NCAP -- we got a notice  
9 on the street now asking for comments on  
10 future NCAP.

11           So we know that there is going to  
12 be a lot of big improvements in terms of NCAP  
13 and IIHS. And they are not going to come free  
14 in terms of weight. I mean they are going to  
15 be either additional structure, additional  
16 sensors, additional things on the car. What's  
17 that? Oh, sorry.

18           So like I said, there is no free  
19 lunch. Everything costs money.

20           We also have to look at the  
21 potential for the safety impacts of mass  
22 reduction. And one of the things here I have

1 at the top of one of the bullets here is the  
2 timing and influx of advance crash avoidance.  
3 And it's not that we expect crash avoidance to  
4 sort of suddenly say okay, it's going to be --  
5 it's going to compensate for, you know,  
6 vehicle safety effects from mass reduction.

7 But one of the things that crash  
8 avoidance can do is actually change the  
9 relative crash modes. For example, the ESC  
10 has done a great job in reducing rollover. So  
11 as you look at your safety analysis, you have  
12 to also say well, are these crash avoidance  
13 technologies changing the relative crash  
14 modes? And what is that doing to safety,  
15 because the mass effects, safety mass effects,  
16 may be different from frontal, side, rear and  
17 rollover? So that's something you have to  
18 also include. And again, the potential  
19 further enhancement for crashworthiness will  
20 add mass as well.

21 Again, some of the more important  
22 safety studies. As we talked about periodic

1 reviews, again, I think and I would encourage  
2 NHTSA to kind of continue what they have done  
3 which is to track the real-world safety  
4 benefits. Kahane has often revised and  
5 reanalyzed his studies. And as these more  
6 mass-reduced vehicles enter the fleet, I think  
7 that is going to be ever critical to continue  
8 that.

9           And again, I think the bottom line  
10 idea of this is to try to estimate that  
11 balance between what is the rate of mass  
12 reduction and the potential impact? You know,  
13 do you pull the mass reduction lever? If you  
14 pull it too fast, too far, I think you could  
15 get some significant mass mismatches between  
16 the existing fleet and what is coming out in  
17 the future. And so I think there is a managed  
18 approach to try to bring that down and try to  
19 minimize that.

20           We also just kind of noted that  
21 even back as the 2016 -- 2012 to 2016, there  
22 were a number of NHTSA studies that talked

1 about -- I think a number of them have been  
2 done, but I believe there a couple that  
3 haven't -- we haven't seen yet.

4 So I think a lot of those analyses  
5 that were talked about would have benefit even  
6 as we go forward further, because this is an  
7 issue that never goes away. You are pushing  
8 the envelope, these studies will need to be  
9 continually done or updated.

10 One of the recommendations for the  
11 Chuck Kahane is that, you know, he did a  
12 statistical analysis and he looked at kind of  
13 the effect of 100 pound increment. Well, the  
14 real-world is not in 100 pound increments and  
15 we think that it would be very helpful to try  
16 to do some more varied scenario studies that  
17 will look at different levels of weight  
18 reduction and not necessarily just a 100 pound  
19 increment up and down.

20 Now, with respect to the sort of  
21 the non-safety stuff, there are a lot of  
22 things that we also think the midterm review



1 or reviews should include and that is sort of  
2 the baseline fleet assumptions, because we  
3 have noticed that there is a lot of vehicles  
4 that already have some of those technologies  
5 that are in the baseline of fleet assumption.

6 They have already been  
7 implemented. And again, one of the things  
8 that was mentioned was you have to maintain  
9 performance objectives. Sometimes it is hard  
10 to tell whether you have maintained that,  
11 because there are internal standards and I  
12 realize that's a problem, but that's one thing  
13 that we have to try to do.

14 There is noise vibration targets  
15 and functionality. We also have the whole  
16 issue of the lightweight material availability  
17 and cost. And I'll cover that a little bit  
18 more and also the state of the manufacturing  
19 techniques and the assembly processes.

20 I mean, moving from a steel-  
21 centric manufacturing base to something  
22 aluminum, carbon fiber or whatever, has its

1 challenges and has a lot of costs and will  
2 have lead time involved.

3 And we also have the whole issues  
4 of durability and serviceability. I mean,  
5 some of the things like carbon fiber panels,  
6 what happens when the vehicle is crashed? How  
7 do you repair them? Even aluminum which is  
8 fairly well understood, I think there could be  
9 some more information brought out to try to  
10 help the service industry, the body shop to be  
11 able to repair them properly, especially  
12 things that are heat treated.

13 You don't just take a MIG welder  
14 and blast in new panel, throw some bondo and  
15 call it good. And I think that if we can  
16 provide that information to the service  
17 industry, hopefully that will help these  
18 vehicles get a better reputation out in the  
19 real world.

20 The last thing we want is somebody  
21 saying "oh, I don't want an aluminum vehicle.  
22 I saw Joe put his in and he couldn't get it

1 fixed." I mean, word of mouth can kill a  
2 vehicle very quickly.

3           Again, we are always looking for  
4 the what are the actual midterm fuel economy  
5 benefits coming out and are they -- are the  
6 predictions panning out? And there is always  
7 the field of dreams. You know, build it, they  
8 will come. Well, we have built some cars in  
9 the past that they didn't come. Those are  
10 some classic ones that I'm not going to call  
11 out, but you all know those.

12           So customer acceptance and  
13 willingness to pay are key aspects of any kind  
14 of a winning or profitable business plan. And  
15 so that's something that also needs to be  
16 looked into. So you need to be looking at the  
17 customer's acceptance of some of these new  
18 powertrains. And are they being -- are the  
19 customers -- are we getting ahead of the  
20 customer too much?

21           This is kind of a busy chart. It  
22 is really kind of -- it touches on a lot of

1 the aspects of mass increase. And really  
2 there is kind of -- there is the safety issues  
3 of mass increase and you can see some of them  
4 here on the chart. And there is also the  
5 customer I want, I want more.

6 And customers are always raising  
7 their expectations. And our engineers are  
8 working day and night, losing sleep, trying to  
9 provide those wonderful, open those Christmas  
10 present moments when you get into a car and  
11 it's like "oh, wow, this does that. Oh, 16  
12 speakers, oh, you know, 10-way power seats,  
13 oh, I can look up. It's almost like a  
14 convertible, except I don't get wet or I don't  
15 have wind in my ears, because you've got  
16 panoramic sun."

17 So, you know, a lot of these  
18 things are now the norm in business in selling  
19 cars. You know, once somebody brings this  
20 out, everybody is like oh, well, he has got  
21 one. "I want that car" and the other  
22 manufacturers note that and say, "we are

1 putting it on ours, too."

2 So there is this ever increasing  
3 list of options that we are trying to put in  
4 our vehicles. And one of the things that was  
5 brought up a little bit about was well, you  
6 know, why -- the whole idea of having this one  
7 platform and you have these niche vehicles  
8 that, unfortunately, because they are niche  
9 vehicles, they tend to reduce the kind of  
10 flexibility to optimize that design on your  
11 core high-volume.

12 But there is a reason they are  
13 niche vehicles because customers have a desire  
14 for those. There may not be a lot of  
15 customers, but that's your way of satisfying  
16 your customers.

17 And I don't know that we want to  
18 go back to the Model T where it is the  
19 customer can have everything as long as it's  
20 black and a single model. These models have  
21 a purpose and they are what differentiate our  
22 manufacturers among themselves in this intense

1 competition.

2 So that is going to be continued,  
3 not going to be, it is going to continue to be  
4 the norm within our industry. We are just  
5 going to have to accommodate that when we deal  
6 with our standards and deal with the cost of  
7 trying to bring these and optimize our  
8 vehicles across those product lines.

9 The other thing, and unfortunately  
10 I had a chart, but it is copyrighted and I  
11 haven't got permission to show it yet, but I  
12 can explain it, was sort of the relative  
13 effect. And this was something that the Honda  
14 people brought out, too, and that is when we  
15 looked at the baseline vehicle structure since  
16 the '80s when the big fuel economy craze came  
17 in, the actual baseline basic structure has  
18 stayed about the same mass.

19 What you see is a little bit of  
20 increase for emissions. Then a bigger  
21 increase for safety. And a big increase for  
22 the customer convenience. And we, again, as

1 I mentioned for the customer convenience,  
2 don't see that going down. The customer is  
3 greedy. He wants everything and he wants to  
4 pay less for it.

5 And safety is the same way.  
6 Safety is now selling. We have got the new  
7 IIHS, the new NHTSA and you know, we are  
8 putting out crash avoidance technology. And  
9 while some people say "well, that's just a  
10 software change" all the sensors are not  
11 software, so it (A) adds cost, but it also  
12 adds a little bit of weight to it.

13 So those are some of the realities  
14 that we are going to have to keep in mind as  
15 we go through our midterm reviews.

16 The other thing is that we are a  
17 global manufacturer and, as such, you know, we  
18 have to meet vehicles on all these different  
19 continents. And one of the things that we  
20 have noticed is in the U.S. our fuel economy,  
21 global greenhouse gas requirements are based  
22 on a footprint basis.

1                   However in Europe, it is  
2                   normalized to mass, which they are -- kind of  
3                   don't really match up very well when you are  
4                   trying to build a car and optimize the car for  
5                   both markets. So it's a real challenge.

6                   And I'm not saying one is better  
7                   than the other. I'm not trying to do that,  
8                   but they are different and it makes for, you  
9                   know, a real challenge there. That needs to  
10                  be at least recognized and accommodated as we  
11                  move forward.

12                  Again, scalability concerns. You  
13                  know, it is one thing to do something in low-  
14                  volume. And the low-volume is great because  
15                  it becomes an incubator for technologies. You  
16                  see all these whizbang technologies, all this  
17                  -- it's on the Corvettes. It's on the -- and  
18                  that's a good thing. That's how it should  
19                  work.

20                  But scalability -- when you get  
21                  within a company is one thing, but scalability  
22                  has an industry and it can -- you know,



1 suddenly everybody decides oh, magnesium is  
2 what we are going to do. We need tons of  
3 magnesium.

4 Well, is the supply base ready to  
5 scale for that? And so you have to always say  
6 "okay, how scalable is this? Can we take  
7 these technologies and scale them overnight?"  
8 Probably not. We can scale them gradually?  
9 Probably. And again, we also have to -- it's  
10 one thing to have -- even have the product  
11 available. The question is, is the cost able  
12 to support the investment? And is it so  
13 volatile?

14 One of the things that this chart  
15 shows is sort of the market material price  
16 volatility. And you notice the steel and, of  
17 course, the big jump is during the recession,  
18 a big jump in almost every chart during the  
19 recession.

20 But the idea here being is that  
21 you can see steel and it has volatility. We  
22 always have to deal with that. We are always

1 -- but for the material, for the aluminum, it  
2 was a lot larger. And so when you are trying  
3 to develop a product that you are going to  
4 have to be selling quite a bit of you are  
5 going to have to meet a power -- a price point  
6 and you are trying to predict availability and  
7 cost and you have got something that has got  
8 a lot of variability in it and volatility, you  
9 manage for the worst case and that's what you  
10 base your business decisions on.

11 You don't do an optimistic  
12 projection because you will get burned. And  
13 so you, basically, and that may be a reason  
14 why you might see some of the go-slow take  
15 more time on some of these technologies,  
16 because the business model says these -- we  
17 are not sure about this availability. The  
18 cost is an issue and the volatility is an  
19 issue.

20 And those all drive the business  
21 models that we all have to run. And the  
22 business realities we have to deal with. And

1 again, some of the -- you know, the material  
2 challenges, this slide you have all seen a  
3 million times.

4           Again, you know, while the advance  
5 high strength steels are very well developed  
6 in many areas, just like everything, they are  
7 pushing the envelope and with new alloys, new  
8 formability techniques. And so as we even  
9 push out in the steels, there is a lot we  
10 don't know and that's something that needs to  
11 be accounted for.

12           Aluminum. Again, we have the  
13 feedstock cost, the manufacturability and some  
14 of the improved alloys again are something  
15 that we are working on. Magnesium is very  
16 similar, except it does have some of the  
17 corrosion. It is a little more reactive from  
18 a galvanic position standpoint, so you have to  
19 do more to protect corrosion and that might  
20 limit its applicability in certain areas.

21           Maybe inside the vehicle interior  
22 cocked headlight under the dash, that is

1 probably pretty protected, that's probably not  
2 that big of an issue. But in other areas you  
3 just can't say "let's just do magnesium since  
4 it is so light."

5 And, of course, carbon fibers have  
6 some of the same issues. There is -- fiber  
7 cost is the first one. The manufacturing for  
8 high-volume, that's the next big deal. We  
9 also have some of the predictive modeling  
10 issues, recycling and, of course, joining.

11 So one of the things again within  
12 -- with respect to the actual EDAG's FEV, and  
13 ICT, we talked about is that again a large  
14 number of the suggested solutions are at least  
15 partially incorporated in many of the current  
16 designs.

17 Again, some of the proposed mass  
18 reductions violate the assumptions that  
19 functionality performance or safety should not  
20 be degraded. The Honda presentation sort of  
21 gave some specifics to that.

22 And for some proposals, the

1 performance functionality constraints, we  
2 really weren't even sure. We are still trying  
3 to get some more information on how they can  
4 be really evaluated.

5 And again, the last point is kind  
6 of a key one, because an integrated vehicle  
7 solution for a mass reduction is missing a  
8 system approach. And this is -- people think  
9 of systems as the vehicle systems.

10 Well, there is a vehicle system.  
11 There is a manufacture system. And there is  
12 the industry system. And so you might be able  
13 to do something on a vehicle system's approach  
14 that gives you an answer. When you do it on  
15 a manufacture system's approach, you will get  
16 a different answer.

17 Again, you are trying to -- you  
18 only have so many engines that -- you can't  
19 just scale back your engines to a 1.5-cylinder  
20 engine. You are either a one-cylinder, two-  
21 cylinder, three-cylinder. You can go back  
22 down in displacement, but it's not like you

1 are going to just build a new engine facility.

2 So you have stair steps, not  
3 continuous. So until you can get enough mass  
4 reduction that you can go down to the next  
5 available engine in your portfolio, assuming  
6 that even has the proper characteristics,  
7 because sometimes they are high RPM  
8 performance engines versus other kind of  
9 engines, assuming you can do that, you know,  
10 you won't get quite the level of mass  
11 reduction that you could on paper, if you are  
12 willing to build a dedicated engine for every  
13 vehicle design.

14 And again, the systems approach  
15 for the industry kind of keeps up with the is  
16 there a supply base? You are going to be  
17 making decisions as a manufacturer looking at  
18 the total industry and saying okay, is the  
19 supply base there to provide these materials?  
20 Do they have the volatility that is going to  
21 be -- have to be managed for a potential  
22 issue?

1                   And so we really have to think in  
2 terms of three systems and make sure that we  
3 contemplate all of those systems when we make  
4 our decisions. And that's it. I'm ready for  
5 any questions.

6                   (Applause)

7                   MODERATOR BONANTI: Thank you,  
8 Scott.

9                   MR. SCHMIDT: Yes.

10                  MODERATOR BONANTI: Questions,  
11 please? Okay. We have a few coming in.

12                  The first question, how much mass  
13 has increased in the last 10 years based on  
14 different standards and consumer need?

15                  MR. SCHMIDT: I can't show the  
16 chart, but I could read off it. Let's see,  
17 kilograms to about 1,600 kilograms, so that's  
18 400 kilograms over the span from 1980 to  
19 present.

20                  MODERATOR BONANTI: 400 kilograms?

21                  MR. SCHMIDT: According to Steven  
22 Zoepf, Masters of Science Thesis MIT 2011.

1 I've got the citation. I just wasn't able to  
2 get copyright to be able to show it.

3 MODERATOR BONANTI: Okay.

4 MR. SCHMIDT: This is in -- this  
5 chart is in -- also had been shown, I think,  
6 in the -- in some of the NES presentations.  
7 So if you want the chart, send me an email or  
8 a business card and once I get permission, I'm  
9 sure we will get permission, it's just the  
10 problem is this author had to go through his  
11 campus to get permission which takes a while.

12 So I'm assuming I'll be able to  
13 get the chart and maybe we will put in the  
14 docket as part of the presentation or I can  
15 certainly provide it.

16 MODERATOR BONANTI: Okay. Thank  
17 you. The second question, how do you overcome  
18 for material usage in different countries for  
19 global models?

20 MR. SCHMIDT: I think if I had the  
21 answer for that, I would make a lot of money.  
22 One of the problems we have is, of course,



1 that some of these materials -- some materials  
2 are fairly scarce and they are located around  
3 the country and not always in the most stable  
4 economic region either.

5 So that probably provides for some  
6 volatility. Again, the other part is is that  
7 well, what -- you have supply and demand. And  
8 it is a chicken and egg. Do you have the  
9 factories there? And is the -- if the demand  
10 outstrips the factories, your price is going  
11 to go up. If the demand drops, then it's  
12 somebody -- they over-build factories, the  
13 price may go down.

14 So there is this constant tension  
15 between supply and demand, but, you know, I  
16 don't have a good answer, because I think our  
17 members are grappling with that.

18 MODERATOR BONANTI: Okay. This is  
19 the third question from the same person.

20 MR. SCHMIDT: Yes.

21 MODERATOR BONANTI: Despite many  
22 of the challenges, how many -- what's the

1 percentage of mass reduction that can be  
2 achieved without a big cost impact?

3 MR. SCHMIDT: That's a very loaded  
4 question and a good question. I think we are  
5 talking in the time frame. I mean, again,  
6 mass reduction is kind of an evolutionary  
7 thing. You will notice that people have been  
8 putting in more efficient structures as we get  
9 better and better at our CAE, our model is  
10 more predictive. We are able to put that in.

11 And so over time, yes, you can  
12 provide a level of mass reduction at a  
13 reasonable cost rate. The question is when  
14 you have to pull that level too fast, too far.  
15 And again, you can have safety implications  
16 and you have cost implications.

17 I don't have the number for that  
18 slope that said either a zero cost or a low  
19 cost line, but I envision there is at least  
20 some level of reduction, that's sort of a  
21 natural evolution of industry that is probably  
22 pretty low cost or no cost.

1                   MODERATOR BONANTI:   Okay.   Are  
2                   there any other questions?   Yes.   Do your  
3                   members hedge prices of materials?

4                   MR. SCHMIDT:   I have no clue.   You  
5                   mean hedge in terms of?

6                   MODERATOR BONANTI:   Cost.

7                   MR. SCHMIDT:   Cost.   I don't know.  
8                   I know they -- from periods -- well, they do  
9                   whatever they need to do to try to live in the  
10                  economic certainty.   So I don't have a real  
11                  answer for that.

12                  MODERATOR BONANTI:   Okay.   Are  
13                  there any other questions?   Any questions from  
14                  the web?   Okay.

15                  MR. SCHMIDT:   Thank you.

16                  MODERATOR BONANTI:   More  
17                  questions?   Okay.   Thank you, Scott.

18                  MR. SCHMIDT:   All right.   Thanks.

19                  (Applause)

20                  MODERATOR BONANTI:   We have  
21                  scheduled a break in between and we are  
22                  definitely ahead of schedule by about 15

1 minutes. So let's take a 15 minute break at  
2 this point. Let's be back at 40 after. Thank  
3 you.

4 (Whereupon, at 2:24 p.m. the  
5 proceedings went into recess until 2:43 p.m.)

6 MODERATOR BONANTI: Okay. I would  
7 like to welcome Blake Zuidema from  
8 ArcelorMittal. He is going to be talking  
9 about the role of body-in-white weight  
10 reduction in the attainment of the 2012 to  
11 2025 U.S. EPA, NHTSA fuel economy mandates.  
12 So I welcome him.

13 And, please, if you -- during the  
14 discussion, if you have the opportunity to  
15 write down some questions, so after the  
16 presentation is over I can immediately ask  
17 instead of us waiting, because I would really  
18 like to, if possible, finish either on time or  
19 ahead of time and that will enable us to have  
20 a further discussion during the panel session  
21 in the afternoon. So thank you. Blake?

22 MR. ZUIDEMA: Okay. Thanks. What

1 I would like to do is try to take some of the  
2 things that you have heard so far today and  
3 put them in a perspective from the steel  
4 industry's point. And we all know and I think  
5 can stipulate to the really significant  
6 challenge we have before us in getting to the  
7 2025 Fuel Economy Regulations.

8 And as we look at the technologies  
9 that will be available for getting us there,  
10 it does not really surprise us that weight  
11 reduction in a particular body-in-white weight  
12 reduction ranks as one of the most important  
13 technologies from a magnitude of improvement  
14 standpoint.

15 In fact, if we look at some of the  
16 assumptions in the EPA models, it is right up  
17 there and, in fact, is surpassed only by  
18 things like electrification, battery-electric  
19 vehicles, hybrids and the like.

20 And if you look at body-in-white  
21 weight reduction from a cost-per-improvement  
22 or improvement-per-dollar standpoint,

1 especially those which come from the steel  
2 light-weighting solutions, rank as some of the  
3 most cost-effective of all technologies.

4           So no matter what we do, body-in-  
5 white weight reduction has to be a significant  
6 part of any fuel economy attainment strategy.  
7 So that immediately brings up a number of very  
8 important questions for the materials and for  
9 steel and are some of the things that we have  
10 been trying to answer ourselves.

11           The most important is how much do  
12 you need to get to 54.5 in terms of weight  
13 reduction? And can any of these materials  
14 really deliver it? And for steel, it is can  
15 steel deliver enough body-in-white weight  
16 reduction to get the fleet to 54.5?

17           But that's not the only set of  
18 questions. We also have to look at it from a  
19 cost standpoint. We also have to look at it  
20 from a total lifecycle CO2 analysis footpoint  
21 as well.

22           So I'm going to try to touch on

1 each of these as we go through.

2           When we start to look at weight  
3 reduction, you have heard a couple of terms  
4 that I really want to stop and just reinforce  
5 right now. When we talk about body-in-white  
6 weight reduction, there have been two  
7 approaches shown here.

8           The first is a simple 2-G, gauge  
9 and grade optimization. That is basically  
10 where you go into the body structure and keep  
11 the same basic load paths, but then substitute  
12 a different material and then redo the gauge  
13 to make sure that the material meets all of  
14 the requirements. That's what we call the 2-  
15 G.

16           But there is also, as Harry  
17 pointed out, a 3-G where we include geometry.  
18 And this is where we go back out and start to  
19 relook at the load paths to make those more  
20 efficient. Why would we do that? Well, in  
21 many cases, vehicles evolve over several  
22 different design cycles and vehicles can't

1 always have the opportunity to do a clean  
2 sheet each time.

3 As the input requirements change,  
4 so do the optimum load paths and after two or  
5 three vehicle cycles where we haven't had a  
6 chance, there is often a lot of weight that  
7 can come from now reoptimizing the load paths.

8 When the steel industry did the  
9 Future Steel Vehicle Program, and in fact just  
10 recently we completed the last phase of it, we  
11 found that we were able to get from a roughly  
12 2009 baseline, a 29 percent body-in-white  
13 weight reduction, and this was achieved  
14 through a 3-G optimization.

15 Now, steel has a number of  
16 different grades that are used right now.  
17 This represents the grades that were largely  
18 shown in the future steel vehicle as well as  
19 the three programs you heard about today: The  
20 Lotus study, the FEV and the EDAG/Honda Accord  
21 study.

22 And again, these are giving the



1 kinds of weight reductions you see. But as we  
2 move up and to the right on this graph, we are  
3 getting more weight reduction, because as we  
4 go to the right in higher strength, we can,  
5 again, for those parts which are still not  
6 stiffness challenged, get additional gauge  
7 reduction.

8           And more importantly, as we go up  
9 in formability and particularly as we go up  
10 into higher strength, we can now get higher  
11 strength into parts that were previously  
12 precluded from a formability standpoint. So  
13 both of those directions are important for  
14 getting more weight.

15           And this really shows the map of  
16 where the steel industry is going right now.  
17 It truly is up and to the right and for future  
18 reference, the little open circles are grades  
19 that we are working on and are going to become  
20 available in the next couple of years. The  
21 solid ones are the grades that are available  
22 right now.

1                   And I just want to talk briefly  
2                   about an epiphany I had a couple of minutes  
3                   ago here. When I looked at this chart, it all  
4                   of a sudden became very clear to me that we  
5                   have been talking about multi-material  
6                   solution. And it just occurred to me that  
7                   steel is already a multi-material solution,  
8                   because each of the grades that you see here  
9                   have been through reverse engineering  
10                  developed specifically for certain parts in  
11                  the car.

12                  And we, as a steel industry, have  
13                  gone through many of these loading case  
14                  requirements and looked at the mechanical  
15                  properties that require or are required in a  
16                  part and these grades are the result of that.

17                  For example, you would never use a  
18                  high strength martensitic product to build a  
19                  hood outer panel. And for the same reason,  
20                  you would never use the bake-hardenable steel  
21                  you use for a hood outer panel to build a B  
22                  pillar.

1           The grades of steel we are using  
2           for each of those components are specifically  
3           engineered for the unique requirements. So  
4           steel is already a multi-material solution.

5           So let's go through a couple of  
6           the studies and start with the Venza Phase 1.  
7           I looked very closely and as far as I can  
8           tell, guys correct me if I'm wrong, this was  
9           a 2-G study, gauge and grade. Where, for the  
10          low development, the basic structure was  
11          retained and new grades were substituted.  
12          This achieved a 21 percent vehicle weight  
13          reduction. And within the body-in-white  
14          itself, about an 18 percent weight reduction,  
15          a cost increase for the body, but when looking  
16          at the whole vehicle, it was a net decrease.

17          And when we look at the grades of  
18          steel, we are seeing that there was an  
19          increase in the amount of the advanced steel  
20          grades, but, at this point, it looks like it  
21          is probably around a 65 percent or so of the  
22          body structure was advanced steel grades and

1 I didn't do the numbers, but this is probably  
2 going to come in around 450 or 500 as the  
3 average tensile strength.

4 So compared to the EDAG study we  
5 saw a little bit earlier, again, these  
6 applications are on the fairly conservative  
7 side in terms of using the advanced grades  
8 that are available today. And this chart  
9 shows where each of the original Venza grade  
10 solutions are.

11 And again, you can see they are on  
12 the lower part of the strength curve of grades  
13 that are available right now.

14 When we look at the Phase 2 study  
15 that was done by FEV, we found after going  
16 through and now in, what is the word,  
17 accommodating all of the various crash  
18 requirements and doing the full CAE, their  
19 final solution achieved an 18 percent vehicle  
20 rate reduction, a little bit lower, and the  
21 body-in-white weight reduction was around 13  
22 percent.

1                   One of the things I looked at when  
2                   you see the grades of steel, they used a  
3                   little bit higher strength level mix. And  
4                   this is taking the average tensile strength up  
5                   a little bit.

6                   So a little bit more aggressive  
7                   use of the advanced steel grades. And again,  
8                   in this case, the weight reduction went down  
9                   because they had to do certain things to meet  
10                  all of the crashworthy requirements.

11                  Again, looking at the grades that  
12                  were used, they are all commercially available  
13                  today. And you can see they are starting to  
14                  use them out to a little bit higher strength  
15                  level.

16                  Now, I wanted to look a little bit  
17                  about the EDAG Honda Accord study. This  
18                  achieved a 22 percent body-in-white weight  
19                  reduction in the study itself. And we do have  
20                  to take into account now the comments from  
21                  Honda on the practicalities of some of these  
22                  things, but it was a 22 body-in-white weight

1 reduction, a similar vehicle weight reduction,  
2 a small cost penalty for the steel solutions  
3 in the body-in-white.

4 But again, if you look at the  
5 grades used by EDAG, they represent a much  
6 larger cross-section of the advanced grades  
7 available. And you now start to see grades in  
8 the above 1,000 MPA UTS and so EDAG here has  
9 pushed the envelope a little but further and  
10 has gone to an even higher level of average  
11 tensile strength.

12 But again, if you look at the  
13 applications of those grades, again, they are  
14 grades that are largely commercially available  
15 today.

16 So what I wanted to do is to try  
17 to put these things in perspective. And  
18 again, realizing that we have 2-G approaches  
19 and 3-G approaches, I wanted to show those  
20 separately because the 3-G, when geometry  
21 comes into play, is providing a little bit  
22 larger increment in weight reduction.

1                   So if we look at these, the 2-G  
2 approaches are coming in somewhere around 13  
3 up to maybe 18 percent or so. The little, I  
4 think it is, purple diamond up there is a 2-G  
5 approach, but that was one of the  
6 ArcelorMittal S-in Motion solutions where we  
7 used both today's as well as emerging grades.

8                   And so we were getting a little  
9 bit extra increment in strength from some of  
10 the other higher strength, higher formability  
11 grades, but again, you can see two batches of  
12 data.

13                   So when we try to put those in  
14 perspective, we are coming up with three  
15 levels of weight reduction attainment. At the  
16 lower end of the scale, somewhere around 15  
17 percent plus or minus a couple of percent, we  
18 are finding the 2-G solutions where we are  
19 just doing grade substitution with today's  
20 grades.

21                   A little bit higher than that,  
22 somewhere around the 20 percent mark, are the

1 3-G solutions where now we bring geometry into  
2 play or the 2-G solutions if we apply the  
3 additional weight we can get with some of the  
4 higher strength materials. And then up around  
5 the 25 weight percent body-in-white weight  
6 reduction we see perhaps some of the more  
7 aggressive applications where we are using  
8 both the 3-G geometry optimization as well as  
9 the emerging steel grades to get the full  
10 benefit of that, which can come out of steel.

11 So this gives us at least now a  
12 picture of the level of weight reduction that  
13 we can get out of steel.

14 Now, how much do we need is  
15 something that we, as a steel industry, really  
16 can't answer. It requires knowledge of the  
17 full vehicle integration. This is something  
18 that, obviously, the OEMs are working on very,  
19 very carefully and it is not something that  
20 they discuss outside of their own internal  
21 discussions.

22 And so we had to go to some of the



1 public domain material to find some models and  
2 tools that we could use. Fortunately, there  
3 are a number of such models. The EPA has the  
4 data visualization tool. They have the ALPHA  
5 model, the OMEGA model. Of course, NHTSA has  
6 the Volpe model.

7           And when we looked at each of  
8 these, we found the Volpe model to be most  
9 suited for our effort to look at the role of  
10 weight reduction in the overall scheme of  
11 getting to 54.5 miles per gallon.

12           So we took the Volpe model and now  
13 started to put into it some of the weight  
14 reductions that we feel we can get from steel  
15 and compare those to the weight reductions  
16 that we see we are getting from some of the  
17 other materials.

18           And so for the basic weight  
19 reduction, we looked at levels ranging from  
20 zero up to 50 percent in the body-in-white.  
21 And that would reflect the couple of levels of  
22 15 to 25 percent from steel, something around

1 40 percent, which is around that which we are  
2 seeing from some of the aluminum solutions and  
3 then, of course, the carbon fiber gives us a  
4 little bit more up around 50 percent.

5 But we also had to look at a  
6 number of other key assumptions. I won't go  
7 into them in detail. We used a secondary  
8 weight compounding of 35 percent and that's  
9 lower than the number you saw from Harry,  
10 primarily because Harry's included body  
11 structure compounding.

12 In a sense, that is assumed to  
13 already be in those preliminary body weight  
14 reductions. We can't double count for it. So  
15 we are only looking at the secondary from non-  
16 body-in-white sources.

17 We used the weight elasticity of 7  
18 percent, in other words a 7 percent  
19 improvement in fuel economy for each 10  
20 percent reduction in vehicle weight and I  
21 think that is fairly consistent with the  
22 numbers I have heard so far today.

1                   And the other thing I want to  
2 point out is we looked at levels of non-body  
3 weight reduction because we know the body is  
4 not the only place. In fact, many of the  
5 studies you saw today looked at weight  
6 reductions from non-body-in-white sources.

7                   We went through, trust me Harry,  
8 all 500 or so pages of your report and pulled  
9 out what we felt are some of the more short-  
10 term viable non-body-in-white weight  
11 reductions and they added up to about a 7  
12 percent vehicle weight reduction.

13                   But we also know that you can't  
14 count on all of that for reasons we have heard  
15 today. Maybe consumers want more cup holders.  
16 Maybe we are going to have to put sensors in  
17 computers for vehicle-to-vehicle connectivity.  
18 And most likely, the static safety  
19 requirements are going to continue to go up.  
20 So we can't account for all of that.

21                   We also -- and I want to say this  
22 with all due respect to my EPA and NHTSA

1 colleagues here, we assumed that we may,  
2 through some quirk of fate, not get all of the  
3 improvements in powertrain technologies that  
4 were assumed in some of the initial EPA  
5 models.

6 We don't know the future. They  
7 may have been optimistic. There may be other  
8 things which prevent us from getting all of  
9 that. And if we don't get as much as we think  
10 out of the powertrains, that is going to put  
11 more pressure on weight reduction. So we had  
12 to account for some changes there.

13 So what we are looking for is a  
14 gap. We know that you can get only part way  
15 to 54.5 miles per gallon with powertrain  
16 technologies. The rest of that is going to  
17 have to be made up with weight reduction.

18 And so what we are looking for are  
19 do these weight reductions from the other  
20 materials make up that gap or is there  
21 something left over?

22 So we start with the case of all

1 of the weight coming from the body-in-white.  
2 That is the only source of weight reduction.  
3 And what we are seeing here are the gaps and  
4 the degree to which the 54.5 mile per gallon  
5 standard has been met.

6 Now, a couple of things to point  
7 out. First of all, there are two completely  
8 unrealistic scenarios here at the lower end of  
9 the EPA assumption reductions, because that  
10 says no material will close the gap. And in  
11 a case like that, the only solution will be to  
12 change the regulation.

13 On the other end of it, with the  
14 improvements coming from the EPA, even the  
15 steel solutions provided sufficient weight  
16 reduction to get the entire fleet to 54.5  
17 miles per gallon without paying fines.

18 Okay. Now, let's look at the  
19 situation where we include the weight  
20 reduction from these other sources. This  
21 provides additional increment in fuel economy  
22 and takes some pressure off of the body-in-

1 white. And again, there is a scenario at the  
2 most pessimistic powertrain improvement  
3 assumption where no material gets us all the  
4 way. This again is considered to be  
5 nonrealistic.

6 But again, with the other levels  
7 of powertrain improvement, the steel solutions  
8 are providing situations where we are getting  
9 the fleet to 54.5 miles per gallon. So there  
10 are a number of foreseeable circumstances  
11 where steel will provide the necessary weight  
12 reduction to get the fleet to 54.5 miles per  
13 gallon, but that's not the end of it.

14 We also know that the other  
15 materials will provide an additional increment  
16 in weight reduction. And if that additional  
17 weight reduction affords the removal of  
18 powertrain technologies that had cost more  
19 than that material, it could still result in  
20 a lower cost vehicle.

21 But when we go through the  
22 calculations, what we find is that in each of

1 the scenarios where steel gets the fleet to  
2 54.5 miles per gallon, it is doing so at a  
3 lower cost than if these other lighter-weight  
4 materials are being used. So in these cases,  
5 steel provides the lower cost solution.

6 Now, we can't leave without at  
7 least mentioning the lifecycle assessment part  
8 of all of this. When we talk lifecycle, the  
9 first thing that comes up is the as-  
10 manufactured footprint. It is fairly well-  
11 known that steel is far less carbon-intensive  
12 to manufacture than other materials.

13 In fact, it's about five time less  
14 carbon-intensive than aluminum, ten times less  
15 than carbon fiber and about 15 times less than  
16 magnesium. And what happens is when you build  
17 a car out of these materials, the car sitting  
18 on the showroom floor before even one mile  
19 goes on to it has a larger as-manufactured  
20 carbon footprint if you build it out of some  
21 of these other materials.

22 But now here is where the

1 arguments start. The other materials, in  
2 theory, are going to be lighter and therefore  
3 provide better fuel economy. And so during  
4 the use phase, they are going to be putting  
5 out fewer emissions. And over time, depending  
6 on the number of miles driven, that benefit is  
7 going to offset the initial as-manufactured  
8 carbon footprint.

9 And if you drive the vehicle long  
10 enough, it will match or end up with a lower  
11 carbon footprint. So there are discussions  
12 around how many miles do you drive the  
13 vehicle? What is the increment in fuel  
14 economy?

15 There are discussions around  
16 recycling credits. Steel inherently is more  
17 recyclable because it is magnetic. It is a  
18 little bit easier to separate from the mix.  
19 We also know that aluminum and other materials  
20 are making excellent strides in improving  
21 their overall recyclability.

22 So we can't count on that



1 advantage forever. But again, there are  
2 differences. And we, ArcelorMittal, published  
3 a paper last month in SAE that basically  
4 showed by the time you account for some of  
5 these uncertainties, the relative differences  
6 in total carbon footprint are, in many cases,  
7 less than the noise introduced by the  
8 uncertainty.

9           So with the uncertainty many  
10 times, it is difficult for us to make any  
11 statements. So we thought about this a little  
12 bit and I would like to try to take some of  
13 the uncertainty out of it.

14           The first is whether or not in  
15 2025 an aluminum or carbon fiber or magnesium  
16 vehicle is going to get better fuel economy.  
17 And we have looked at this very carefully. If  
18 you take a vehicle in steel that is getting  
19 its required fuel economy, and you substitute  
20 another material, aluminum, it is going to be  
21 lighter and that weight reduction is going to  
22 give it probably about a 2.5 to 3.5 better

1 mile per gallon fuel economy.

2 Over 15,000 miles per year that  
3 adds up to a \$50 per year fuel savings at \$4  
4 a gallon gas and \$100 a year for \$8 a gallon  
5 gas.

6 Now, I don't have exact numbers  
7 for the additional cost to the consumer, but  
8 I'm pretty sure it is going to cost far more  
9 than \$100 per vehicle to build these aluminum  
10 or magnesium or carbon fiber vehicles.

11 The point is OEMs have shown many  
12 times that consumers will not pay for things  
13 where they cannot get a payback in less than  
14 a year. And this is a case where yes, these  
15 other materials are going to provide better  
16 fuel economy, but it's not going to pay the  
17 consumer to do it.

18 What is probably going to happen  
19 is the OEMs are going to take away powertrain  
20 technologies to bring the cost back in line  
21 and vehicles are going to get very close to  
22 their 2025 fuel economy target no matter what

1 material we make them out of.

2 And so realistically, we don't  
3 anticipate that there is going to be a big  
4 difference in fuel economy in the fleet  
5 whether or not they are made out of steel or  
6 some of these other materials.

7 Now, let's look at the other end  
8 of it. The recycling phase. There is still  
9 uncertainty as to where we are going to be.  
10 Right now, there is no major recycling stream  
11 for aluminum. That needs to be built up. But  
12 again, we recognize that this is going to  
13 happen over time.

14 So when we ran the UCSB and  
15 lifecycle analysis models, we assumed the same  
16 recycling rates, whether it is steel or  
17 aluminum, we wanted to take that uncertainty  
18 out. And so when we do that, when we take  
19 away the uncertainty, the steel solutions are  
20 still providing the lower total lifecycle  
21 carbon footprint.

22 So right now based on this, what

1 we are finding is that at least according to  
2 the Volpe model and the publicly available  
3 tools we have at our disposal, the steel  
4 solutions are getting us to 54.5 miles per  
5 gallon and they are doing that at a lower cost  
6 and they are doing that at a lower carbon  
7 footprint.

8 But this is not game over and we  
9 are not ready to go to the midterm review.  
10 Obviously, there are a lot of other  
11 considerations that have to go into this and  
12 we, as steel, just as the other materials, are  
13 committed to working with the OEM community to  
14 try to find the best and most optimum  
15 applications of these solutions to get those  
16 requirements at the lowest possible cost.

17 And that brings me to conclusion  
18 and I would be happy to answer any questions  
19 that come up.

20 (Applause)

21 MODERATOR BONANTI: Thank you,  
22 Blake. Let's see what we have. You referred

1 to adding weight that would come with sensor  
2 components -- computers, sensor computers. If  
3 and when cars have sensors to detect other  
4 vehicles and other things, isn't it likely  
5 that, at that time, the sensor computers will  
6 be tiny devices? I'm sorry, I can't read  
7 this.

8 MR. ZUIDEMA: That's okay.

9 MODERATOR BONANTI: They,  
10 basically, --

11 MR. ZUIDEMA: Yes.

12 MODERATOR BONANTI: I can't read  
13 the last half part of it, but, basically, they  
14 are asking: does that impact, do you believe  
15 that that is going to impact weight?

16 MR. ZUIDEMA: Yes, I do, because  
17 no matter what, it is going to be a net  
18 increase. Between the sensors and the  
19 additional computers and other things that go  
20 into it, there is going to be a weight gain.  
21 We can't ignore the fact that there are other  
22 things that are going to add to it and this is

1 just one component.

2 My point is there is still a lot  
3 of opportunity in some of these other non-  
4 body-in-white components. And while these  
5 weight gains are going to take up some of it,  
6 I don't think that is going to take up all of  
7 it.

8 So I think there is a good portion  
9 of that additional non-body-in-white weight  
10 which is going to find its way to the bottom  
11 line of the vehicle.

12 MODERATOR BONANTI: Next question.  
13 How is Arcelor making -- managing steel  
14 production for global model vehicles, like  
15 Toyota -- like the Toyota Corolla or Honda  
16 Accord and others?

17 MR. ZUIDEMA: Well, we certainly  
18 have facilities around the world and of the  
19 steel makers, we are probably the most global.  
20 We are not everywhere and we recognize we are  
21 not everywhere yet. And for those regions  
22 where we are not producing certain grades of

1 steel, we have supply arrangements and very  
2 good pipelines for exporting from those  
3 regions where we do have the capability to  
4 make these products.

5 So I'm not aware of any customer  
6 which is going without steel because of local  
7 supply problems right now, at least not from  
8 ArcelorMittal.

9 MODERATOR BONANTI: Okay. What  
10 are the challenges for high strength materials  
11 with lower elongation? Is there an issue with  
12 productivity?

13 MR. ZUIDEMA: No. I'm going to  
14 say no, there are not issues. Are  
15 productivities lower in the steel mill? Yes,  
16 they don't process nearly as fast, but that is  
17 taken into account in the overall design and  
18 scheduling of the mill.

19 Are there problems in the  
20 manufacturing? No, because those properties  
21 have already been accounted for in the  
22 selection of the manufacturing processes. And

1 so we are naturally steering these products to  
2 things like roll-forming or crash-forming  
3 where we don't need the strong formability in  
4 more conventional processes.

5 So this has been a real evolution  
6 where the material properties have been looked  
7 at from both the design and the manufacturing  
8 standpoint to make sure we are using them in  
9 the right areas.

10 And when I said we don't want to  
11 use a Martensite to make a hood outer, this is  
12 what I'm talking about. We are using  
13 Martensite in roll-formed applications where  
14 we can account for the lower forming.

15 MODERATOR BONANTI: Okay. Thank  
16 you. What is your projection for high  
17 strength and high elongation materials which  
18 can be used in normal stamping processes, such  
19 as time frame, 5 to 10 years from now or even  
20 more?

21 MR. ZUIDEMA: Within the next 5  
22 years, we are going to have commercialized



1 this third-generation of advanced high  
2 strength steels. These are going to provide  
3 strengths ranging from 1,000 up to about 1,500  
4 MPa and the target ductilities are ranging  
5 from about 30 percent total elongation at the  
6 1,000 MPa level up to about 20 percent at the  
7 1,500 MPa level.

8 And this is being done entirely to  
9 provide for grades which are stampable. And  
10 in many cases, they are going to be replacing  
11 some of the press-hardening steels. And we  
12 are going to be able to get the strength in  
13 something which can be stamped by more or less  
14 conventional coil stamping processes.

15 And so I believe those grades are  
16 going to be available much sooner than that 5  
17 to 10 years that you are talking about.

18 MODERATOR BONANTI: Thank you.  
19 Has Toyota vetted the Venza Lightweight  
20 Project?

21 MR. ZUIDEMA: I ask you.

22 MODERATOR BONANTI: No.

1 MR. ZUIDEMA: Okay.

2 MODERATOR BONANTI: I don't know  
3 why. Okay. Sorry, strike that.

4 MR. ZUIDEMA: Yes.

5 MODERATOR BONANTI: Second  
6 question. Honda stated the need for milder  
7 grades of steel than the high strength steel  
8 used in the FEV study due to embrittlement.  
9 Can you comment?

10 MR. ZUIDEMA: Yes. There again  
11 are today a number of solutions. One of the--  
12 the first and foremost that struck me was the  
13 cracking they were getting in the lower B  
14 pillar area. Arcelor Mittal has specifically  
15 developed a grade called ductabler, which is  
16 used as a laser welded component in a  
17 traditional hot stamping process, except the  
18 chemistry has been adjusted so that after hot  
19 stamping, it provides a level of strength and  
20 ductility which is more commensurate with some  
21 of the DP 590 grades, and it was done  
22 specifically to provide hot stamping

1 components, which provide that level of  
2 ductility in areas that are required by the  
3 crash.

4 So there are a number of steel  
5 solutions available already today to address  
6 some of those challenges.

7 MODERATOR BONANTI: Okay. The  
8 questions keep coming in. The Europeans are  
9 regulating emissions at more severe levels  
10 than the United States and are now considering  
11 even tougher future laws. Are you aware of  
12 any interest in Europe in the inclusion of LCA  
13 in future regulations, say beyond 2020?

14 MR. ZUIDEMA: At this point, the  
15 Europeans have agreed that it is important to  
16 look at total lifecycle. They have decided it  
17 is important and will look at it for the rules  
18 after 2020, but as of right now, there is no  
19 official mandate. They are looking at it.  
20 And I think they are seeing lifecycle as  
21 something which really needs to be taken into  
22 account and slowly the process of working it

1 into the regulations in a means which is fair  
2 and equitable to everybody is happening right  
3 now.

4 So they are, I think, already  
5 moving in that direction, but from where I see  
6 it, there is still a ways to go.

7 MODERATOR BONANTI: Okay. What is  
8 the rate limiting factor for automotive OEMs  
9 to implement more advanced high strength steel  
10 into the vehicle component content?

11 MR. ZUIDEMA: It is a problem of  
12 both experience and rate of carryover. The  
13 more constrained they are, the fewer  
14 opportunities they are going to have to do  
15 revolutionary new things with advanced grades  
16 of steel.

17 This has been a problem which has  
18 been going on for quite some time and we heard  
19 philosophy change as one of the requisites.  
20 This is one area where we might have to look  
21 at those paradigms and rethink how we are  
22 building different vehicles off of each other

1 and how we are paring those things to try to  
2 find a way to give the designers a little bit  
3 more freedom in terms of the application of  
4 the grades.

5 And then the other is experience.  
6 And, obviously, nobody is going to use a brand  
7 new grade of steel which they have never  
8 touched, tasted or smelled. And so getting  
9 them into prototype development programs,  
10 getting them into at least limited  
11 applications is also very important because we  
12 need some small successes before we can really  
13 start to use it on a wide scale.

14 MODERATOR BONANTI: Okay. And  
15 what are the major cost drivers to producing  
16 high strength steels relative to conventional  
17 steels?

18 MR. ZUIDEMA: There aren't  
19 significant cost drivers. And the costs go up  
20 fairly slowly in terms of the production cost.  
21 And in many cases, particularly for cold  
22 stampings, our experience is the cost of the

1 steel itself goes up at a slower rate than the  
2 weight of the steel goes down. And in many  
3 cases, there is a net cost saved to the  
4 manufacturer.

5 MODERATOR BONANTI: Here is a  
6 question from the audience, of course. What  
7 time frame would you consider for the  
8 regulation of material production for  
9 greenhouse gases? And does your company  
10 support economy-wide cap and trade?

11 MR. ZUIDEMA: I'm --

12 MODERATOR BONANTI: I qualified it  
13 by saying it came from the audience.

14 MR. ZUIDEMA: Yes, okay. I'm  
15 going to have to decline. And if somebody  
16 wants to get with me, I will get them in touch  
17 with the appropriate folks in our organization  
18 who can comment on the broader aspects of cap  
19 and trade.

20 MODERATOR BONANTI: Okay. For  
21 CAFE compliance, NHTSA set constraints on the  
22 maximum mass reduction due to the estimates of

1 fatalities and maintaining safety neutrality.  
2 In your study, did you relax the constraint to  
3 meet 54.5 miles per gallon?

4 MR. ZUIDEMA: None whatsoever. We  
5 are assuming that the safety regulations and  
6 safety performance are going to be maintained.  
7 Of course, the issue of what happens when mass  
8 goes down is going to be addressed tomorrow.  
9 And I'm not a safety expert, so I'm not going  
10 to comment on that.

11 But in all of our studies when we  
12 do weight reduction, we are always focusing on  
13 maintaining parity in terms of the body  
14 structure's ability to withstand the crash  
15 loads and maintain a safe passenger  
16 environment.

17 MODERATOR BONANTI: Okay. I think  
18 this is the last question, unless there is any  
19 further questions from anyone. But are the  
20 higher lifecycle emissions you estimate for  
21 aluminum and other materials unsolvable or  
22 inherent in the material or can they be

1 addressed?

2 MR. ZUIDEMA: To the extent that  
3 the free energy formation of aluminum oxide  
4 and iron oxide and in certain physical things  
5 that I have to profess not even I am an expert  
6 are controlling, it is kind of hard to say  
7 long-term whether or not there is going to be  
8 a closure of that gap.

9 From what I have seen, it is  
10 always going to be more energy-intensive.  
11 There are certainly technologies for aluminum  
12 which are trying to reduce the CO2 intensity,  
13 but I can assure you at the same time, there  
14 are programs going on in the steel industry  
15 that are focusing on revolutionary new ways to  
16 reduce iron ore and iron oxide with much more  
17 carbon friendly.

18 So long-term, I think both  
19 materials are going to reduce their  
20 manufacturing footprint. And I think  
21 ultimately it comes down to the laws of  
22 physics as to which one is going to take more



1 carbon.

2 MODERATOR BONANTI: Okay. Well,  
3 thank you. Are there any other questions?  
4 No, okay.

5 (Applause)

6 MODERATOR BONANTI: Okay. Our  
7 next speaker Doug Richman from Kaiser. He is  
8 going to be talking about aluminum and the  
9 growth and trends associated with it. So  
10 thank you.

11 MR. RICHMAN: Thank you, Chris.  
12 Well, the title of this -- by the way, for  
13 complete disclosure, although I work for  
14 Kaiser Aluminum, I represent Kaiser Aluminum  
15 on the Aluminum Association Automotive  
16 Transportation Group and I am here  
17 representing that group, not Kaiser. Just so  
18 we get it all straight here.

19 And you know, I have been in this  
20 industry a while and I've got to tell you, I  
21 am -- I have never seen and I don't believe  
22 ever in the history of the automobile has this

1 industry ever been as exciting as it is now  
2 and will be for the next five years.

3 We have never been challenged on  
4 so many fronts at the same time and we have  
5 never had the strong tools and talented people  
6 to address those challenges that we have got  
7 now. The computers, the science, the advanced  
8 materials, this is just a spectacular time for  
9 an engineer. And I happen to be an engineer,  
10 so it's a great time.

11 I'm going to talk about how -- the  
12 strategy for lighter and safer cars. And Jim  
13 actually gave me a great segue this morning  
14 when he talked about the statistical analysis  
15 looking backward and the paper studies looking  
16 forward. And I had never really thought about  
17 it that way, but it was a great lead-in,  
18 because we look at the statistical studies and  
19 that is history.

20 And history is really important.  
21 We need to learn from our own history so we  
22 don't make the same mistakes again. And it

1 gives us clues about what we have to address  
2 going forward. So I think these studies are  
3 great to look at. We have to be careful just  
4 how much we try to read into them, because  
5 technology marches on every single day in this  
6 industry and in most industries.

7 Every time these engineers come to  
8 work, they've got another bright idea and some  
9 of them are actually good ideas and they work.  
10 So as we look at history, we take the learning  
11 that is in it, apply it to the new frontiers  
12 we are dealing with and we will get to a new  
13 level that we could never have imagined  
14 before.

15 And I was telling Jim at the  
16 break, I used to do engine technology. 25  
17 years ago we did forecasting on where engine  
18 technology should be for the next generation  
19 engines. Horsepower per liter was one of the  
20 parameters.

21 We wondered if 50 horsepower per  
22 liter for a naturally aspirated engine was

1 realistic, not question whether we could do it  
2 next year. Would it ever be realistic? 75  
3 horsepower per liter today is average in 25  
4 years. And I actually plotted that out, just  
5 hear for a minute. I plotted that back to  
6 1902.

7 Do you know what the horsepower  
8 per liter was in 1902? It was 6. 6! We have  
9 gone from 6 to over 60 in 100 years. Every  
10 year got better. And safety engineering is in  
11 the same category as I see it. The engineers  
12 are going to get better every year.

13 Now, I'm going to talk about --  
14 I'm not going to talk any more about history.  
15 I'll go forward looking and I wanted to review  
16 a couple of the studies which we think are of  
17 value. They are independent third-party  
18 studies that looked at various aspects of  
19 lightweighting and safety.

20 Some specific to aluminum, some to  
21 the general question of lightweighting. And  
22 I'm going to talk about first a DRI study.

1 DRI will be here tomorrow speaking, but a DRI  
2 study that was done in -- a few years ago.  
3 Talk about some -- because they give us some  
4 insight into how to think about safety going  
5 forward and because the title of this  
6 conference was safety, I thought I would tie  
7 it in there.

8           So now the DRI study was 2008 and  
9 the objective was to look at the compatibility  
10 question. Now, why compatibility? We have  
11 IIHS. We have NHTSA tests. We have European  
12 Crash Test Standards. Well, even at that  
13 time, the general feeling was that car  
14 companies were already pretty darn good at  
15 engineering to meet those tests. And the cars  
16 are way better from a safety standpoint than  
17 they were before engineering focused on these  
18 objectives.

19           Those were achievable, but one  
20 question that really bothers a lot of people,  
21 engineers and regulators and insurance  
22 companies, is the compatibility question,

1 which wasn't clearly addressed in those  
2 standardized tests.

3           So we ran some tests, some  
4 studies. I'll show you some data on that or  
5 they did, DRI. And really they are dealing  
6 with the question of how much energy must be  
7 dissipated in a collision? And how do the  
8 vehicles decelerate? What is going on inside  
9 the vehicles in a compatibility vehicle-to-  
10 vehicle type situation, where vehicle weights  
11 are different and vehicle sizes are different?

12           Now, these are paper studies. All  
13 of the studies I'm going to be talking about  
14 are paper studies. Generally, I think any of  
15 us who have actually gone from paper studies  
16 to production vehicles -- Honda said from the  
17 paper study on that particular vehicle in  
18 their set of circumstances, a 50 percent  
19 reduction in expectation may be realistic from  
20 a mass reduction standpoint.

21           Depending on the situation, we use  
22 10 to 20 percent. We don't really normally

1 have all the constraints that Honda has to  
2 deal with, the International Frontier and the  
3 platform separations, multiple platforms.

4 So somewhere between 10 and 50  
5 percent, but the directionality is what is  
6 important, not the absolute values. So the  
7 compatibility of cars and trucks, SUVs and the  
8 DRI folks simulated 3,500 collisions that were  
9 part of the NCAP Pulses Study and NAS  
10 descriptors for the collisions.

11 The metric for collision  
12 performance was equivalent life units, ELUs,  
13 and so I'm going to show a couple of tables on  
14 the ELUs for a series of thousands of  
15 simulations that DRI did, particularly looking  
16 at SUVs versus lighter SUVs and passenger  
17 cars.

18 Now, this is a very busy chart,  
19 but it tries to summarize a very long study in  
20 just a couple of charts. I won't kill you  
21 with these charts. But what we have got here  
22 is the SUV and the driver in the SUV and a

1 driver in the other vehicle and we have a  
2 number of crashes.

3 One important takeaway is when  
4 people -- when I talk to people about safety,  
5 and safety professionals, there is normally a  
6 particular collision that comes to mind and it  
7 is usually the vehicle-to-vehicle.

8 But really when we look at the  
9 whole spectrum of typical accidents in the  
10 marketplace throughout -- this is North  
11 American cross-section of 3,500 sampled  
12 accidents, vehicle-to-vehicle is certainly a  
13 large part of it, but rollover accidents,  
14 hitting objects, hitting passenger cars, we  
15 kind of hit about everything that is out  
16 there.

17 The car-to-car is an important  
18 one. And we have looked at the car-to-car or  
19 vehicle-to-vehicle. PC is passenger car and  
20 LTV is light truck and van. And then we have  
21 the SUV and the driver, number of cases. This  
22 is the baseline data from the initial survey.



1                   Now what DRI did was they created  
2 models of these various platforms. So they  
3 have a baseline vehicle and fundamentally the  
4 baseline societal impact for these collisions  
5 in the standard fleet, call it 86 ELUs just as  
6 an index.

7                   They then reduced the weight of  
8 the SUV and they reduced the weight by 20  
9 percent. It was just an estimate of what  
10 might be achievable with lightweighting  
11 technologies as it was viewed in 2008. And  
12 the overall societal impact of reducing the  
13 heavy vehicle weight was a reduction of about  
14 28 percent. This is the percentages over  
15 here.

16                  So the lightweight vehicle reduced  
17 injuries in the total fleet by 28 percent,  
18 although, the driver of the SUV, when it hit  
19 a passenger car, was actually at a  
20 disadvantage. The driver in the lighter  
21 vehicle was at a disadvantage. The rest of  
22 society was ahead by 28 percent.

1                   Now, they then took that same  
2                   vehicle and re-engineered it to make it longer  
3                   by 4 inches and added 30 pounds to the vehicle  
4                   for the 4 inches that were added. When they  
5                   did that, virtually all of the configurations  
6                   got better. All of the collision experiences  
7                   got better.

8                   24 percent overall societal impact  
9                   improvement without any deterioration for any  
10                  individual configuration of accident.

11                 Encouraging. It says that mass reduction can  
12                 be done, I think I wrote that, I have stepped  
13                 through this already, and reduce equivalent  
14                 life units in the fleet.

15                 Mass reduction at 20 percent, 28  
16                 percent, reduced the struck vehicle ELUs by 61  
17                 percent. If you are in the lighter vehicle  
18                 being hit by the other vehicle and it is  
19                 lighter, we are all better off for that. And  
20                 that's where the gains go.

21                 And there was some increase in  
22                 ELUs for the driver of the lightweighted

1 vehicle. By increasing the length, this is  
2 design. This is the design part. Increasing  
3 the crush space and managing the energy in the  
4 collision reduced the fleet by 24 percent, it  
5 reduced the long vehicle driver by 10 percent  
6 and the target vehicle by 33 percent. A win-  
7 win for everybody. Okay. That's the DRI  
8 study.

9 Now, a few years ago, 2010, the  
10 Institute of Automotive Engineering at Aachen  
11 University did a study on a European midsize  
12 passenger car to see what could be done on  
13 mass reduction with the constraint that, to  
14 the best of their modeling capability, would  
15 have equivalent -- indexed equivalent  
16 performance on safety.

17 And they looked at -- they wanted  
18 to understand the feasibility with steel and  
19 with aluminum for the autobody. Now, this was  
20 just the body. It wasn't like Harry and the  
21 FEV study with a total vehicle. It's just  
22 looking at what could be done in reducing the

1 body.

2                   And they did a modeling exercise  
3 and they classified each body component as  
4 stiffness-dependent or strength-dependent in  
5 a collision environment, also for NVH. And as  
6 most everybody in this room knows, probably  
7 better than I, that body engineering is the  
8 balancing act between NVH expectations and  
9 collision expectations.

10                   So they did both, looked at  
11 stiffness-dependency and strength-dependency  
12 of every element or group of elements in the  
13 vehicle. I'll show that in a minute. And  
14 they looked at high strength steels.

15                   Now, the vehicle they started with  
16 was a comprehensive European -- it was  
17 actually a spin-off of the Ultralight European  
18 Vehicle Study, if you are familiar with that.  
19 And it had about a comprehensive use of  
20 advanced steels for 2010. I think it was  
21 around 45 percent early advanced steels.

22                   They broke the body into 26

1 subsystems, looked at each subsystem in  
2 detail, calibrated the models to actual -- to  
3 an actual body structure performance for  
4 torsional stiffness, bending, tried to do a  
5 decent -- and I think they did a reasonable  
6 job of calibrating the models to reality -- to  
7 the reality of the body from a stiffness  
8 standpoint, modeling, number of collision  
9 environments, FMVSS 301, rear crash, NCAP  
10 side.

11           They classified and came up with  
12 an index for each body component on which  
13 components would gain from use of advanced  
14 high strength steels. They would have weight  
15 reduction potential with high strength steels,  
16 which ones would have weight reduction  
17 potential with aluminum.

18           This is the rank order and all the  
19 parts didn't gain with aluminum and all the  
20 parts didn't gain with steel.

21           The key finding was that in their  
22 study to the limit of their modeling

1 capability, their conclusion was NVH and  
2 safety parameters seem to be achievable with  
3 either lightweight strategy, steel or  
4 aluminum, both could be met.

5 Strength was not the limiting  
6 factor on a majority of the mass of the  
7 vehicle. And the maximum optimizations study  
8 for the steel vehicle, they achieved with  
9 steel grades up to 1,200 MPa, about an 11  
10 percent reduction in body mass. Now, that's  
11 body-in-white and the closures.

12 The aluminum study on all aluminum  
13 or aluminum -- it was actually all aluminum in  
14 this study achieved about a 40 percent  
15 reduction in mass. And they felt that, again,  
16 to the extent of their modeling, these would  
17 be technically feasible.

18 The practical sense is that at  
19 least a 10 percent reduction in those numbers  
20 would be a more realistic number and perhaps  
21 with a lot of real-world constraints, it could  
22 be half of that to the Honda example.

1           Okay. The studies that were done  
2 by Lotus and FEV and EDAG, in my opinion, are  
3 just outstanding pieces of work. They are not  
4 absolute. They are paper studies, but they  
5 are really outstanding pieces of work and they  
6 give us again a sense of direction for what  
7 might be achievable.

8           It is not proof that anything is  
9 achievable, but what might be achievable. And  
10 that's what we need to keep in front of us, I  
11 think.

12           So this is the SUV, midsize SUV  
13 study. And I wanted to show this chart  
14 because it kind of says why do we look at --  
15 why do we want to look at the body or can we  
16 look at something else and get our -- get the  
17 mass reduction objectives met?

18           Well, this bar chart the absolute  
19 height of each of these bars is the  
20 distribution of mass of that original vehicle.  
21 And what we find out is the body-in-white plus  
22 closures is a little over 30 percent of the

1 total curb weight of the vehicle. Throw in  
2 the interior and we get over 50 percent of the  
3 -- now, when I say interior, that includes the  
4 seating, the cross-car beam for the IP, the  
5 full structure as well as the trim. The  
6 combination is over 50 percent of the total  
7 weight of the vehicle.

8 If we are going to get significant  
9 mass reduction on these vehicles, we can't not  
10 do the body. In fact, well, I think Babyface  
11 Nelson said "Why rob banks? Because that's  
12 where the money is." Why the body? Because  
13 that's where the weight is.

14 You could -- if we wanted a 20  
15 percent mass reduction, we could take the  
16 entire engine out of the vehicle and not  
17 achieve our objective. So we have to look at  
18 the body. We don't have any choice, but it's  
19 a great opportunity.

20 The findings in general and we  
21 have heard summarized, I'm really delighted  
22 that my predecessors already covered these.



1 I don't have to explain these studies again,  
2 so that's great. I'll just give you my rehash  
3 on the findings.

4 The crossover SUV was about an 18  
5 percent and we call that, I call that, the MMV  
6 Solution. Not only is it multiple steel  
7 grades, as Blake talked about, but that  
8 vehicle had aluminum fenders, deck and hood.  
9 So it's a mix. It's a multi-material. And I  
10 think this industry has been talking the  
11 solution is a multi-material solution. In  
12 fact, it's always been a multi-material  
13 solution.

14 18 percent of the vehicle mass was  
15 achieved -- reduction was achieved. Advanced  
16 steels for the body-in-white achieved about a  
17 14 percent, total body mass about 14 percent,  
18 aluminum we'll use for closures, but a big  
19 area that the aluminum was deployed and in the  
20 body discussions, we kind of overlooked some  
21 of the other areas, a lot of applications in  
22 the chassis.

1                   And we heard about them from Harry  
2                   and other discussions, suspensions, control  
3                   arms, brake calipers, estimated cost, argue  
4                   about it. I can't stand behind the number.  
5                   The team that did the work says it is a cost  
6                   savings. I think Honda sort of says well,  
7                   maybe in a perfect world, but the reality is  
8                   it probably costs something.

9                   Our position is mass reduction  
10                  generally costs something. It doesn't come  
11                  for free. If it did, Honda and GM would  
12                  already have done it. Okay.

13                  Now, we took that study and you  
14                  saw that these models were heavily calibrated,  
15                  very, very thorough, very detailed analysis,  
16                  probably as good as anybody outside of an OEM  
17                  engineering department can do. And we said,  
18                  okay, we have got now an MMV study and we have  
19                  an assessment under a certain set of  
20                  guidelines about what the mass reduction could  
21                  be for a vehicle that, on paper, has the  
22                  potential to meet the safety objectives.

1                   We then went to the EDAG, in this  
2 case, and said we would like to take that  
3 exact model with the same modeling assumptions  
4 and the same structure, no change in structure  
5 and see what it does as an aluminum-intensive  
6 vehicle.

7                   The same set of guidelines, same  
8 vehicle, same objective, must meet the safety  
9 requirements, everything is the same as the  
10 original study. Technique, you have heard  
11 about it, but the baseline vehicle was  
12 calibrated, as we saw, converted to an  
13 aluminum design, the initial concept evaluated  
14 for NVH and collision iterative process and  
15 coming up with a full aluminum design that  
16 met, essentially, all the objectives of the  
17 lightweight steel design.

18                   Interestingly, and I will come  
19 back to this in a minute why this is  
20 interesting, it wound up that because of the  
21 sections that were involved, and in cases of  
22 aluminum we had some thicker walls and things,

1 the design in almost all NVH criteria except -  
2 - in fact in all of them was actually stiffer  
3 than the steel-bodied vehicle it replaced in  
4 the models.

5 Generally, that was traced back to  
6 wall thicknesses. It is stiffer. That is  
7 going to be important in a second.

8 We ran the collision models or  
9 they did for deformations to see about the  
10 classic index of safety performance. Of  
11 course, the intrusion, the amount of the  
12 intrusion and also G-forces. This happens to  
13 be a picture of the front end on a -- this is  
14 a 35 mile barrier and this is -- the top view  
15 is the steel vehicle. The highlighted areas  
16 are the intrusion mounts.

17 And, in fact, the steel vehicle  
18 actually had higher intrusions than the  
19 aluminum, basically triggered back by the  
20 increased stiffness in front of the cab. A  
21 little red light went on and said well, if it  
22 has got less intrusion and it is stiffer, what

1 is that doing to G-forces?

2 This is the side view of the same  
3 collision. Less deformation, slightly less,  
4 but quite a bit less deformation throughout  
5 the front of the vehicle compared to the  
6 aluminum vehicle.

7 A red flag went up looking at the  
8 acceleration or these are the force curves.  
9 We see significant differences. The 001, the  
10 blue line, is the original vehicle. The red  
11 is the lightweight, the steel or the aluminum-  
12 intensive vehicle, it's all aluminum. Now,  
13 when I say all aluminum, by the way, we wound  
14 up using high strength steel for the door beam  
15 and reinforced the A pillar. It is a multi-  
16 material solution.

17 Higher loads, higher forces in the  
18 initial -- these are along the length of the  
19 front beam. We looked at the -- so the  
20 findings. An aluminum-intensive crossover  
21 vehicle appears capable of meeting all of the  
22 functional objectives and safety objectives.

1 That study concluded a 28 percent reduction in  
2 total vehicle mass.

3 And what we did here or they did  
4 was take all of the weight savings in the rest  
5 of the vehicle and applied it to the aluminum-  
6 intensive vehicle. So if you went up from 28  
7 percent total vehicle, body mass reduction 39  
8 percent, almost exactly what the Aachen study  
9 said. Cost impact, net cost after corrections  
10 for the secondary mass reductions \$534  
11 premium.

12 But as I stated in the outset of  
13 this discussion, the real story on safety, at  
14 least the one we have been looking at, is the  
15 compatibility question, vehicle-to-vehicle  
16 compatibility.

17 So we had this and we had a little  
18 concern when we saw that we were stiffer and  
19 we had less deformation in front of the  
20 vehicle, so we ran some offset frontal  
21 collisions. This was the base vehicle offset  
22 frontal. This is the aluminum-intensive

1 vehicle.

2 The red again is the penetration,  
3 dash panel intrusion. And again, same story,  
4 less intrusion in the aluminum vehicle than in  
5 the steel vehicle.

6 This was the chart that convinced  
7 us engineering needs to now step in. This is  
8 again the structure was not changed from the  
9 parent vehicle. What we have got here is a  
10 velocity curve of the original vehicle and the  
11 velocity curve of the lightweight vehicle.

12 The lightweight vehicle's time to  
13 zero was 20 percent shorter than the heavier  
14 vehicle. We have the G-forces. The standard  
15 vehicle, the lightweight vehicle.

16 Substantially higher G-forces. What that told  
17 us was for this structure, for this  
18 lightweight aluminum-intensive concept to be  
19 viable, it must be re-engineered to remanage  
20 the energy. It needs to be softened.

21 And the DRI work said adding 4  
22 inches had a substantial improvement in the

1 safety performance of their predicted safety  
2 performance for the vehicle. We stopped at  
3 this point, but the offsetting story here is  
4 we have done some preliminary look at this and  
5 it does seem technically feasible to re-  
6 engineer the front end of this vehicle to  
7 increase the crush space, soften it up and  
8 bring down -- actually lengthen the stopping  
9 distance, the time to zero speed and reduce  
10 the G-forces inside the cab.

11 Now, so the conclusion is just  
12 taking the weight out without re-engineering  
13 when we take substantial chunks of weight out  
14 would not be an overall significant strategy.

15 Now, this distribution of the --  
16 how am I doing on time? I'm over? Okay.  
17 I'll fast-forward here.

18 Key findings. Floor plan  
19 intrusion was reduced. Velocity and  
20 accelerations, the AIV concept had more severe  
21 deceleration and potentially higher occupant  
22 loading. The increased structural stiffness



1 is the -- was the result and we need to put in  
2 higher energy absorption capacity.

3 And the final conclusions to this  
4 discussion, vehicle design, not mass, is the  
5 key to collision performance. That's our  
6 opinion. Reduce mass body structures with  
7 equal or superior collision performance appear  
8 feasible. We by no means have the definitive  
9 answer here, but they are not out of the  
10 question based on these studies.

11 Potential mass reductions based on  
12 the three studies I talked about, advanced  
13 high strength steels from today's baseline  
14 technology about 10 to 12 percent reduction in  
15 mass.

16 Now, these are the theoreticals.  
17 And if the practical constraints of multi-  
18 platform, multi-national production and  
19 business strategies and investment capital  
20 constrain that, these will go down from 10, 20  
21 to 50 percent of these numbers.

22 Multi-material optimization, 12 to

1 16 percent mass reduction, theoretical.  
2 Steel, advanced high strength steel, aluminum,  
3 magnesium are the candidates. Aluminum-  
4 intensive vehicle 24 to 28 percent. This is  
5 body mass, not vehicle.

6 But what is the future? Mass  
7 reduction is not a single point problem. It  
8 is a multiple problem and it is different for  
9 each manufacturer, each vehicle configuration  
10 and each market that is being served. What do  
11 we think is going to happen? There will be a  
12 mix. The mix is likely. There will be  
13 advanced high strength steels, particularly in  
14 the price critical segments of the market that  
15 may require some downsizing. May.

16 There will be multi-material  
17 vehicles and unlike Blake's this is the one  
18 with aluminum and steel. This is not the  
19 three different steels. The size, where size  
20 and cost are, both need to be optimized.  
21 There may be some moderate downsizing in  
22 there. And there will be aluminum-intensive

1 vehicles serving certain segments of the  
2 market where downsizing is just not consistent  
3 with the overall objective of the vehicle.

4 Thank you.

5 (Applause)

6 MODERATOR BONANTI: Thank you,  
7 Doug. Questions? I have several. Okay.  
8 Okay. The first question. Aluminum costs  
9 fluctuate 100 to 180 percent based on  
10 commodity indexes. On the other hand,  
11 automotive industry has tight budgets for  
12 vehicles. What are your thoughts on this?

13 MR. RICHMAN: Well, I have not  
14 seen 100 or 180 percent, so that's, I mean,  
15 kind of a loaded question. But there is --  
16 it's a commodity like all other metals and it  
17 does fluctuate. It is managed. It is quite  
18 well-managed. It has been -- we have, you  
19 know, 22 billion pounds of aluminum going into  
20 the marketplace today and it's managed just  
21 like any other commodity.

22 I'm not in the trading side of the

1 business, so most of the -- I heard the  
2 comment about manufacturers must do their  
3 planning on the peak price. They have to  
4 protect for the peak, but they usually -- my  
5 experience is they have been doing it based on  
6 averages.

7 The long run average rather than  
8 the short run, because usually when it spikes  
9 up, not too long after that, it goes back down  
10 the other way and then finds an equilibrium  
11 point. Most of the work I have seen for the  
12 last over 20 years has more often at kind of  
13 a long run average. So I don't know if that's  
14 the right answer for what you are asking.

15 MODERATOR BONANTI: I'm just  
16 asking the questions. Okay. Next question.  
17 What was the crush zone distance for the crash  
18 models that you show in your presentation?

19 MR. RICHMAN: The baseline?

20 MODERATOR BONANTI: I believe so.

21 MR. RICHMAN: I don't know. Not  
22 off hand. I mean, there is -- I don't know

1       what the actual crush -- I mean, it's the  
2       whole front end. There wasn't a designated  
3       space in the original vehicle that I know of  
4       that was -- maybe, Harry, do you know?

5                   MR. SINGH: It should be about 650  
6       millimeters --

7                   MODERATOR BONANTI: You are saying  
8       670?

9                   MR. SINGH: 650.

10                  MODERATOR BONANTI: 650  
11       millimeters. And that's the whole front?

12                  MR. SINGH: Yes.

13                  MODERATOR BONANTI: The whole  
14       front. All right.

15                  MR. SINGH: The crush distance in  
16       front.

17                  MODERATOR BONANTI: Okay. That's  
18       the whole front. Yes, okay.

19                  MR. RICHMAN: We added 4 inches  
20       with nothing. You know, with nothing on -- no  
21       neighbors inside, you know.

22                  MODERATOR BONANTI: Okay. What is

1 the rate limiting factor for more aluminum to  
2 be used in BIW construction? Body-in-white  
3 construction, I guess.

4 MR. RICHMAN: I think it's the  
5 practical need and the evolution of platforms  
6 as they -- platforms that need to be an  
7 aluminum body intensive -- aluminum-intensive  
8 body. It's not every platform. It's going to  
9 be a multi-material approach for most  
10 vehicles.

11 We are not limited on availability  
12 and material. It is mostly the need of the  
13 OEMs to have that type of product in their  
14 portfolio and the time it takes them to bring  
15 it to market.

16 MODERATOR BONANTI: Okay. Next  
17 question. Your results seem to violate the  
18 conservation of momentum and energy. How is  
19 this explained?

20 MR. RICHMAN: I like that  
21 question. I actually do. If you noticed --  
22 I didn't point it out and maybe I should have,

1 but the -- in that -- when I showed that  
2 chart, if you noticed the zero velocity, we  
3 are not violating any conservation momentum.  
4 The red line, the velocity goes negative. The  
5 lighter-weight vehicle gets pushed back. It  
6 does.

7 But what the -- but the first  
8 order conservation of momentum fails to  
9 recognize what all of those safety engineers  
10 all over the world have been working on. How  
11 many years ago would you have said no way when  
12 somebody said you can drive your car at 35  
13 miles into a wall and walk away? Conservation  
14 of momentum says you are dead, but you can do  
15 it today.

16 The safety systems, the ability to  
17 absorb energy in the structure are the  
18 difference. That vehicle does -- it gets  
19 pushed back. The heavier vehicle doesn't. It  
20 keeps going forward. The lighter vehicle  
21 bounces back a little.

22 The heavier vehicle gets pushed

1 back quite a bit. The G-forces went up. It  
2 is all accounted for. The energy is totally  
3 accounted for. Our objective is to consume  
4 the energy in the structure, in the crush  
5 zone, not in the cab, but it's there.

6 MODERATOR BONANTI: Okay. We can  
7 get your engineering question. Aluminum is  
8 very energy-intensive with a huge influx of  
9 cheap reliable natural gas. Do you expect  
10 aluminum prices to stabilize or remain low?

11 MR. RICHMAN: Well, there are two  
12 elements to that very important question.  
13 Aluminum is 95 percent recycled. I mean,  
14 repeat that because there was maybe some other  
15 image here. Aluminum in automotive is 95  
16 percent recycled. There is no loss of  
17 properties. There is no degradation.

18 Now, primary aluminum is energy-  
19 intensive, but the real energy content and the  
20 products that go into an automobile are 95  
21 percent recycled, which has the same energy  
22 content as other recycled metals and ferrous



1 metals particularly. So at an energy balance,  
2 it's about the same.

3 Now, do I expect the price of  
4 aluminum to change with the price of gas?  
5 It's a commodity. I don't know that they are  
6 related. This is not -- commodities are not  
7 a cost plus business anywhere on earth and not  
8 in this particular -- I didn't see gold come  
9 down when gas prices went down. It's just a  
10 commodity. I am not a speculator. I'm not a  
11 commodity broker.

12 MODERATOR BONANTI: Okay. What is  
13 the effect of the aluminum-intensive vehicle  
14 weight reduction on the collision parameter in  
15 delta v? Yes, partner. Sorry, collision  
16 partner in delta v?

17 MR. RICHMAN: Well, this is the  
18 lightweight vehicle, 20 percent mass reduction  
19 was quite a bit of mass reduction. This is a  
20 full weight vehicle hitting a lightweight  
21 vehicle or a lightweight vehicle hitting a  
22 head-on collision.

1                   So there is a collision partner  
2                   issue, but again, these are not -- this  
3                   aluminum -- the lightweight structure was not  
4                   fully engineered to absorb the energy. This  
5                   told us it has to be. The take-away from this  
6                   is it has to be. And we haven't got that  
7                   model, but I believe we, as engineers, will  
8                   figure out how to manage that energy very  
9                   efficiently.

10                   The folks at Honda will know how  
11                   to do it. I won't know how to do it. The  
12                   folks at GM, the folks at Daimler, they will  
13                   know how to do it eventually. Maybe right  
14                   now. So we don't know the answer in a truly  
15                   engineered lightweight vehicle.

16                   What we do know is that aluminum-  
17                   intensive vehicles that are in the marketplace  
18                   today, there is three of them and we all heard  
19                   about them, every one of them has a higher  
20                   safety rating than the vehicle it replaced.  
21                   Every single one of them.

22                   Every time somebody has actually

1       gone to production with aluminum-intensive  
2       total vehicle concept, it has had higher  
3       safety ratings than the heavier vehicle it  
4       replaced.

5                   MODERATOR BONANTI:   Okay.   Well,  
6       thank you, Doug.   That's all the time we have  
7       for today, outside of this afternoon's panel.

8                   (Applause)

9                   MODERATOR BONANTI:   If you could  
10       bear with us for a second, we are going to be  
11       trying to get Jackie Rehkopf on the telephone.  
12       She is going to be giving a presentation via  
13       telephone, because she is currently  
14       predisposed and in the hospital.

15                   So but she still wants to give her  
16       presentation, so bear with us a few minutes.

17       Okay.   Jackie?

18                   MS. REHKOPF:   Yes, can you hear  
19       me?

20                   MODERATOR BONANTI:   Yes, we can  
21       hear you, Jackie.

22                   MS. REHKOPF:   It's working very

1 well.

2 MODERATOR BONANTI: Great.

3 Jackie, if you have the opportunity, please,  
4 speak a little louder, so everyone can hear  
5 you. Thank you.

6 MS. REHKOPF: Okay. Is that loud  
7 enough now?

8 MODERATOR BONANTI: Yes.

9 MS. REHKOPF: Okay. First of all,  
10 I want to apologize for not being able to be  
11 there in person, but I do want to thank, you  
12 know, Chris and Lixin, for working out the  
13 technical aspects to allow me to present  
14 remotely.

15 So, you know, if I'm not speaking  
16 loud enough, somebody just yell out and I'll  
17 try to up my volume a little bit and with that  
18 I'll just start.

19 And I would like to sort of spend  
20 a bit of time talking about the feasibility  
21 and likelihood of carbon fiber composites  
22 entering mainstream automotive. I'll give you

1 a little outline introducing Plasan Carbon  
2 Composites because I don't expect everybody is  
3 familiar with us.

4 I'll outline some opportunities  
5 for carbon fiber reinforced plastic in  
6 mainstream automotive and our viewpoint of  
7 what requirements there are to have efficient  
8 production of carbon fiber composites for the  
9 auto industry specifically.

10 We will also talk about the  
11 evolution going from the NHTSA use of carbon  
12 fiber composites into mainstream developed  
13 through advances in our technology and our  
14 business development.

15 Plasan Carbon Composites is one of  
16 several companies owned by Plasan Sasa which  
17 is based in Israel. It is a well-renowned  
18 military company that does work in armor  
19 protection, both for military vehicles and  
20 personal protection.

21 And we are a company that only  
22 does carbon fiber composites and with only for

1 the automotive industry, not for the other  
2 military or marine industries. We have got  
3 the partner companies that are doing that.

4 We do leverage the research and  
5 development capabilities across the companies,  
6 so expertise say in the high rate performance  
7 of composites in ballistics we can translate  
8 some of that knowledge and expertise into  
9 automotive crash performance.

10 Okay. Plasan Carbon Composites  
11 has two Michigan facilities. We have a  
12 customer development center in Wixom. It is  
13 24,000 square feet with half of it being  
14 manufacturing space that allows us to have a  
15 scale-up facility for new technologies.

16 So the equipment we have on-site  
17 there is exactly the same as what we had at  
18 our manufacturing plants, so it is production  
19 representative. Our customers can come on-  
20 site and see first runs or prototype parts  
21 being developed very hands-on.

22 We have our new manufacturing

1 facility in Walker, Michigan, which is almost  
2 200,000 square feet and it was developed with  
3 some very nice incentives from the Michigan  
4 Economic Development Corporation. The parent  
5 company invested over \$20 million in capital  
6 investments and last year and going into the  
7 next year, we will create over 200 new jobs in  
8 the community.

9 This facility is geared strictly  
10 to mid- and high-volume production for the  
11 automotive industry. It incorporates our new  
12 manufacturing methods and the processing  
13 breakthroughs that Plasan has developed.

14 Those breakthroughs are currently,  
15 today, supporting 30,000 to 50,000 vehicles  
16 per year and the future development that we  
17 have got underway are targeted to reach that  
18 100,000 units per year. So we think it is  
19 very amenable to what the automotive OEMs are  
20 in need of and so we are on target to meet  
21 their needs.

22 Most of us, if you do know us, are

1 probably familiar with us in more of a niche  
2 market. We were the provider of the hood,  
3 fender, roof, roof bow covers, rockers and  
4 splitters on the specialty models of the  
5 Corvette ZR1 and ZR6. And we are also  
6 providing the hood/fender assembly, the roof  
7 assembly and lift gate assembly of the 2013  
8 FRT Viper.

9           The carbon fiber components  
10 reduced the car weight by 100 pounds from the  
11 previous model and 44 percent of the exterior  
12 components are in carbon fiber composites.

13           We see great opportunities for  
14 carbon fibers to be used in mid-volume  
15 vehicles to help with light-weighting goals  
16 that the North American fleet is on target to  
17 achieve. We have kind of stayed at the main  
18 drivers for the evolution going on in the  
19 automotive industry are led both by Government  
20 and the consumer.

21           We have got those CAFE Regulations  
22 that we all know about and also the Energy



1 Independence Initiatives. The consumers are  
2 also concerned about the high gasoline prices  
3 and environmental concerns.

4 Carbon fiber addresses only one of  
5 the main vehicle aspects that will be to  
6 improve fuel economy and better environmental  
7 emissions. We are basically focused on the  
8 mass reduction. We are not involved in better  
9 propulsion systems or aerodynamics, unless it  
10 is through styling. But carbon fiber does  
11 offer great opportunities for mass reduction.

12 Okay. It's common knowledge  
13 amongst everybody in the audience, you know,  
14 the lower density, the high specific strengths  
15 to weight ratio that carbon fiber has compared  
16 to the other light-weighting technologies.

17 It offers excellent corrosion  
18 resistance as well as good thermal and  
19 moisture stability, good NVH characteristics,  
20 not always improved, but often times improved,  
21 great design flexibility, part consolidation,  
22 fairly shortly times because of different

1 capital investment that is required and fairly  
2 low capital costs compared to some of the  
3 other technologies.

4 The consumers also benefit,  
5 however, for example, the vehicle that has a  
6 roof replaced from a metal to a carbon fiber  
7 roof will experience usually improved  
8 structural rigidity and that will be felt by  
9 the consumer in terms of improved vehicle  
10 dynamics and handling.

11 Having a lighter weight on certain  
12 components such as the roof or the hood will  
13 also lower that center of gravity improving  
14 the vehicle dynamics and improving that power  
15 to weight ratio.

16 We are looking at the market  
17 segment where we see a need for significant  
18 weight reduction, both in the hybrid vehicles  
19 and the crossover vehicles. The hybrids,  
20 obviously, because of the battery pack and the  
21 then the crossover vehicles because of a  
22 larger vehicle size, but we do see those as

1 very strong opportunities for us to enter  
2 mainstream automotive.

3 Okay. Just a little history on  
4 how carbon fiber composites entered into  
5 automotive. It was obviously an offshoot from  
6 aerospace using the autoclave process. And  
7 the autoclave process does have some very good  
8 attributes, one of them being it produces very  
9 high quality parts, very good structural  
10 integrity.

11 Limitations, however, are that it  
12 has a very slow cure cycle. It is very  
13 thermally inefficient, very energy-intensive.  
14 It requires a nitrogen atmosphere to do your  
15 curing. It is very labor-intensive and only  
16 supports low-volume, so it's not at all  
17 amenable to the automotive industry for  
18 mainstream.

19 Plasan views a few key  
20 requirements to efficiently get carbon fiber  
21 composites into mainstream and that is,  
22 basically, a target around 50,000 units or

1 greater per year. We look at cost in terms of  
2 a system cost and I'll touch on that a little  
3 bit more later, but, basically, we have a rule  
4 of thumb that, you know, it shouldn't be more  
5 than 3 to 4 times the cost of a lightweight  
6 metal. And then the other cost factors like  
7 capital investment can come into play.

8 Obviously, the high surface  
9 quality, high structural integrity, low void  
10 content are very key to entering mainstream  
11 automotive. You have got to have that  
12 repeatability and reliability in the integrity  
13 of your material system.

14 And you also need to be able to  
15 readily fasten the composites to other  
16 components on the vehicle. And that's a huge  
17 issue for the industry in terms of joining  
18 dissimilar materials. Okay.

19 Just taking a step back at what we  
20 view as a good market segment, it's that mid-  
21 volume range where you are looking at  
22 somewhere between 50,000 to 100,000 units per

1 year. And I just highlighted some of the  
2 brands that are out there in that target  
3 range. You have got the Chevy Camaro, Ford  
4 Taurus, Dodge Journey, the Mazda 6. It is  
5 quite a large segment and that's the market  
6 that we are after.

7 We are not trying to hit in the  
8 first step that 200,000 vehicles per year  
9 class. We think there is lots of  
10 opportunities to start cascading carbon fiber  
11 components into the 30, 50, 75,000 units per  
12 year and there are quite a few nameplates that  
13 are in that range, as you can see from this  
14 chart.

15 So for the target such as volume,  
16 Plasan developed a new technology. We call it  
17 a pressure press technology, which  
18 unfortunately is a bit of a misnomer. It is  
19 not run under high-pressure. It is only 150  
20 psi and it's not a press. So we apologize for  
21 the name, but that's kind of what stuck with  
22 us.

1                   What we have done with the  
2                   technology is reduced the cycle time about 75  
3                   percent from the conventional autoclave  
4                   technology. The pressure press technology is  
5                   amenable to both Class A, which is Plasan's  
6                   forte, as well as structural parts.

7                   It has got the capability of being  
8                   a one-coat-primed quality surface. It can hit  
9                   production volumes right now of 30,000 per  
10                  year. It will reach 100,000 per year with  
11                  multiple tool sets and some other advancements  
12                  in the entire production cycle, which I'll  
13                  touch on.

14                 And we are doing further  
15                 development, obviously, to continue to reduce  
16                 that cycle time, but right now as it stands in  
17                 the technology that we are launching this  
18                 year, we have a faster cycle and an improved  
19                 circuit quality.

20                 As it stands today, our cycle time  
21                 is below 20 minutes and it is a balanced  
22                 cycle, meaning that there is no step within

1 our entire part production cycle that is  
2 greater than 20 minutes.

3 It doesn't look too different from  
4 a convention autoclave cycle where you start  
5 with a kit cut stage. Plasan is currently  
6 working with prepreg carbon fiber, so our  
7 parts are, you know, a stack-up of a  
8 particular laminate structure.

9 So we start with a kit cut. We do  
10 our layup. Instead of going into an  
11 autoclave, we go into our pressure press and  
12 then it goes through trim and finishing  
13 operations. And we keep all of those steps  
14 balanced so that it just is a continuous flow  
15 and no step is greater than 20 minutes.

16 So any time we reduce one of those  
17 steps, say we want to improve the technology  
18 on the resin chemistry to reduce the cycle  
19 time in the press, we would also reduce the  
20 time in any of the other stations.

21 For the mid- to high-volume  
22 automotive applications, we have taken the

1 same material system that we used in the  
2 autoclave parts. So on the high-end Corvettes  
3 and we have taken that material system,  
4 process it under a pressure press technology,  
5 which is less than 20 minutes per cycle and we  
6 have the same end mechanical and physical  
7 properties of the material system.

8 This was a great strategy that  
9 Plasan developed in order to get the material  
10 system qualified, based on just a simple  
11 change in the processing side of it and not  
12 also a change in the material system. We will  
13 continue to make advances in the overall cycle  
14 by improving the material system, the resin  
15 chemistry and things like that and that would  
16 require a different qualification, but we took  
17 the first step at only, you know, changing the  
18 process and not the material at the same time.

19 The economies that we have from  
20 our pressure press technology are pretty  
21 great, we think. In terms of energy, we are  
22 using about half the energy that the autoclave



1 process would use. Our parts are made using  
2 a single-sided tool, so we have got  
3 consumables for the vacuum side and we have  
4 reduced the consumables down to a third of  
5 what were used on the autoclave.

6 In terms of labor, we are running  
7 at about two-thirds of the labor costs for the  
8 autoclave technology. And when it comes to  
9 tool transfer and part teardown, we have got  
10 huge savings. Our tool transfer time is about  
11 10 percent of what it was for the autoclave  
12 technology and our part teardown is about a  
13 quarter of what it was for the conventional  
14 autoclave.

15 So from a business perspective, we  
16 have got great economies to go to the OEMs  
17 with this technology and say it is very  
18 amenable to the mid- to high-volume vehicles.

19 We link our technology development  
20 very closely with business development, so we  
21 have got, you know, our near-term technology  
22 and business developments. We have got our

1 long-term and our medium-term where we are  
2 looking at different things from either the  
3 current pressure press cycle or RTM for our  
4 structural components, that's an area that  
5 Plasan is getting into for both thermal sets  
6 and thermoplastics.

7 In the medium-term looking at  
8 cutting down the cycle time of our pressure  
9 press down to seven minutes, and that would be  
10 through new resin chemistry, also looking at  
11 thermoplastic two minute cycles, which is then  
12 targeting closer to the 100,000 vehicle per  
13 year and also the structural and semi-  
14 structural components that are needed for the  
15 body-in-white applications.

16 In the long-term, we have got  
17 business and technology paths to be looking at  
18 alternative-based carbon fibers, besides the  
19 pan-based, so we are looking at the lower cost  
20 carbon fibers that there is a lot of activity  
21 on with the National Labs and other companies  
22 and also looking at different resin chemistry,

1       epoxies, urethanes, thermoplastics, that type  
2       of thing.

3                   But we don't do any technology  
4       development without its partnered business  
5       development in step with it. In order to  
6       reach sort of the higher volume, the 100,000  
7       and above vehicle per year, the technology  
8       developments that we will have to achieve are  
9       advances in the mold tooling to reduce the  
10      cycle time.

11                   With our current pressure press  
12      process, we use a highly engineered tool. It  
13      has got a nickel shell surface to improve the  
14      heat transfer right from the tool to the  
15      composite and it is also plumbed on the back  
16      side to have a heat transfer fluid that is  
17      used for both for heating and cooling that  
18      tool, so you get very quick heat transfer into  
19      the composites.

20                   But in order to get up to the  
21      100,000, we would have to improve some of the  
22      materials that are used for the plumbing and

1 for that heat transfer. We are looking at  
2 laser placement and we are already currently  
3 using that on one of our programs and that  
4 helps us to control the localized thickness  
5 variation, so you have an optimized layup, but  
6 you are also having very repeatable well-  
7 documented control of that particular layup.

8 Water jet trimming will be needed  
9 to trim the parts to have a balanced process  
10 flow. Our current programs that we have with  
11 the Corvette and the Viper don't warrant water  
12 jet trimming yet, but the next step up in  
13 terms of volume will require some automated  
14 trimming.

15 Likewise, we will need automated  
16 tape lay once we get to a slightly higher  
17 program volume. The advanced resin  
18 development is needed for a faster cure time.  
19 And automated etching for the paint  
20 preparation, which will greatly speed up that  
21 final finishing touch.

22 And then getting into the

1 structural side of things with the RTM molding  
2 and the preforming, there is a lot of work to  
3 do with partner companies on developing  
4 quicker preforms and very high-cycle RTM  
5 molding operations.

6 On the business side, we are very  
7 focused on just-in-time material supply. We  
8 are trying to reduce that time and the  
9 distance from the source of our carbon fiber,  
10 either preform or prepreg, from that source to  
11 our manufacturing locations.

12 We are also wanting to minimize  
13 the supply risk, so we do work with multiple  
14 material suppliers and qualify multiple  
15 sources, but not too many, because with the  
16 advances that are going on with carbon fiber  
17 these days, there is a phenomenal movement  
18 going on right now. I'm very excited to be  
19 part of it, but you can't be latched on to  
20 every development that is underway.

21 So we pick and choose, you know, a  
22 few strategic partners and we work with them

1 and qualify those material sources, so that we  
2 minimize the risk to our customers.

3 Plasan is also going to continue  
4 leading the qualification advancement that our  
5 technology has developed. We have been  
6 leading the qualification process already with  
7 our customers and we will continue to do that.

8 Our view is that as the carbon  
9 fiber fabricator and provider of these  
10 components, we should have the best knowledge  
11 about their performance and their reliability  
12 and their quality. So we will continue to  
13 lead the qualification on those.

14 And, obviously, to meet our  
15 customers' demands, we will be expanding our  
16 manufacturing processes into RTM and other  
17 things as well as expanding our material  
18 portfolios. This is not a one-size-fits-all  
19 for any family of materials, you know, whether  
20 it is aluminum, advanced high strength steel,  
21 magnesium, carbon fiber, and even within any  
22 one of those lightweight options, such as

1 carbon fiber, there is not a one-size-fits-  
2 all. So we need to have a portfolio to offer  
3 our customers, so they can pick the best  
4 system for their particular application.

5 And then another point to touch on  
6 a little bit in depth is the design and  
7 analysis tools for composites, for carbon  
8 fiber specifically. We are working heavily on  
9 that independently as well as with some other  
10 companies to improve the design analysis  
11 capabilities for carbon fiber, so that we can  
12 work with our OEMs and have proper design.

13 Cascading our technology from the  
14 niche to the mainstream is what we are doing  
15 currently. We have taken some of the  
16 technology from the Viper hood assembly. The  
17 Viper hood is basically a hood/fender  
18 combination, a single piece very large complex  
19 clamshell geometry and to our knowledge it's  
20 the largest single piece, carbon fiber  
21 composite that -- on a vehicle that is sold by  
22 a mainstream OEM.

1                   So we had a lot of technology  
2                   development in order to manufacture a part  
3                   that size. We also developed a textured  
4                   surface on the B side of the outer panel, we  
5                   thought, exposed with inner panels, integrated  
6                   mounting points and it meets all the  
7                   structural requirements through some local  
8                   section thicknesses and layup changes.

9                   On the roof assembly of the Viper,  
10                  the roof assembly is a key structural  
11                  component of that vehicle. It does meet roof  
12                  crush, so there are some very local layup  
13                  thicknesses and orientations that are, you  
14                  know, tuned specifically to meet various  
15                  requirements of that part, structurally and  
16                  otherwise.

17                  And our CAE tools were very useful  
18                  in permitting us to develop the kits and work  
19                  instructions before the tools actually  
20                  arrived. And using our CAD-driven laser  
21                  placement system ensures very accurate layups.  
22                  That is shown on the picture on the right hand



1 side where the laser sort of outlines the  
2 piece of the kit that needs to be placed in  
3 that particular location and it guides the  
4 operator through to making sure that the right  
5 piece is put in the right place in the right  
6 sequence.

7 So our strategy is to engage and  
8 collaborate with our OEMs very early in the  
9 design stage, that way you can have a hope of  
10 combining several of the advantages of carbon  
11 fiber not just its reduced mass and increased  
12 stiffness or strength, but also part  
13 consolidation, design flexibility. In some  
14 cases, some safety improvements.

15 We have found the pedestrian  
16 impact can really benefit from a carbon fiber  
17 composite design. And at times, there is an  
18 improvement in NVH. There is always  
19 definitely a change in NVH performance, so it  
20 needs to be assessed whether it is an  
21 improvement or a detriment.

22 We also look at the cost from a

1 comprehensive systems model with the OEMs  
2 looking at the cost all the way through the  
3 development, manufacturing and lifecycle, so  
4 they get a very bird's-eye view of the true  
5 cost to them as a business.

6           And what I mean from a systems'  
7 viewpoint, we kind of look at everything in  
8 terms of, you know, reduced warranty costs  
9 that could be potentially realized through the  
10 use of a carbon fiber composite, reduced  
11 supply chain costs, part consolidation, map  
12 and talk consolidation, the reduced capital  
13 costs.

14           Typically the capital investment  
15 for carbon fiber composites is much less than  
16 the competing lightweight materials, so that  
17 can be factored in.

18           We also like to factor in some of  
19 the value adds and -- to put a number, like a  
20 monetary value to that depends on the OEM's  
21 perspective. But there are particular  
22 attributes that carbon fiber can bring in

1 terms of either permitting the OEM to add  
2 additional content that they couldn't have  
3 unless the part was made out of carbon fiber  
4 and reduced the weight by a certain amount or  
5 there might be other parts that the consumer  
6 might find great delight in having  
7 lightweight, such as the sliding door on a van  
8 or a lighter-weight lift gate or hood on a  
9 vehicle.

10 There might be a true benefit that  
11 the OEM can realize when the customer sees  
12 that they really like that particular  
13 component being made so light.

14 MODERATOR BONANTI: Jackie, this  
15 is Chris Bonanti. I just wanted to make you  
16 aware that your -- actually, you are over  
17 time, but I wanted to ask how much further you  
18 have? I know it's a situation where you are  
19 not here, so I couldn't give you a sign.

20 MS. REHKOPF: That's all right. I  
21 can just speed up. Would you like me to  
22 finish in like five minutes, three minutes?

1                   MODERATOR BONANTI: Okay. That  
2 would be fine. Thank you.

3                   MS. REHKOPF: Okay. All right.  
4 In terms of the tooling costs for carbon fiber  
5 composites there is really a sweet spot that  
6 is somewhere around that mid-volume range,  
7 50,000 or so, so that's sort of another reason  
8 why we are targeting that market segment.

9                   Another thing that we point out  
10 with our OEMs is the final finished assembly  
11 cost. And over the last four to five years,  
12 Plasan has been able to reduce the cost per  
13 pound of a bonded finished prepreg assembly by  
14 40 percent. So that's quite a significant  
15 change in cost that the industry can benefit  
16 from.

17                   I'll go real quick through the  
18 composite design and analysis tools, which we,  
19 obviously, use all the way through the  
20 business from R&D to quoting, prototyping,  
21 prepreg and manufacturing.

22                   We use it for the materials'

1 models database as a sandbox for new design  
2 technique, so that we can test new layups and  
3 sort of ply design techniques without actually  
4 using the material or using tools or operators  
5 and we can take a look at our roll width and  
6 ply counts, cycle times, production volumes,  
7 etcetera, all virtually.

8 Obviously it is used for creating  
9 a virtual analysis of our ply structures, so  
10 we have to build fewer physical prototypes.  
11 We can get quick design feedback to our  
12 customers in terms of design constraints and  
13 limitations. Every material system has its  
14 own manufacturing constraint.

15 We can communicate that very  
16 effectively with the CAE tools and we can also  
17 demonstrate joint construction nominal  
18 thicknesses by giving them cross-sections to  
19 show what the laminate would actually look  
20 like.

21 It allows us to do quick and  
22 reliable kit design much faster than without

1 the software tools and cost estimation is a  
2 huge benefit. We can get, you know, a  
3 directional cost turned around in about four  
4 hours for the OEM to decide whether it is  
5 worth pursuing for their particular program  
6 that they are interested in.

7 Improved quality control are  
8 achieved with this software, as well as grid  
9 exchange with the operators on the shop floor  
10 in terms of operations that might be  
11 repeatable that we can design right into the  
12 kit themselves so that the operators aren't  
13 having to do a specific task.

14 And I'm just going to touch a  
15 little bit on some of the challenges for  
16 getting carbon fiber composites into  
17 mainstream automotive. Obviously, cost is a  
18 factor that needs to be addressed. The cycle  
19 time, how it's assembled to the rest of the  
20 vehicle.

21 But another big one that I know  
22 others have talked about with the

1       lightweighting vehicle studies is predicting  
2       the behavior of this material in crash. And  
3       Plasan is fortunate to be a principle  
4       investigator in a DOE program looking at the  
5       capability of current software models to  
6       predict the performance of carbon fiber in  
7       automotive crash.

8                   And a big part of that project  
9       will also be characterizing the behavior, so  
10      you have the input for the material model.

11                   We also look at composite  
12      processing. The process itself dictates what  
13      kind of properties you are going to get in the  
14      end part, that is addressed through analytical  
15      tools.

16                   And then this summarizes all into  
17      our current forte into a base model vehicle,  
18      the 2014 Corvette Stingray. Using our new  
19      technology, using the same prepreg as we had  
20      previously on a higher end Corvette, where we  
21      have got the hood and the roof in painted or  
22      exposed weave, and it's the first entry into

1 a baseline vehicle, so we see that there is a  
2 huge future for carbon fiber composites in  
3 mainstream automotive.

4 And you know, it's just a matter  
5 of deciding with your OEM or our customer, you  
6 know, what is the best material system to meet  
7 their particular needs?

8 And with that, I'll take any  
9 questions if there is time for those.

10 (Applause)

11 MODERATOR BONANTI: Thank you,  
12 Jackie. We are going to be collecting any  
13 questions that we do have here. I know there  
14 are a few. Also, I wanted to ask you if you  
15 will still be available for the panel  
16 discussion in about 30 minutes or so?

17 MS. REHKOPF: I can be if you  
18 think it is beneficial. I'm not sure how well  
19 this works with me being not able to see the  
20 audience.

21 MODERATOR BONANTI: Okay. Well,  
22 that's totally up to you. I'll understand



1 either way.

2 Okay. The first question, you  
3 said you are all about mass production.  
4 Others have claimed that CFRP can greatly  
5 improve crashworthiness. Do you disagree or  
6 are you focused entirely on non-structural  
7 components?

8 MS. REHKOPF: I do not disagree.  
9 I think carbon fibers can improve crash  
10 performance, but it is an area that needs  
11 particular work. And as my -- the previous  
12 speaker mentioned, it is all about the design.  
13 You would definitely design a part differently  
14 for carbon fiber than any other material  
15 system.

16 So it's about designing it to  
17 manage that crash energy appropriately.

18 MODERATOR BONANTI: Okay. Is it  
19 true that carbon fiber components is brittle  
20 and shatters into shards flying wide during a  
21 crash?

22 MS. REHKOPF: Well, I guess

1 anybody who has seen Formula One racing knows  
2 what happens in a crash. There are many  
3 different architectures of carbon fiber  
4 composites the way the fiber and the matrix  
5 are combined, so you can control that type of  
6 deformation, whether it is going to break off  
7 into shards or whether it is going to be  
8 retained somehow.

9 So that's again something that  
10 needs to be designed for and the material  
11 system needs to be developed to get the  
12 performance that you want. Obviously, carbon  
13 fiber, yes, it doesn't have much elasticity in  
14 itself, but there is ways to use the  
15 architecture to get a bit of that flexibility  
16 that you need in a crash.

17 MODERATOR BONANTI: Okay. What is  
18 the cost index for carbon fiber? What is the  
19 cost index for carbon fiber hoods compared to  
20 steel or aluminum, if aluminum or steel are at  
21 a 100 index?

22 MS. REHKOPF: That's a tough one.

1 Just to generalize, we are definitely more  
2 expensive, at this point, and part of that is  
3 because we are not at those mid-volume  
4 production levels. You know, we are just  
5 entering that 30,000 per year phase and we are  
6 also currently limited by, basically, having  
7 a bolt-on component that is replacing the  
8 aluminum or advanced strength steel.

9 So until we start designing  
10 specifically for carbon fiber, the cost index  
11 is always going to be higher than an aluminum.

12 MODERATOR BONANTI: Okay. Is  
13 recyclability a potential aspect associated  
14 with carbon fiber?

15 MS. REHKOPF: There is and we are  
16 working with a few firms on reclaiming carbon  
17 fiber and reusing it both from the end of life  
18 use as well as manufacturing scrap. It's not  
19 -- I couldn't say it's, you know, as  
20 recyclable as aluminum is, at this point, but  
21 there is definitely a means to reuse the  
22 material.

1                   MODERATOR BONANTI:   Okay.   And  
2                   last question unless there are others, but  
3                   what is the fidelity of the software to actual  
4                   performance, 10 percent, 15 percent?   Which is  
5                   it?

6                   MS. REHKOPF:   That's an excellent  
7                   question and I think that's why the DOE put  
8                   out the FOA for us to analyze the capabilities  
9                   of existing software tools, so USCAR is  
10                  working on that project as well with Plasan  
11                  and its partner companies.   We are going to  
12                  determine in the next three to four years what  
13                  that fidelity is.

14                  MODERATOR BONANTI:   Okay.   Thank  
15                  you, Jackie.   You can stick around on the  
16                  telephone if you would like or sign-off, it's  
17                  up to you.   But I wanted to thank you for  
18                  participating either way.

19                  MS. REHKOPF:   Thank you for having  
20                  me.

21                  MODERATOR BONANTI:   Okay.

22                  (Applause)

1                   MODERATOR BONANTI:   Okay.   Next up  
2                   we have Stephen Ridella, that's what I was  
3                   told.   Stephen, Stephen.   He is going to be  
4                   talking about the fleet safety evaluation  
5                   methodology application to lightweight vehicle  
6                   design here at NHTSA.   Thank you.

7                   MR. RIDELLA:   Thanks.   Wow, you  
8                   stayed long.   Appreciate it.   My office is  
9                   responsible for developing test procedures and  
10                  methodologies to assess vehicle structure  
11                  restraint systems to improve crashworthiness  
12                  and occupant protection.   We do this through  
13                  a variety of methodologies and research  
14                  projects.

15                  Currently, we have some projects  
16                  going on: dynamic rollover, as you know, and  
17                  oblique impact, those are still ongoing among  
18                  many other projects.

19                  We also do research in our  
20                  biomechanics groups, both here and in the VRTC  
21                  in Ohio to assess occupant protection and, you  
22                  know, human tolerance to impact, developing

1 crash test dummies, evaluating current dummies  
2 and maybe even future dummies under the  
3 associated injury criteria. So this project  
4 really brings together those two kind of  
5 divisions into, I think, a really elegant  
6 study.

7 I'm glad Jim mentioned earlier  
8 this morning where we are at in the timeline  
9 on CAFE. This study really does support, you  
10 know, our rulemaking decisions that we are  
11 going to make and then the evaluation we have  
12 to do for the midterm that he mentioned  
13 earlier.

14 So we are in that kind of early  
15 phase, that bubble I think you show between  
16 2013 and 2016. Two years ago, at this  
17 symposium, Steve Summers, my Division Chief of  
18 Structural Restraints, really outlined some of  
19 the programs that you have heard about this  
20 morning.

21 And the program that he had  
22 mentioned that I'm going to give you some

1 results today for the first time really came  
2 together from -- after that presentation 2011.

3 And we awarded the project to  
4 George Washington University, but it has  
5 really been a project between the GU folks,  
6 GWU folks or folks at NHTSA, both in  
7 rulemaking and the research and also some  
8 outside consultants that we will acknowledge  
9 later.

10 So really a great study to bring a  
11 lot of expertise together in evaluating how we  
12 can bring these vehicles together, but not in  
13 a test environment, just in a pure simulation  
14 environment, at this point, because it's just  
15 we don't have these vehicles to test right  
16 now, that many of them. So we're going to be  
17 doing most of this evaluation in the virtual  
18 space.

19 The agenda today, I just want to  
20 review the goals of the study, the field crash  
21 assessment that was done by GW to look at the  
22 sort of crash modes that we want to

1 investigate, the simulation approach that they  
2 took, injury assessment that was used, how we  
3 brought all that together and some of the  
4 model results into what we call a societal  
5 injury risk, an overall synthesis of all the  
6 results that were generated from the study  
7 together into something that we can compare  
8 the lightweight designs versus the baseline  
9 designs and also against the self and partner  
10 protection that we did in the study and then  
11 some conclusions on where we are going after  
12 that.

13 So I'll try to get through this as  
14 soon as we can and get to the panel discussion  
15 and actually get you guys out, because it has  
16 been a long day, but I think a very productive  
17 day.

18 I think Jim actually put up this  
19 slide earlier, but just to review it again, we  
20 did use new and existing vehicle crash models  
21 to evaluate the safety of future lightweighted  
22 vehicles. This involved vehicle-to-vehicle



1 and vehicle-to-structure, fixed-object  
2 crashes.

3 It only focused on belted-  
4 occupants for the study. And we looked at  
5 regulated and also non-regulated, non-standard  
6 crash test conditions with a variety of speeds  
7 from 15 up to 40 miles an hour, which we  
8 thought represented the real-world crash  
9 conditions and risk occurrence that was out  
10 there.

11 Of course, the whole idea was to  
12 assess the interaction of lightweighted  
13 vehicle designs with existing vehicles in the  
14 fleet. This could allow us to look at  
15 countermeasures in the future, such as  
16 restraint systems, airbag deployment timing  
17 and stuff we did a long time ago, but still is  
18 relevant today.

19 And also, looking at adaptive  
20 restraint systems, projects that we have  
21 ongoing right now at NHTSA that we can put  
22 into this program at a later date, once we

1 develop those systems.

2 First, what they did was an  
3 assessment of traffic fatalities. They looked  
4 at data, a variety of data in the FARS and  
5 NASS CDS. They looked at light vehicle  
6 crashes, vehicle-to-vehicle, vehicle-to-  
7 object. We didn't want to look at rollover  
8 for this study, only light passenger vehicles.

9 And if you look at the two pieces  
10 of the pie here, the -- I wish I had a  
11 pointer, the sort of red one, the orange one,  
12 this was the two vehicle crashes, no rollover  
13 and this was a light vehicle, single vehicle  
14 crash into fixed objects, no rollovers also  
15 and it's comprised of about 32 percent of the  
16 fatal crashes that we wanted to analyze.

17 Diving a little bit further, there  
18 is a lot more statistics that were on the  
19 paper, but I'm just going to be giving you  
20 some of the highlights.

21 We only want to look at frontal  
22 crashes in the study and that presented about

1 51 percent of the non-rollover one or two  
2 vehicle crashes in the study. So overall  
3 then, the study evaluated about 16 percent of  
4 the fatals, about 5,500 crashes, fatal  
5 crashes, that were out there.

6 We also looked at speed of the  
7 crash. So this -- instead of just looking at  
8 delta v, which had a little less  
9 representation and mass, we looked at BES for  
10 the barrier equivalent speed. We found that  
11 when we looked at different cumulative risk of  
12 injury versus speed for the passenger cars and  
13 the pick-ups, it was pretty equivalent. The  
14 SUVs went a little bit farther, but we limited  
15 the study only to about 64 KPH, which  
16 represented about a 50 percent chance of a  
17 NAIS 3+ injury.

18 I did take a drink of water the  
19 last two hours. Okay. In the fleet vehicle  
20 models that we used, where existing vehicles  
21 that had been developed actually by GW over  
22 the last several years, we wanted to make sure

1 we represented the fleet. And the smallest  
2 car, like a Yaris, midsize SUV, like an  
3 Explorer, larger car like a Taurus and also  
4 the largest pickup, like the Silverado.

5 So we have used a large fleet  
6 modeling characterization and then compared  
7 the performance of the fleet to the  
8 lightweighted models that we had.

9 Let's talk about those models. We  
10 talked about them earlier. You have heard  
11 about them. We did sort of a sanity check at  
12 the beginning that we call a sanity check, but  
13 sort of a methodology check.

14 We had a baseline Taurus model  
15 that GW had evaluated before and we did some  
16 variations on that, which I'll explain in a  
17 minute. And then earlier today you heard  
18 about both the Venza lightweight- and high-  
19 option and the Accord lightweighting that was  
20 done. These are weights that represent sort  
21 of the test weights that we had in the -- with  
22 the dummies and everything that we would

1 evaluate in a typical test, we put that into  
2 the model and those are what we compared  
3 against.

4           The Taurus model variations had  
5 two variations, one for both lightweighting  
6 where we had the -- we basically just reduced  
7 the density of the steel in the model, kept  
8 the same stiffness. We also had one with the  
9 same weight, increased stiffness by using more  
10 advanced high strength steels.

11           And these are some of the forces  
12 placed and characteristics to show the  
13 differences in the models that were run for  
14 the Taurus model variation.

15           For the Venza, you heard about  
16 this earlier, both the lightweight low-option  
17 and the high-option. And then the Accord  
18 model. We had to lease the baseline model, I  
19 think, from Altara and then we had the  
20 lightweighted model that we used from the  
21 study that was completed by EDAG.

22           So all those were brought together

1 and really a simulation -- this is the  
2 overview of how we actually did the process or  
3 how GW did the process. First, we did a  
4 finding on the fleet simulation. So a single  
5 vehicle, multiple vehicle, I'll get to that in  
6 a second.

7 But the simulation was done in  
8 finite element. The crash pulse was then  
9 extracted from that as well as things like the  
10 intrusions of the occupant compartment and  
11 other interior things that we could get out of  
12 the simulation.

13 This was fed into a MADYMO model  
14 and from the MADYMO model we did both 50th  
15 percentile male dummies and 50th percentile  
16 female dummy modeling, extracted the injury  
17 criteria, light HIC, chest deflection, femur  
18 load outputs, compared those to the risk  
19 curves that we had in NCAP and created a sort  
20 of risk of injury, NAIS 3+ injury, that was  
21 synthesized from all the different model runs  
22 that we ran.

1                   These are the model runs then that  
2 we did. For both on the top side, we ran five  
3 different speeds, fixed-object crashes with  
4 full engagement, partial engagement and center  
5 pole. We used both midsize male and small  
6 female occupants in those crashes.

7                   When we compared the target  
8 vehicles, again this is the lightweighted  
9 vehicles at different crash speeds to the  
10 fleet vehicles that I mentioned earlier. We  
11 did both full engagement and offset and we had  
12 different dummies and different things, so we  
13 had midsize male, midsize female in both the  
14 target as well as the partner vehicle.

15                   Now, you can imagine now we are  
16 creating all these simulations and getting  
17 lots and lots of injury data, so the point was  
18 to summate all the different injury risks from  
19 both speed partner crash-type and occupant and  
20 then weight those according to exposure in the  
21 field to come up with something called a  
22 combined injury risk.

1           So these are the simulations that  
2           were done about a single vehicle crash. We  
3           did about 120 LS simulations, which translates  
4           into about 240 MADYMO runs. With the two  
5           vehicle crashes, we had 320 simulations and  
6           over 1,200 MADYMO runs. So now, we have got  
7           all this injury risk data and we've got to put  
8           it together and come up with something.

9           So let's step back a second and go  
10          back into the MADYMO runs. The MADYMO models  
11          were developed kind of generically. I mean,  
12          we had -- the finite element models don't have  
13          a lot of interior stuff, that's some of the  
14          issues that we had with some of the GW models.  
15          It's very specific to the vehicles and the  
16          manufacturers.

17          But we did -- were able to extract  
18          a lot of good data from what we had and what  
19          we could get in terms of occupant compartment  
20          geometries and restraint systems, airbags that  
21          we could get and put this all together and did  
22          some sanity checks, did some runs to make sure



1 that these did actually look correct and  
2 weren't out there getting strange results. A  
3 lot of work was done.

4 And like I said, we brought in the  
5 things like toe pan intrusion and other  
6 intrusions and then used the acceleration  
7 fields to apply to the occupant and to assess  
8 the injury assessment for all these different  
9 MADYMO runs.

10 Like I said earlier, we used the  
11 NCAP risk functions for the male and small  
12 female dummies. We looked basically at head,  
13 chest and femur risk injuries. This was done  
14 based on some analysis I did in the NASS data  
15 that showed the head, chest and lower  
16 extremities had the highest incidence of  
17 injuries.

18 We did three different combining  
19 measures, head, neck, chest and femur; head,  
20 neck and chest; and then head, neck, chest and  
21 -- and then something called an intrusion  
22 penalty where we looked at the models and we

1 saw some major intrusions that came in. We  
2 kind of said okay, well, that could actually  
3 increase both head and chest injury, so those  
4 were added to the combined injury risk in the  
5 third different method that they used.

6 This kind of summarizes that whole  
7 thing I just talked about. For each impact  
8 speed and vehicle, we did the single vehicle  
9 simulations and the combined injury risk that  
10 I mentioned for head, neck, chest and lower  
11 extremities; head, neck and chest; and then  
12 head, neck and chest with A Pillar intrusion.

13 Then looked at all the different  
14 simulations with the fleet vehicles and all  
15 the combined injury risks from that as well.  
16 Eventually, these were all summated, if you  
17 will. I'm going to get to -- a little bit  
18 into it and one single injury risk that could  
19 be compared across both the target vehicles as  
20 well as the field vehicles.

21 So let's look at some of the data.  
22 It's kind of interesting, actually, I think

1       it's very interesting.

2                   The combined injury risk for the  
3       single vehicle crashes looking at full  
4       engagement, we looked here just at the Honda  
5       Accord. So what you see is some interesting  
6       stuff. This was full engagement, offset the  
7       center pole, like I said, so self-protection  
8       for both the baseline vehicle in the solid  
9       line and the lightweight vehicle in the red  
10      and then the green is the lightweight vehicle  
11      and then 50th percentile is solid, the dashed  
12      line is female.

13                   So in general, what you see right  
14      away is there is increased risk for the  
15      lightweight vehicle at almost all the speeds,  
16      crash speeds and that the female has a higher  
17      injury risk. That's pretty much, you know,  
18      expected. When you give a female the same  
19      restraint system as a male dummy, typically,  
20      you will see higher injury values. That has  
21      been shown many times and also the increased  
22      risk of injury based on increased crash speed.

1                   Interestingly enough, looking at  
2                   the vehicle-to-vehicle models, we looked at  
3                   this evaluation, both crash mode, partner and  
4                   speed and we see the same effects. Higher  
5                   risk for females, higher risk as the speed  
6                   increases. Now, this is across all the  
7                   different vehicles that we modeled.

8                   And then we found that in some  
9                   respects when we had the femur load it was  
10                  dominating the injury risk. So in some cases,  
11                  we took it out and this was just the combined  
12                  injury risk when you take out the femur load.  
13                  So it comes down, obviously.

14                  So what we did with all those  
15                  injury risks was sum them. This is kind of  
16                  doing it very, very fast. In the paper they  
17                  go through very exhaustive treatment of how  
18                  they came up with these final injury risks.

19                  Basically, it is to combine the  
20                  injury risks to get an overall crash risk for  
21                  that vehicle, for society. So looking at the  
22                  target vehicle, we've got that target vehicle

1 risk in both the single vehicle and vehicle-  
2 to-vehicle, combining them for both single  
3 vehicle and vehicle-to-vehicle to get an  
4 overall risk for each vehicle and crash mode.

5 So what you see here is the  
6 vehicles that we had, the Taurus baseline, the  
7 Taurus lightweight, the Accord baseline, the  
8 Accord lightweight, the Venza baseline, the  
9 Venza -- both options.

10 This is looking at single vehicle  
11 risk. And you would compare them and say the  
12 baseline risk for both the male dummy and  
13 female dummy, you can see that the baseline  
14 risk is here, there is increases, slight  
15 increases for the lightweight options that I  
16 mentioned, both in stiffness and in reduced  
17 mass. It pretty much holds true for almost  
18 all the vehicles when you compare these, you  
19 know, individually, if you will.

20 Looking at, in this case, the two  
21 vehicle crashes, we start to see numbers that  
22 are a little bit higher. These approach a 1

1 to 2 percent which is pretty much consistent  
2 with the injury risk that Chuck Kahane showed  
3 earlier in his crash test that he used. I  
4 think he will document again tomorrow.

5 So we feel that these were, you  
6 know, in the right range of risks that are  
7 capable and that are possible compared to  
8 field risk. So what we are seeing in the  
9 simulation is mirroring what we see in the  
10 field. And that was a good sign and good for  
11 us to see that result.

12 This was really the punchline  
13 slide, if you will, looking at all three kinds  
14 of ways. As I said, we combine the injury  
15 risks. This was when you combined for all the  
16 different crash risk -- injury risk modes for  
17 head, chest, neck and femur.

18 Then looking at just head, neck  
19 and chest and then looking at head, neck,  
20 chest with the intrusion penalty comparing  
21 let's say the Taurus baseline, 1.25101101. We  
22 saw increases, slight increases, if you will,

1 but they are on the order of 12 to 20 percent  
2 increase in societal risk and the lightweight  
3 options are the stiffer options.

4 Comparing the Accord is the same  
5 thing, about 10 percent risk compared to  
6 baseline. The Venza about a 5 to 15 percent,  
7 depending on what method you chose for the  
8 societal risk.

9 So again, these are in line with  
10 what we think that Dr. Kahane has shown.  
11 Slight increases, note those are very small  
12 risks on the order of 1 to 2 percent.

13 So a lot of information a short  
14 amount of time. The study is undergoing  
15 review at the Agency. Eventually peer review  
16 and publishing later on this summer. But we  
17 think we really did find a methodology that  
18 evaluated designs for a range of crash  
19 configurations and speeds.

20 These results are sensitive to the  
21 vehicle interior and occupant models as we all  
22 know who run these models. Small changes can

1 make a difference, so we have to be sensitive  
2 to that and understand what we are doing when  
3 we do these models.

4           And then we will probably have to  
5 do some refinement to the models in the  
6 future. We did -- with the Taurus model it  
7 was both mass and stiffness changes and we  
8 found out they do affect occupant injury risk,  
9 in that, you know, the lower speeds really are  
10 important. They do dominate some of this  
11 analysis, because we know that, you know,  
12 historically lower speeds and I'll say in the  
13 10 to 20 mile an hour range really are the  
14 peaks of where we see the highest numbers of  
15 injuries and fatalities.

16           And also this methodology helps us  
17 look at both self- and partner-protection in  
18 two vehicle crashes. We intend to look at  
19 more column and intrusion in the future to see  
20 how that can actually -- instead of just using  
21 a penalty factor, see how it does actually  
22 play a role in injury.



1                   Look at, as I said earlier, more  
2                   advanced occupant restraint systems. We can  
3                   look at other vehicle types. This methodology  
4                   says hey, you know, we have got -- we can do  
5                   it for one vehicle, we should be able to do it  
6                   for a variety of vehicles in both the fleet,  
7                   the lightweight fleet as well as the current  
8                   fleet that is going to be out there in the  
9                   future if these vehicles start to interact  
10                  with each other.

11                  We would like to improve the  
12                  correlation between fleet model and real-  
13                  world. It is there, but it can be even  
14                  better.

15                  Finally, I just think this study  
16                  really did show us how we can combine all this  
17                  information together and come up with an idea  
18                  and a methodology to assess the lightweight  
19                  vehicle fleet interactions you are going to  
20                  have with the fleet in the future.

21                  So with that, like I said, the  
22                  study will be available some time this summer.

1 We would appreciate your feedback and comments  
2 on it and I'll take any questions now. Thank  
3 you.

4 (Applause)

5 MODERATOR BONANTI: Thank you,  
6 Steve.

7 MR. RIDELLA: Before I -- I do  
8 want to acknowledge everybody that worked on  
9 the study at GW. They are all most of them  
10 here in the audience. We want to thank you so  
11 much for your work on this and our people at  
12 NHTSA as well. It has been a very  
13 collaborative study.

14 MODERATOR BONANTI: I totally  
15 agree. Okay. So questions? Let's see, Jamie  
16 is bringing some.

17 MR. RIDELLA: If I can't answer  
18 them, there are plenty of people here who can.

19 MODERATOR BONANTI: Okay. The  
20 first question, Steve. Can you describe what  
21 factors in a crash between two lightweight  
22 vehicles is increasing a risk? What happens

1 differently?

2 MR. RIDELLA: Two lightweight  
3 vehicles? Okay.

4 MODERATOR BONANTI: Yes, but  
5 that's not what the question says.

6 MR. RIDELLA: One more time?

7 MODERATOR BONANTI: Yes, two  
8 lightweighted vehicles increasing the risk.

9 MR. RIDELLA: Do we have that  
10 data, Steve, the lightweight-to-lightweight?  
11 We did run those in this simulation. Exactly.  
12 So at this point, we are only looking at the  
13 two. We didn't run the lightweight-to-  
14 lightweight, at this point.

15 We probably will in the future,  
16 but we want to see what would affect more on  
17 the current fleet evaluation as these enter  
18 the fleet, how they interact with the other  
19 vehicles. I think we will get to that  
20 eventually.

21 MODERATOR BONANTI: It's going to  
22 take a while for the original fleet to turn

1 over, so it's definitely something we need to  
2 look at from when it comes to a safety basis.

3 MR. RIDELLA: I mean, they will  
4 eventually start to interact. Right away?  
5 Maybe not.

6 MODERATOR BONANTI: Okay. Next  
7 question. Is 20 percent of 1 percent  
8 significant?

9 MR. RIDELLA: Well, I think you  
10 have to look at the numbers. Clearly, you  
11 know, we look at small numbers, but we deal  
12 with these kinds of numbers. I mean, you  
13 know, your risk of injury in any given crash  
14 is very low. It's only the 1 to 3 percent  
15 range anyway. So these seem to be in line  
16 with that.

17 And differences like that can make  
18 -- you know, are showing us something, that  
19 there is an effect there, yes.

20 MODERATOR BONANTI: The follow-up  
21 to that is, is it acceptable with regard to  
22 safety?

1 MR. RIDELLA: I think that's your  
2 job, isn't it? I'm just a research guy.

3 MODERATOR BONANTI: You are the  
4 one answering the questions. I'm just asking  
5 them. Yes, you are correct. Okay. Next  
6 question. Kahane's study is 1.5 percent  
7 increase in fatality risk for every 100 pound  
8 mass reduction. Is your study using the same  
9 measure in terms of mass reduction?

10 MR. RIDELLA: Not really. I mean,  
11 it is similar showing that the lighter mass  
12 vehicles will have an increase in injury risk,  
13 but it's not using quite the same methodology  
14 in terms of looking at it from a perspective  
15 of, "for every 100 pounds, you have this  
16 increase." And we are also looking at injury,  
17 not fatalities.

18 MODERATOR BONANTI: Okay. Is the  
19 societal injury risk parameter a new statistic  
20 or a parameter created for this study, or is  
21 it a standard metric commonly or previously  
22 used by NHTSA?

1                   MR. RIDELLA: Those are comments  
2 that we are looking for. Clearly, for this  
3 study, it was something that we had to make up  
4 to synthesize all the different variety of  
5 results that we were getting.

6                   So it is fairly new. In fact, it  
7 is very new for this, and I think that it came  
8 across very well in giving us an idea of how  
9 to combine all that data we are getting from  
10 the simulations into kind of like one measure,  
11 if you will, for that vehicle.

12                   So I think it was an effective  
13 way. And we will take feedback on it. I  
14 think this will be good to see what kinds of  
15 feedback you have and if there is other  
16 measures that we should be using in the  
17 future.

18                   MODERATOR BONANTI: Okay. I think  
19 this is the last question, unless there is any  
20 others.

21                   The stiffer but same weight Taurus  
22 seemed to have a higher increase in societal

1 risk than any of the lightweight scenarios.

2 Why?

3 MR. RIDELLA: That would be this  
4 one. Yes, it does show interesting -- did we  
5 make any assessment on that, guys, besides  
6 just saying the increased stiffness, the  
7 increase in acceleration? So I would say the  
8 pulse would be higher, so it's going to make  
9 a difference.

10 MODERATOR BONANTI: Okay. I have  
11 another question coming. We are ahead of  
12 schedule, which is a good thing, I guess,  
13 since it's late in the evening. We are going  
14 to have our panel discussion.

15 Jackie, are you still with us?  
16 She is still on. Okay. Well, after I ask  
17 this last question, then we will set up the  
18 chairs and we will have our panel discussion.  
19 You can start writing up your questions now,  
20 if you would like, for the panel.

21 Okay. Can the re-engineering or  
22 3-G of the front crash load paths enable the

1 mass reduction deficiency to be overcome?

2 MR. RIDELLA: It sounds like it's  
3 something beyond the scope of the study. One  
4 more time?

5 MODERATOR BONANTI: One more time?

6 MR. RIDELLA: Yes.

7 MODERATOR BONANTI: Okay. Can the  
8 re-engineering or 3-G of the front crash load  
9 paths enable the mass reduction deficiency to  
10 be overcome?

11 MR. RIDELLA: Well, I think yes.  
12 I mean, we look at this from just the vehicles  
13 that were out there. Certainly, that changes  
14 the front end and how it affects both, you  
15 know, load paths and stiffness is going to  
16 make a difference. So, you know, this is just  
17 a study to look at the current models that we  
18 had, but future models that have that kind of  
19 capability and changes that we can make to it  
20 to look at load paths and restraint systems,  
21 we will certainly see if we can make that  
22 difference, that -- it's small, but it's



1       there. Maybe it will get less or go away.  
2       So, clearly more to do and we are looking  
3       forward to it.

4                   MODERATOR BONANTI: Okay. Great.  
5       Thank you very much.

6                   (Applause.)

7                   MODERATOR BONANTI: Okay. You can  
8       take a seat. Okay. Can I have all the  
9       individuals that will be on the panel, those  
10      are the authors and presenters today, come up  
11      and sit down, please?

12                  Okay. Since we have everyone up  
13      here, and this is a holistic approach, we have  
14      individuals from the Agency presentations as  
15      well as the OEMs and everyone else. So I  
16      suggest that those individuals in the audience  
17      that have questions, please write them down as  
18      we have done all day, and please provide them  
19      to our panel. Thank you.

20                  Well, I guess the questions that I  
21      have already written, I'll wait on. Okay.  
22      The first question to the panel, and depending

1 on how you would like to answer it, feel free.

2 Should the projections for  
3 affordable mass market vehicle weight  
4 reductions fall short, can any of the  
5 panelists explain the penalties for  
6 noncompliance under the Clean Air Act?  
7 Anyone?

8 I can't, but -- Jim, there is  
9 another seat here. You were -- yes, do you  
10 want to sit down?

11 MR. TAMM: Sure. I think maybe  
12 the perspective from the regulatory agencies  
13 would be that mass reduction is one of a  
14 number of technologies that manufacturers  
15 could use to comply with standards. So the  
16 expectation would be that other technologies  
17 would be used.

18 I did, in the presentation at the  
19 beginning of the day, list the amount of mass  
20 reduction that we assumed in the analysis, and  
21 you might have noticed that for a lot of the  
22 vehicle categories, it was zero or fairly low

1 levels.

2 So that would be a scenario.

3 Honestly, I don't think we evaluated,  
4 assuming, you know, no mass reduction, but we  
5 did have pretty low levels in our base  
6 assumption. I think, on average, overall  
7 fleet was probably around 8 percent, so maybe  
8 our assumption is at least that type of level  
9 would be achievable and that would be  
10 consistent with the analysis that we did do.

11 MODERATOR BONANTI: The one thing  
12 I would say is that takes into consideration  
13 CAFE-related aspects. The question  
14 specifically asked about the Clean Air Act,  
15 which I don't know if --

16 MR. TAMM: Yes, maybe I'll just  
17 comment. We have got a couple of EPA  
18 representatives. But when we structured the  
19 standards for 2017 and beyond, we essentially  
20 tried to have coordinated standards, so the  
21 expectation is that manufacturers would be  
22 able to build a single fleet that would comply

1 with both the greenhouse gas and the CAFE  
2 standards.

3 So our expectation would be that  
4 there would be a single technology -- you  
5 know, a collection of technologies that would  
6 enable compliance with both. So my comments  
7 towards CAFE we would expect to also apply to  
8 greenhouse gas program.

9 MODERATOR BONANTI: Okay. For the  
10 panel, these are a few questions on cost  
11 reduction over time. Should the cost  
12 reductions be a function of industry-wide  
13 production volumes or individual manufacturers  
14 or supplier production volumes? Anyone? We  
15 have some OEMs and we have the manufacturers.

16 MR. KOLWICH: My opinion, I guess,  
17 is it is going to be the --

18 MODERATOR BONANTI: Could you  
19 state your --

20 MR. KOLWICH: Sorry. Greg from  
21 FEV. So I think it will be an industry-wide  
22 use of aluminum or carbon fiber or high

1 strength steels that will eventually drive the  
2 price down. Any one OEM that chooses to use  
3 it will pay the premium up front. Over time,  
4 I think, as more people jump in, it will only  
5 get the cost down lower.

6 MR. THOMAS: Yes, this is Chuck  
7 Thomas with Honda. I would agree with that.  
8 I think that all manufacturers -- you know, we  
9 are trying to solve really the same problem  
10 and we are going to use the same technologies  
11 and the same approaches to solve it.

12 And you know, the economics of the  
13 situation are such that for any large mass  
14 market vehicle, it's just not practical to try  
15 to introduce some of these technologies until  
16 enough people are beginning to use it. You  
17 know, we can really have very little impact on  
18 the cost of the vehicle for mass reduction.

19 I mean, you know, we have talked a  
20 little bit today about what people are willing  
21 to pay for mass production -- mass reduction.  
22 And, you know, my experience is people really

1 aren't willing to pay for mass reduction.

2 So, you know, they are not going  
3 to give us a premium for the vehicle, for a  
4 vehicle like the Honda Accord or the Honda  
5 Civic, to be lighter. That's just something  
6 that they are not interested in, because they  
7 don't perceive that as a feature that really  
8 is going to be something desirable.

9 MODERATOR BONANTI: Okay. I'm  
10 going to ask a follow-up question to that  
11 specifically. And that is to what extent is  
12 prior adoption of technology or materials in  
13 Europe accelerate cost reductions in the  
14 United States?

15 MR. THOMAS: Well, I'm not from  
16 Europe, but I'll try to answer. I think it  
17 helps. You know, we have looked at a lot of  
18 technologies that were first introduced into  
19 European market and they are slowly beginning  
20 to move their way into the United States  
21 market.

22 A lot of the press hardened steels

1 that we use today were first introduced in  
2 Europe. What we see, you know, we touched on  
3 during the discussion there are sort of two  
4 issues that are necessary for these things to  
5 become available.

6 One is the availability of the  
7 material itself and then secondly, is the  
8 availability of the supplier base that's  
9 actually able to, you know, work with these  
10 materials for these parts.

11 You know, even though it's a  
12 global market, it's not really practical to  
13 ship a lot of these, both, materials and  
14 fabricated parts around the world. If you  
15 look at the United States, you know, when we  
16 move our factory productions around,  
17 typically, our suppliers come with us.

18 So when we build a factory in say  
19 the southern part of the United States,  
20 suppliers that we already have say in Canada,  
21 they set up facilities in the southern part of  
22 the United States to produce the parts locally

1 that we can send directly into our factories.

2 So as those suppliers and  
3 technologies in Europe have become available  
4 here in the United States, we have introduced  
5 them. And as they move and become available  
6 in other countries, I think we will continue  
7 to do the same.

8 MODERATOR BONANTI: Okay. We have  
9 a substantial amount of questions specifically  
10 focusing on mass reduction and, of course,  
11 this is the topic of the workshop, but there  
12 is about four or five different types of  
13 questions that are all very similar, so I'll  
14 try to give a summarized question.

15 Mass reduction is, of course,  
16 important and this individual wants to thank  
17 you all for your presentations today. Now,  
18 can each of you, please, speak to how mass  
19 optimization is constrained in practice? For  
20 instance, the majority of models today share  
21 platforms powertrains and components because  
22 of investment constraints.



1                   Please, speak to how this works on  
2 a fleet of vehicles. I would say the OEMs  
3 and, of course, the Alliance and the  
4 manufacturers would probably be good at  
5 answering this question.

6                   MR. SCHMIDT: Well, I'm not sure  
7 I'll be good at it, but I'll give it a shot.  
8 You know, again, it is a case where you have  
9 a platform, but it does have unique sub-  
10 vehicles or niche parts of that common  
11 platform and they do provide, as I mentioned  
12 in my presentation, real constraints.

13                   They also are marketplace  
14 opportunities, that's why they exist. We  
15 wouldn't make them if there wasn't a  
16 marketplace opportunity. So I think they are  
17 an important part and it's not so simple to  
18 say well, just get rid of those, make the  
19 Model T the modern Model T all one-size-fits-  
20 all.

21                   You can optimize the hell out of  
22 it, pardon my language, but that's just not

1 practical in this customized consumer  
2 environment. I want customized products for  
3 me. I don't want the same thing that  
4 everybody else is driving. And we have come  
5 to expect that, so that's the norm and it does  
6 provide some limitations on the amount of  
7 optimization you can do.

8           And then when you figure that you  
9 have got a -- the manufacturer has got  
10 multiple platforms, yes, maybe that does  
11 provide some opportunities, because there may  
12 be an engine for that platform that when they  
13 downsize, that might fit in there.

14           But you know, Murphy's Law is that  
15 usually that engine may not fit exactly what  
16 you want and so you end up still being  
17 constrained at least at some level in your  
18 ability to optimize and pull parts from some  
19 of your other sub-platforms, because, again,  
20 as vehicle manufacturers we try to communize  
21 as many components and make one component fit  
22 as many different models as possible, that way

1 you don't have the exact same -- you know,  
2 every vehicle doesn't have unique parts to  
3 just that vehicle. This model has unique  
4 parts to that vehicle.

5 So we do our best to optimize  
6 weight and do what a lot of these manufacture  
7 -- a lot of the analyses are saying, but there  
8 are some real limitations.

9 MR. THOMAS: I think that I  
10 mentioned before and we kind of touched on it  
11 that, you know, from a particular platform,  
12 there is a lot of different configurations and  
13 different vehicles that are developed and that  
14 really is necessary for several reasons. I  
15 mean, one is that some of these small volume  
16 vehicles, they really couldn't survive the  
17 amortization, you know, scrutiny based on the  
18 volumes if we had to really design completely  
19 unique parts for them.

20 Also, two, you should keep in mind  
21 that, you know, most of these vehicles that  
22 are derived from the same platform are built

1 in the same factory. So, you know, the  
2 factory itself deals with limitations and we  
3 had significantly designed differences  
4 between, you know, say like the Acura TL and  
5 the Honda Accord, which are built on the same  
6 line, even though they are not the same car.

7 If we had radical different  
8 architecture developed for one vehicle than  
9 other, it creates a lot of complexity in our  
10 manufacturing environment.

11 The other thing, too -- which  
12 particularly with platforms and they create  
13 challenges for us is, you know, we have talked  
14 a lot about kind of clean sheet design. So,  
15 you know, if we could just kind of back-up and  
16 we could just start from scratch and design a  
17 vehicle, that gets even more complicated,  
18 because of the life-cycle of each vehicle that  
19 is derived off of this platform isn't  
20 synchronized.

21 So for example, when the current  
22 Accord went into production, it's a new

1 platform, but the TL, which is still being  
2 produced, is based on the old platform being  
3 built on the same line.

4 So we have to be able to  
5 accommodate two different platforms on the  
6 same line at the same time, because the TLs  
7 product renewal cycle isn't completely  
8 synchronized with the Accord. And this  
9 happens across a lot of different vehicles.

10 So you know, I don't want to sound  
11 like I'm making excuses, but as a  
12 manufacturer, there is a lot of moving pieces  
13 involved in the development of a platform and  
14 development of all the daughter vehicles that  
15 are associated with it and the management of  
16 all that sort of machinery makes it difficult  
17 sometimes to sort of approach this as this  
18 kind of clean sheet idea and we will just kind  
19 of tear down everything that we have done and  
20 start over every five years or every six  
21 years.

22 So you know, I think somebody used

1 the description that, you know, mass reduction  
2 in vehicles, because of the nature of the  
3 industry, I think is more evolutionary than  
4 revolutionary, because even when we come up  
5 with good ideas, it takes time to kind of work  
6 those ideas into the machinery of both  
7 platform engineering and vehicle production to  
8 kind of introduce itself through our entire  
9 product cycle.

10 MR. RICHMAN: We are talking about  
11 technology innovation in general now. And it  
12 is a really complex problem in the auto  
13 industry, because of all the invested capital,  
14 the product cycles, the spare parts, the  
15 commonality, the different platforms. It is  
16 a hugely complex problem.

17 History has been that typical  
18 evolution -- and it is absolutely technology  
19 is an evolution in automotive and it has to be  
20 -- typical technology adaptation curves are on  
21 the order of 20 years from 10 percent of the  
22 fleet to 90 percent of the fleet. It's a 20

1 year cycle.

2 I would question anybody that  
3 thinks there is a technology that went from 10  
4 to 90 in much less than 20 years. We are not  
5 talking revolution here. This is evolution,  
6 like all the other advancements in automotive  
7 for a lot of very important business and  
8 technical and commercial reasons.

9 MR. KOLWICH: This is Greg from  
10 FEV. So I agree. I think, as I mentioned  
11 earlier, time kind of heals all wounds. So  
12 you look at a lot of the technologies in  
13 engines and transmissions, lightweight  
14 technologies, and they will make it into one  
15 engine platform first. They will slowly work  
16 its way across.

17 So one argument could be these  
18 platforms will share that lightweight  
19 technology. There are going to be certain  
20 technologies that are going to be maybe more  
21 custom to a vehicle platform, but a lot of  
22 these technologies that we have investigated,

1 be it brake calipers or caliper brackets or  
2 knuckles or whatever it may be that are shared  
3 across platforms, some of these technologies  
4 will be brought across all the platforms.

5 Now, cost is one factor. You are  
6 not going to put maybe an expensive aluminum  
7 suspension on an A Class vehicle necessarily.  
8 But as costs come down and things evolve and  
9 time goes on, maybe that will be the case. In  
10 Europe you see it already. You see it,  
11 smaller cars do have the use of aluminum  
12 throughout.

13 So I think it is -- and when we  
14 generalize it is hard to kind of wrap our  
15 hands around, but time does heal that. And  
16 eventually if it makes financial sense, it  
17 will come down to that.

18 MR. PETERSON: Gregg Peterson,  
19 Lotus. Lotus, although we are a very low-  
20 volume car manufacturer, we certainly are  
21 looking into economies of scale and one of the  
22 ways we are doing that is looking at using



1 some of our nodal castings which are four-  
2 corner type connection points, which are  
3 highly integrated, and using extrusions that  
4 can be cut to various lengths, very cheaply,  
5 very inexpensively, to create longer wheel  
6 base or shorter wheel base platforms that can  
7 be built in the same plant very simply by the  
8 same people with similar skills to what is  
9 used in body and weight construction for steel  
10 bodies.

11 MR. ZUIDEMA: From a supplier  
12 perspective, it does not escape us that the  
13 cars we launch in 2021 are still going to be  
14 built in 2025 when the full magnitude of the  
15 fuel economy requirements kick in. And those  
16 cars are really going to be locked into their  
17 production by 2018.

18 So we are looking at almost one  
19 vehicle cycle or less in which to really  
20 commercialize all of these technologies and  
21 one of our biggest points all along is we, as  
22 suppliers, want to work with the OEM community

1 to find a way to overcome some of those  
2 roadblocks and make sure we get the right  
3 solutions and the right applications, because,  
4 frankly, we are running out of time.

5 MODERATOR BONANTI: Okay. Thank  
6 you. I'll ask a fairly general question.  
7 Given Government studies and industry  
8 feedback, how much mass reduction is feasible  
9 in model years 2020 and 2025? Anyone?

10 MR. THOMAS: It's what I get for  
11 being the only -- the Honda guy. You know,  
12 kind of like we talked about. I think in that  
13 time scale, I think our estimate of something  
14 on the order of like 2025, something around --  
15 a net of around 175 kilograms is probably what  
16 is, you know, reasonable from what we see.

17 I think we have kind of said  
18 something on the order more of around the 10  
19 percent reduction compared to the 20 percent  
20 reduction that we have seen in some of the  
21 studies.

22 One thing that is very hard to,

1 you know, anticipate in the future is like we  
2 talked about, what are the future demands of  
3 the customer going to be and where the market  
4 is going to go?

5 You know, as customers get more  
6 interested in technology, you know, both  
7 infotainment technology, collision avoidance  
8 technology, as well as, you know, additional  
9 driving technology, comfort, noise, isolation,  
10 as we make cars, you know, more like your  
11 living room, what people are going to want to  
12 do in your living room, you know, I mean,  
13 people might want to have big screen TVs in  
14 their car, so they can watch TV because their  
15 car drives itself.

16 Some of these things are hard to  
17 anticipate, but from a point of view of the  
18 structures of the car and the components of  
19 the car, I think that 10 percent target is  
20 reasonable over those time scales.

21 MODERATOR BONANTI: Okay.

22 MR. RICHMAN: We see an overall

1 average around 10 percent being the kind of  
2 number we are looking at, about 400 pounds on  
3 an average 4,000 pound fleet. That is the  
4 kind of numbers we have been working with.

5 And it actually aligns, I think,  
6 pretty well with the assumptions that we see  
7 in the CAFE Regulations to 2025. It is going  
8 to be a mix. Some cars are going to get more.  
9 Some cars are going to get less.

10 From what we are seeing from OEM  
11 reactions to the long-term planning now, I  
12 think the 400 pounds is a very, very realistic  
13 expectation for 2025.

14 MR. PETERSON: Gregg Peterson,  
15 Lotus. I just want to make a comment. The  
16 presentation I gave earlier certainly showed  
17 a lot more than that, but, please, keep in  
18 mind the fact that we didn't have constraints  
19 that the OEMs do. We didn't have any Legacy  
20 hardware in there and there were a lot of  
21 other considerations that Honda has presented  
22 today that really have a big impact on the

1 mass.

2 So we certainly feel that there  
3 are significant mass reduction opportunities,  
4 but Legacy hardware and plants, existing  
5 plants, etcetera, infrastructure, all play a  
6 huge role in defining what an OEM can actually  
7 do in that time frame.

8 MR. ZUIDEMA: Just a third, I  
9 guess, comment on the 10 percent. Our own  
10 work showed we need somewhere between 7 and 10  
11 percent total vehicle weight reduction to make  
12 up the gap between that which powertrain  
13 technologies can provide and that which we  
14 need to get to 54.5 miles per gallon.

15 But again, a lot of it depends on  
16 how well the powertrain technologies  
17 themselves evolve as well as the additional  
18 mass required to meet some of the other  
19 challenges. My work said it was 10 percent or  
20 I'm sorry, 7 percent. The 10 percent, to me,  
21 sounds like a reasonable safety factor.

22 I think we are right in that

1       ballpark.

2                   MODERATOR BONANTI:   Okay.   Another  
3       comment?

4                   MR. SCHMIDT:   Yes.   I don't have a  
5       whole lot of better data other than the fact  
6       that, again, depending on the vehicles, I  
7       mean, vehicle for duty cycles, for example,  
8       some full-size pickups you often have to have  
9       that vehicle not only carry the payload, but  
10      you also have to be able to bolt on a snow  
11      plow and hit curbs and stuff like that.

12                   So again, the exact number is  
13      really probably vehicle-specific, vehicle  
14      class-specific.   And again, when you have a  
15      vehicle which you are trying to sell, the  
16      majority of your customers may not need some  
17      of these special heavy-duty features, but that  
18      vehicle also is sold as a construction or as  
19      a commercial vehicle and has to have them.

20                   Again, that may have some  
21      limitations and things that they need to  
22      consider.

1                   MODERATOR BONANTI: Okay. This  
2 question is for anyone that doesn't work at  
3 NHTSA. Fuel Economy Regulations in the EU are  
4 mass-based and in the U.S. they are size-  
5 based, of course. Please comment on how you  
6 view mass reduction given these two different  
7 regulatory requirements.

8                   MR. ZUIDEMA: This is Blake  
9 Zuidema from Arcelor Mittal. We are,  
10 obviously, producing steels in both regions,  
11 so it is equally important for us to  
12 understand the dynamics in Europe.

13                   The fact that they are all mass-  
14 based makes the consideration very different,  
15 because light-weighting a vehicle actually  
16 increases its fuel economy. I mean Europe is  
17 all based on tailpipe emissions, but we know  
18 there is a fairly predictable link between  
19 fuel economy and tailpipe emissions.

20                   And the fact is as the weight goes  
21 down in Europe, the requirement for tailpipe  
22 emissions also goes down. And depending on

1 the vehicle size and starting point, the  
2 dynamic can be very different.

3 So the two regulations are very  
4 different. There is talk in Europe, I have  
5 heard, about changing to a footprint-based  
6 regulation as we have here. And from our  
7 initial work, the footprint base is probably  
8 going to put a lot more emphasis on weight  
9 reduction.

10 MR. RICHMAN: Doug Richman with  
11 the Aluminum Association. We very much  
12 support the footprint-based standards. We  
13 think it addresses technology improvement in  
14 all segments of the vehicle fleet and it  
15 avoids the unintended consequence of having a  
16 bias towards unimproved smaller vehicles that  
17 may have some, as we have seen, may have some  
18 safety issues that don't exist with the larger  
19 vehicles.

20 And much like Blake's experience,  
21 our colleagues in Europe actually have -- we  
22 have been in collaboration with them for a



1 couple of years -- there is a very strong move  
2 to try to change the thinking in Europe to go  
3 to a footprint, and even among the regulators,  
4 I understand that they recognize that the  
5 footprint-based standard drives technology at  
6 all levels of the fleet and that's the real  
7 objective of these standards.

8 MR. SCHMIDT: Yes, as I said in my  
9 presentation, you know, that's a real  
10 conundrum for our manufacturers who try to  
11 build a global platform or global vehicle. I  
12 don't think we have yet decided which system  
13 we want to support, but, at this point, it is  
14 an issue and it is an issue that does raise  
15 the complexity of trying to design world-wide.

16 MODERATOR BONANTI: Okay. I think  
17 this would go to the Alliance and as well as  
18 Honda as well as potentially the two material  
19 manufacturers. We will see. We will see who  
20 wants to answer it.

21 To what extent are Asian car  
22 manufacturers developing or suggesting

1 development locally of lightweight materials  
2 that they would use?

3 I'm sorry. To what extent are  
4 Asian manufacturers developing or supporting  
5 the development locally of light-weighting  
6 materials that they would use?

7 MR. THOMAS: This is Chuck Thomas.  
8 I guess that may be directed towards me, since  
9 I have worked for an Asian manufacturer, I  
10 guess.

11 You know, I mean, really, I mean,  
12 I don't really think there is much in the way  
13 of difference. I mean, the vehicles that we  
14 design and engineer here in the United States  
15 as well as the ones we designed in Japan, you  
16 know, we are designing them with the same  
17 types of technologies intended for the same  
18 market.

19 So as an example, the Accord --  
20 last generation Accord was designed in, you  
21 know, our R&D center in Japan. It is produced  
22 here in North America. Almost all of its

1 content is produced here in North America.  
2 The materials that are used to make the  
3 components are primarily sourced here in North  
4 America.

5 Yes, I don't think really so much,  
6 at least from the -- as an Asian manufacturer,  
7 there is really a difference based on, you  
8 know, where the vehicle was designed or, you  
9 know, any technologies that were being created  
10 in different regions that aren't being pushed  
11 here in North America.

12 Realistically, what we are trying  
13 to do is trying to push these technologies  
14 globally into all our markets as quickly as we  
15 can. So I don't really think there is any  
16 difference, as an Asian manufacturer, what we  
17 are making available here in the United  
18 States.

19 MR. RICHMAN: The study we have  
20 seen on aluminum is that the aluminum use in  
21 Europe -- in the developed economies, Europe,  
22 North America and the developed segments of

1 Asia is about the same, about 9 percent of the  
2 vehicle curb weights are aluminum in all three  
3 segments.

4 The segment we see may not be at 9  
5 percent in future thinking, at this time, is  
6 the developing economy is where the starvation  
7 for any level of transportation at the lowest  
8 possible price supersedes any other of these  
9 issues.

10 And you know, where you get three-  
11 wheeled vehicles and motorcycles with a body  
12 on them, you know, that market yet -- that's  
13 the part we are talking about. Not yet. They  
14 are not there yet. They will be some day, but  
15 I segment developed economies versus  
16 developing economies in that discussion.

17 MODERATOR BONANTI: Okay. Anybody  
18 further?

19 MR. ZUIDEMA: Yes. From another  
20 global producer, we really see no difference  
21 in the importance of weight reduction in any  
22 of the, call them, developed or even some of

1 the developing regions, even places like China  
2 are now getting very serious about fuel  
3 economy, safety and many of the other  
4 environmental concerns. And they are just as  
5 interested and committed to weight reduction.  
6 So it truly is a consistent global approach.

7 MODERATOR BONANTI: Okay. Thank  
8 you. The main focus of this session has been  
9 about light-weighting the body structure.  
10 What is being done to reduce the weight of  
11 non-structural mass, such as accessories,  
12 electric devices and so on and so forth?

13 MR. THOMAS: Well, we talked a lot  
14 about the body. I think somebody made the  
15 comment, you know, that's where the money is  
16 or that's where the weight is, which is one  
17 main reason we focus on the body.

18 But if you look at those charts, I  
19 mean, there are a lot of other areas where  
20 there is a lot of mass. A lot of the interior  
21 components, seats, instrument panels, HVAC  
22 systems contribute a lot of weight to the

1 vehicle.

2 I'm sure just like every  
3 manufacturer, you know, we are looking hard  
4 right now at trying to figure out how to  
5 reduce the weight of those.

6 Again, one of the problems you get  
7 into is your development cycle and your legacy  
8 structures make that difficult sometimes,  
9 because what you may have is that seat device  
10 which was designed seven or eight years ago  
11 may be used on six different vehicles whose,  
12 you know, lifecycles aren't coordinated.

13 So if you are going to take it out  
14 of production and replace it with something  
15 else, it takes a lot of planning, so you can  
16 introduce that all at the same time into these  
17 vehicles.

18 You know, we have looked at things  
19 like in the -- the next MDX, which Honda just  
20 designed, you know, the IP support structure  
21 we switched to a cast magnesium structure  
22 which is quite a weight reduction for that

1 vehicle.

2 And you know, we have looked in  
3 the past at steel and then we would kind of  
4 move to aluminum and now we are moving to  
5 magnesium.

6 The same thing with even the  
7 carpet and the insulation material we use. I  
8 know we are looking lighter weight insulation  
9 materials that are just as effective at  
10 reducing noise transmission into the vehicle,  
11 but don't depend so much on mass to do that.

12 Even the electrical systems, you  
13 know, we are looking at electrical components  
14 on where we can reduce the weight of the  
15 housing, you know, things like, you know,  
16 better electrical infrastructure and better  
17 networking allows us to cut down the amount of  
18 harnessing in the vehicle, which believe it or  
19 not, you know, is a lot of weight is actually  
20 in the electrical harness that people don't  
21 even think about.

22 So, you know, I think like most

1 manufacturers we are trying to find, you know,  
2 mass wherever we can, especially in areas  
3 where, you know, sometimes we don't think  
4 about it, because mass can sort of creep into  
5 designs that maybe traditionally aren't as  
6 mass-conscious as areas like the chassis and  
7 the body.

8 And I think that all of us, as  
9 manufacturers, are looking to try and improve  
10 them.

11 MR. PETERSON: A couple of more  
12 comments. One is relative to mass reduction  
13 in the interior. Certainly, one of the things  
14 that Lotus is looking at is using active noise  
15 cancellation. And we are projecting with some  
16 of the studies they are doing today as much as  
17 10 to 20 kilograms of mass reduction, where  
18 you, basically, eliminate the very heavy mass  
19 sticks and use the audio systems of the  
20 vehicle to attenuate the sub-200 Hz  
21 frequencies.

22 And although not many cars can do



1 that today because the audio systems aren't  
2 there, in five or six years --

3 OPERATOR: All participants are  
4 now in listen-only mode.

5 MR. PETERSON: -- our speaker  
6 supplier is certainly projecting that many  
7 midsize cars are going to have sufficient  
8 capacity to do that, so that will almost be a  
9 freebie in terms of being able to start  
10 reducing the mass of carpeting.

11 A couple other areas that we like  
12 are using USEL process, which basically  
13 replaces plastic with air. And you get 30  
14 percent reduction in material density with  
15 some increased properties where you go 1:1  
16 with the ratio, so you can reduce apparent  
17 material thickness.

18 A couple other areas that we like  
19 in the interior are the ability to use the  
20 seat as a structure where you are now  
21 integrating the seat structure in the vehicle,  
22 the body structure.

1                   If you box the seat, form the  
2                   lower seat and box it to the sill on the  
3                   tunnel, you now have created, basically, a box  
4                   section for side impact. And it's something  
5                   that was done in the 1980s by Ford and Audi,  
6                   but it's a time whose time has come again, in  
7                   terms of being able to help reduce the body  
8                   weight by using another ancillary system to  
9                   help contribute to the body structure.

10                   MR. RICHMAN: If you haven't read  
11                   the FEV or EDAG reports, the EPA and NHTSA  
12                   documents, you really should because that  
13                   question is really answered very, very firmly  
14                   and strongly in those studies.

15                   In fact, when we talked about the  
16                   body and that's where the big mass is and we  
17                   talked 14 or 15 or 16 or 18 percent, but when  
18                   the vehicle got to 18 percent, every single,  
19                   and if you remember the chart that stair step  
20                   chart, every single vehicle system was subject  
21                   to similar mass reductions.

22                   We won't get there without

1 attention to every single system in the  
2 vehicle. And even today, the chassis  
3 components, engines, transmission cases, they  
4 have already -- they are 100 percent. It's  
5 already done. There is nothing left to go  
6 after except downsizing.

7           Suspensions are growing in  
8 lightweight materials. Brake calipers and so  
9 there is a lot of attention and there is a  
10 great menu of ideas in those two reports,  
11 those studies. And most of them are in  
12 production some place. They are not dreams.  
13 Somebody is doing them already. They are  
14 production worthy.

15           So it is going to take a village  
16 to get where we need to be and it's the whole  
17 vehicle. It's not -- we talked about the  
18 body, because that's the safety story today.

19           I have another presentation on the  
20 whole vehicle if you want to come back some  
21 time.

22           MR. KOLWICH: I was going to say

1 for the FEV report that we did for EPA, out of  
2 the 18 percent mass reduction, approximately,  
3 4 percent of the mass reduction was body-in-  
4 white and the remainder of the 14 percent was  
5 through brakes, suspension and so on.

6 So thanks for the plug there,  
7 Doug, and read the report, it has got a lot of  
8 good information.

9 MR. SCHMIDT: Yes. I mean, I'll  
10 just kind of agree to some degree. You know,  
11 our manufacturers look at the entire vehicle.  
12 And they look at it with, you know, a  
13 magnifying glass. So there is no component,  
14 no stone that is not turned.

15 Now, every piece/component can  
16 potentially be light-weighted. It is the  
17 difference in cost. I mean, you can look at  
18 this piece and you can change the material.  
19 You can change the design. Sometimes you can  
20 make a more elegant design and it's almost a  
21 free cost.

22 You know, you can go from a so-so

1 design to a superior design. Sometimes to get  
2 that part down a little bit, it's going to  
3 cost new material and that would be very  
4 expensive. So, you know, what you see is the  
5 whole vehicle is looked at. Your first round  
6 of light-weighting is you are picking the low-  
7 hanging fruit.

8 So you are going to pull the  
9 components from all over the vehicle that you  
10 can save ounces, pounds at a low cost. Then  
11 the next round of light-weighting is going to  
12 be at the next higher cost, because, you know,  
13 you need to go even further. And therefore,  
14 you are going to pull the next level.

15 So it's almost a series of  
16 stratified levels of cost. And again, those  
17 weight savings are going to come from the  
18 entire vehicle pretty much.

19 MR. RIDELLA: I think I'm up.  
20 Steve Ridella, NHTSA. The concern I have is  
21 just across the board we have to look at  
22 tradeoffs, so that when we look at things like

1 seat systems and IPs and restraint systems and  
2 inflaters, everything that could possibly be  
3 made lighter and cheaper, the effect on safety  
4 has to be looked at.

5 So I worry about just across the  
6 board with that. It has got to be selected  
7 and tradeoffs have to be looked at.

8 MR. THOMAS: This is Chuck Thomas  
9 with Honda. I agree with what Steve is  
10 saying. I mean, you know, when we look at,  
11 you know, taking weight out of the design, I  
12 mean, the whole goal of course is never to  
13 affect its performance.

14 So, you know, one thing that has  
15 changed over the years and really changed a  
16 lot in recent years is, you know, a lot of the  
17 computer modeling technology that we have  
18 available to us today allows us to do levels  
19 of optimization and a lot of like kind of what  
20 if studies that realistically in the past  
21 weren't practical in a development process,  
22 because we just didn't have the time.

1           You know, one of the differences I  
2 think someone said once between engineering  
3 and science is the scientist can study  
4 something for 10 years and write a paper that  
5 says, you know, he couldn't figure it out and  
6 publish it and get famous and the engineer  
7 just gets fired.

8           So, you know, we really need to be  
9 able to produce and we really need to be able  
10 to solve these problems. And, you know, a lot  
11 of things in the past were designed the way  
12 they were because, you know, given the time  
13 and the constraints that we had, we just  
14 really didn't have a better solution, because  
15 we have to make it work.

16           You know, we can't just say well,  
17 we didn't have time to solve it. We have to  
18 come up with something at the end of the day.

19           The other thing I was going to  
20 mention is to go to my friend Lotus here,  
21 active noise cancellations are a great idea to  
22 help with weight reduction. Honda has been

1 doing it for several years. You may not hear  
2 about it too much, because it's quiet, but --

3 MODERATOR BONANTI: No pun  
4 intended.

5 MR. THOMAS: -- it's part of the  
6 variable cylinder management system that we  
7 use in our vehicles, for the cylinder cut  
8 system we use active noise control to help cut  
9 down on noise.

10 And again, these are great ideas.  
11 They are really nice technologies that are  
12 available that, you know, a lot of people  
13 don't even know about. They are actually  
14 working their way into the fleet today.

15 MODERATOR BONANTI: Well, there is  
16 another question. It's really for Lotus.

17 Had Lotus included the legacy  
18 constraints that Honda and other OEMs have  
19 dealt with? Would they agree 10 percent  
20 reduction is reasonable?

21 MR. PETERSON: That's a good  
22 question. And I answered it a little bit



1 earlier when I referred to a lot of  
2 background. We had a clean sheet of paper and  
3 we had no legacy constraints. And that is  
4 what we hear from all the OEMs is all the  
5 legacy constraints that they have to deal with  
6 and the hoops they have to go through.

7 So I strongly feel that what we  
8 published is very accurate and achievable, but  
9 it takes a huge step to get there in terms of  
10 changing infrastructure of legacy and that's  
11 not going to happen over night.

12 And there is not that much time to  
13 get between here and 2025. So I would agree  
14 that a 10 percent mass reduction is probably  
15 pretty reasonable and still reasonably  
16 aggressive for the OEMs to get there.

17 MODERATOR BONANTI: Thank you. We  
18 have about six minutes left. I have several  
19 questions and I'll be picking and choosing.  
20 Those that are not asked or answered will be  
21 placed into the docket for further discussion.

22 So 54.5 miles per gallon or 40

1 miles per gallon, what is the actual 2025  
2 target? And what specific scenarios would  
3 trigger EPA rulemaking?

4 MR. TAMM: Well, being a NHTSA  
5 guy, I can't answer the second question, but  
6 I can answer the first one. And I'll try to  
7 make it pretty brief, so, you know, we can get  
8 back to maybe some other questions about the  
9 materials.

10 But so if you take 54.5 miles per  
11 gallon and that includes improvements in air  
12 conditioning technologies under the greenhouse  
13 gas program and you essentially pull those  
14 back and what I should say is improvements in  
15 the refrigerants that help reduce global  
16 warming, but they don't really affect  
17 efficiency directly.

18 So if you account for those, it  
19 takes you roughly, I had the exact numbers, to  
20 just around 49 miles per gallon roughly is  
21 what you get.

22 And then the rest is going from 49

1 down to 40 is really accounting for the real-  
2 world fuel efficiency recognizing that the  
3 standards are based on two cycle testing which  
4 we, basically, recognize in our rulemaking  
5 analysis does not reflect real-world fuel  
6 efficiency. And 40 would be more like a label  
7 fuel economy number or label equivalent.

8 So but the reality is if you look  
9 at a percentage improvement, it is -- still  
10 the challenge is there because where you are  
11 starting from would be a lower label-type  
12 value to then, you know, like a 27.5 type  
13 number, which is regulatory.

14 MODERATOR BONANTI: Thank you,  
15 Jim. Does anybody else want to comment on  
16 that? Okay. What is being done to ensure  
17 paired vehicles are still safe and meet  
18 original safety requirements based on the  
19 criteria and the components in the materials  
20 that are being used for light-weighting? Any  
21 comments? Repaired, repaired. Did I say  
22 "paired"?

1 PARTICIPANT: Yes.

2 MODERATOR BONANTI: I'm sorry.  
3 Repaired. I'll restate it. What is being  
4 done to ensure repaired vehicles are still  
5 safe and meet original safety requirements?

6 MR. ZUIDEMA: This is Blake  
7 Zuidema, Arcelor Mittal. From a steel  
8 industry perspective, we have recognized for  
9 many years now that the grades that we are  
10 introducing have to be treated differently.  
11 You can't take a heat treated steel and take  
12 a torch to it on a frame straightener and pull  
13 the frame out and have the same properties.

14 And so we have been working  
15 extensively with the repair industries as well  
16 as the repair people within the OEMs to help  
17 develop specific guidelines for repairing  
18 materials. And now there are guidelines on  
19 what to repair, what to replace and things  
20 like that.

21 And this is the same process we  
22 are going to have to go through for all of

1       these new materials. It has got to be an  
2       education for the repair community.

3               MR. RICHMAN: And the OEMs are  
4       stepping up to that with the new materials.  
5       We are involved with similar activities at OEM  
6       level and in the repair industry on the  
7       introduction of the new aluminum products.

8               So the industry knows how to step  
9       up to those. The OEMs and the repair industry  
10      are getting ready. They know it's coming and  
11      they are preparing.

12              MR. THOMAS: Yes. It's not  
13      exactly my area of expertise, but I know as a  
14      manufacturer, you know, we work with the  
15      repair companies to try to give them  
16      guidelines on what can be repaired and what  
17      cannot be repaired, as well as recommendations  
18      on techniques to try to make certain repairs  
19      to the vehicle.

20              One thing I think that from a  
21      repairability that is really kind of thing I  
22      worry about is that, you know, as we get into

1 these new materials, you know, a piece of  
2 steel isn't a piece of steel any more. A  
3 piece of aluminum is not a piece of aluminum  
4 any more.

5           You know, we have seen some of  
6 this as an OEM and having problems with  
7 repairability with, you know, third-party  
8 parts that are sold to repair our vehicle  
9 with. So there are geometric copies of our  
10 components that people use to replace or  
11 repair the part, but they are not made of the  
12 same materials and they are not made to the  
13 same standards.

14           This is even a bigger problem when  
15 you think about in the future, you may get a  
16 body part that might be, you know, a multi-  
17 phase martensitic hot press part, very  
18 complicated, very sophisticated piece of metal  
19 and the part that you get is a piece of, you  
20 know, 270 megapascal, you know, steel that  
21 looks like the part, but it may not have the  
22 same properties.

1                   So particularly with  
2                   repairability, I think, you know, using those  
3                   original equipment parts is even more so of an  
4                   issue in the future when we look at these  
5                   really advanced materials in the body.

6                   MODERATOR BONANTI: Anybody else?

7                   MR. SCHMIDT: Yes. That was one  
8                   of our points was, you know, some of these  
9                   advanced materials as our members, we have to  
10                  evaluate what the effect is, not just building  
11                  the car, but as it is being used and as it is  
12                  being repaired.

13                  And then, of course, we lose sleep  
14                  at night because even if we put out guidelines  
15                  that say this is a nonrepairable part, and I'm  
16                  not one to pick on carbon fiber, let's say  
17                  there is a carbon fiber part, it's a very  
18                  expensive car, this guy crashes it, our  
19                  recommendation is you replace that whole body  
20                  shell, because it is -- it doesn't -- well,  
21                  somebody is going to decide this is an  
22                  expensive car.

1 I'm not replacing it and they are  
2 going to go out and find some fiberglass and  
3 some of their own carbon fiber and do whatever  
4 and then paint it up to look nice and down the  
5 road it goes.

6 So, you know, we can't control  
7 that, but it is a consideration in some of our  
8 material selections and again, how we try to  
9 put these guidelines out, so that not only are  
10 they out for their repair industry, but we try  
11 to minimize the incentive for people to go  
12 around the guidelines.

13 So it's a tough issue and we don't  
14 have all the answers.

15 MODERATOR BONANTI: Okay. Well,  
16 thank you. At least this one and we'll see if  
17 I can get -- grab another one.

18 How do the weight reductions in  
19 the light-weighted concepts in the NHTSA Fleet  
20 Study compare to the typical expected weight  
21 reductions?

22 MR. RIDELLA: I was thinking about



1 that as I was hearing this discussion that 10  
2 percent is what you guys are talking about,  
3 but these are much higher, on the order of 20  
4 or 30 percent. I mean, the Venza was 18 and  
5 31 percent. The Accord was probably what 20  
6 percent. And the Taurus lightweight was 25  
7 percent.

8 So these were higher reductions  
9 that we did in the simulation than what you  
10 guys are saying now.

11 MODERATOR BONANTI: Anybody else  
12 care to comment?

13 MR. RIDELLA: Well, you will have  
14 to read it in July.

15 MODERATOR BONANTI: Okay.

16 MR. RIDELLA: Yes, something to  
17 consider. I mean, we perhaps in the future  
18 will look at more like 10 percent, but then we  
19 would have to start looking at what you guys  
20 are coming up with before we make those kind  
21 of changes. So I see a lot of interaction  
22 here in the next -- as I said, the next two or

1 three years are going to really be important  
2 for us.

3 MODERATOR BONANTI: Okay. One  
4 last question and there is about six or more  
5 questions, so I apologize we didn't get to  
6 those, but I think this has been a very good  
7 discussion and exchange.

8 To what extent do assumptions  
9 about post-2025 regulations drive decisions  
10 now about materials and progress and  
11 processes? I thought I stumped them.

12 MR. ZUIDEMA: This is Blake  
13 Zuidema from Arcelor Mittal. And I think it  
14 is really way too early to start even thinking  
15 about post-2025.

16 We still don't know for sure that  
17 we are going to get to 2025. There are still  
18 a lot of questions on materials. There are a  
19 lot of questions on powertrain technologies.  
20 And one of the big purposes of the midterm  
21 review is to track the trends of those  
22 technologies and try to figure out if we are

1 on a trajectory to get even to the 2025.

2 And I'm optimistic that by the  
3 2018 time frame when the midterm year review  
4 comes out, we will have a much better feeling  
5 for is even 2025 going to be realistic. And  
6 that's when we can start to think, I think, a  
7 little bit more about post-2025. But we have  
8 got a lot of challenges even to get to 2025.

9 MODERATOR BONANTI: Okay. Well,  
10 thank you for the answers. And any last  
11 minute comments that any of the panelists  
12 would want --

13 MR. RICHMAN: Well, I was going to  
14 put in a plug for the 2025 standard, because  
15 it did a really important service to our  
16 entire industry. It gave clarity to all the  
17 planners.

18 The uncertainty of what the future  
19 may hold, at least from a regulatory  
20 standpoint, became clearer. And I have seen  
21 better alignment across the industry to a  
22 standard than I have ever seen in my career.

1                   So it really has -- it has just  
2                   taking the uncertainty out of the planning  
3                   cycle. There is still the uncertainty of can  
4                   it be -- can it happen? But there isn't a  
5                   whole lot of uncertainty about what are we  
6                   trying to do by then and that has really  
7                   helped a lot.

8                   MODERATOR BONANTI: Okay. Well,  
9                   thank you very much. We have a -- no, you  
10                  can't leave yet. There is a wrap-up that Jim  
11                  Tamm is going to be providing and I think what  
12                  I would say is tomorrow, I think, the agenda  
13                  starts at 8:30 in the morning. I'm looking  
14                  forward to seeing everyone here at 8:30 and  
15                  I'll give five minutes to Jim to do a wrap-up  
16                  session. Thank you.

17                  (Applause)

18                  MR. TAMM: Okay. I'll see if I  
19                  can finish this in less than five minutes,  
20                  that's my goal.

21                  But first on behalf of NHTSA,  
22                  thank you to all of the participants today,

1 particularly those who presented. We  
2 appreciate how much time it takes to prepare.  
3 The presentations were all very outstanding  
4 today, so we thank you for that.

5           Also for the discussion and  
6 answers to questions, we got a whole stack.  
7 We are delighted. I mean, we had to go to the  
8 store to get more index cards, but we are  
9 delighted to have all the questions we had  
10 today.

11           So also thank you to the audience  
12 for participating and bringing up the  
13 questions.

14           So just as an overview, we started  
15 the morning and we talked about, from the  
16 Agency's perspectives, how we go through and  
17 assess mass reduction for fuel efficiency and  
18 also for safety.

19           We also had discussions of the  
20 various mass reduction projects that the  
21 Agency has sponsored.

22           And then in the afternoon, we got

1       into some feedback related to those studies  
2       and some of the concerns and limitations from  
3       manufacturers and the associations as well as  
4       from the various material groups.

5               So we also had a presentation on  
6       the NHTSA assessment of some of the new  
7       lightweight designs and the impact in our  
8       first phase analysis of what the impacts would  
9       be on societal safety.

10              So with that again, thank you to  
11       everybody. As Chris mentioned, tomorrow's  
12       program begins at 8:30 in the morning and we  
13       are -- the topic tomorrow is going to focus  
14       more on the real historical analysis of crash  
15       data and what that tells us about societal  
16       safety and mass reduction in vehicle size.

17              So thank you once again for your  
18       participation today. We are very pleased with  
19       how things went.

20              (Applause)

21              (Whereupon, the symposium was  
22       concluded at 5:36 p.m.)

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Before: DOT/NHTSA

Date: 05-13-13

Place: Washington, DC

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