Carbon Accounting and Sustainable Designs in Product Lifecycle Management

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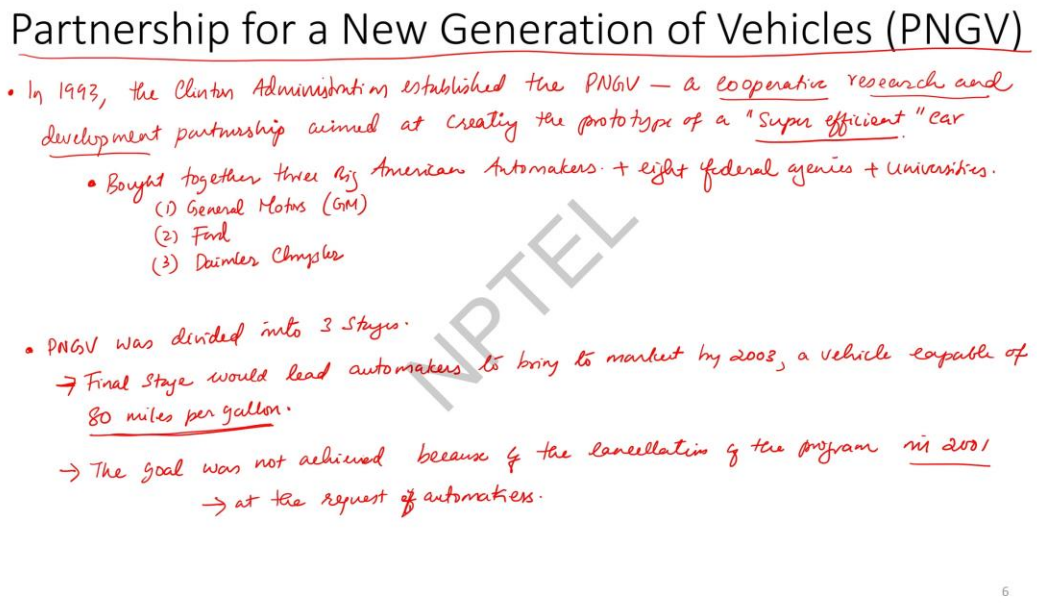
Week 03

Lecture 14

Partnership for a New Generation of Vehicles (PNGV)

Good afternoon, everyone. Welcome to the yet another lecture of the course that will Carbon Credits and Sustainability for Product Lifecycle Management. I'm Dr. Deepu Philip. I'm from IIT Kanpur. And this is a course that we teach as part of the NPTEL MOOCs lecture series.

And along with me, Dr. Amandeep Singh Oberoi and Dr. Prabal Pratap Singh are co-teaching this course. And we have already been seeing about Green Manufacturing. And how the automotive industry, which is the largest in terms of, it was the largest economic activity after agriculture. But then later semiconductor industry overtook it in terms of dollar values. But still, automotive industry turns out to be the largest consumer of raw materials.



So, with that in mind, in 1993, this new program, as we say, called the Partnership for a New Generation of Vehicles (PNGV) came into picture. Okay. So, we have already seen the green manufacturing definition that came under Clinton administration. So, in 1993, the Clinton administration established the partnership for a PNGV, a cooperative research and development partnership aimed at creating the prototype of a super efficient car. That was the key word, super-efficient car. So, the P&GV was a cooperative R&D endeavor, cooperative research and development partnership.

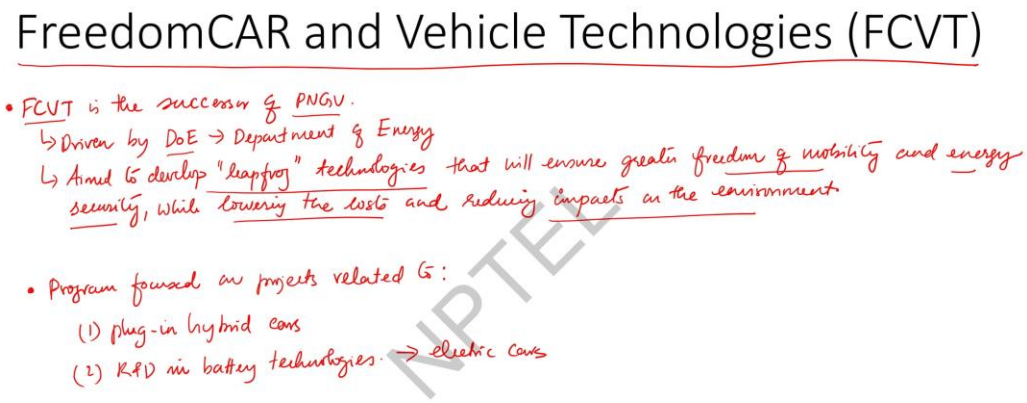
So, then the aim was to create a prototype of a super-efficient car. It brought together three big American automakers. Who are the three? Number one, General Motors, popularly called as 'GM'. Number two is Ford.

Number three is Daimler Chrysler. So, like we people know like things like Jeep and all, they are all part of the Daimler Chrysler, okay. So, these three big American automakers, plus eight federal agencies, plus universities. So, that is how this process was created. Federal agencies that included DOE (Department of Energy), Department of Interior, etc.

I am not listing all of them, but you can read about that. Okay. So, then PNGV was divided into three stages. Okay. So the final stage, the most important is the final stage would lead automakers to bring to market. By 2003, this is 1993, I am talking about 2003 a vehicle capable of 80 miles per gallon, okay. That was the goal achieve very high mileage of 80

miles per gallon, the goal was not achieved because of the cancellation of the program in 2001 at the request of automakers.

The automakers didn't want this program to be continued. So this program was cancelled in 2001. So this 80 miles per gallon target was really not achieved. So the PNGV program died. Okay. And it was cancelled in 2001. But lot of research and development happened as part of this. Okay.



So, then came the next one, which is called as the FreedomCAR and Vehicle Technologies (FCVT). Okay. So, the FCVT is the successor of PNGV. So, MCVT followed by the, and this is driven by DOE. DOE stands for 'Department of Energy'.

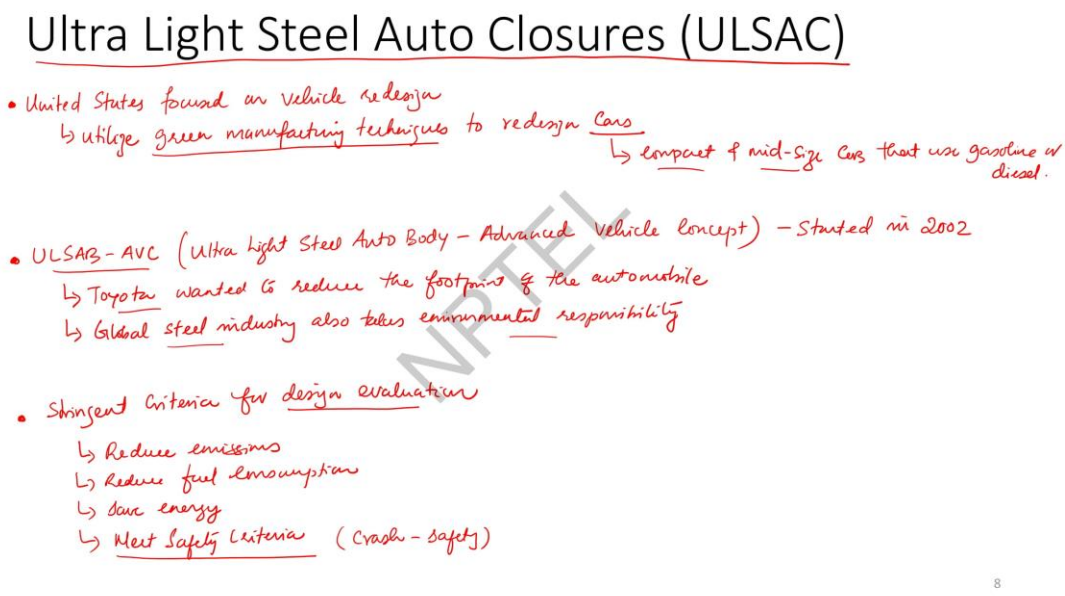
Aim, to develop leapfrog technologies, okay. The aim was to develop leapfrog technologies that will ensure instead of making the car. It was focusing on technologies that will ensure greater freedom of mobility and energy security while lowering the costs and reducing impacts on the environment. So, what we are talking about is the FCVT instead of making a vehicle in the PNGV was focusing on a vehicle which was supposed to make 80 miles per gallon. FCVT which was driven by the Department of Energy, it actually focused on developing leapfrog technologies or futuristic technologies.

Which will ensure greater freedom of mobility and energy security. The aim was to ensure freedom of mobility and energy security. Energy security is meant for the United States.

But at the same time, lower the cost. The 80 miles per gallon product, the biggest problem was the cost.

And reducing the cost and also reduce the environmental impacts. Okay. That's the main thought process. So, the program focused on projects related to. So the program focused on projects that are related to number one plug-in hybrid cars. Now we know there are plug-in hybrid cars that are available, okay.

Number two r and d in battery technologies. Now, almost all the electric cars that we see today, this was meant for what you call as the electric cars. The electric car batteries that we see today, almost all of the R&D in that actually happened as part of the Freedom Car (FCVT) program. Along with the same time, then what happened was, along with the same time the FCVT was running.



There is another project which was called as the ULSAC and Ultra Light Steel Auto Enclosures, ULSAC project actually started.

Then it became an ULSAB and ULSAC, I will tell you what they are. So the focus here again is, this is another program that run parallelly. United States focused on focused on vehicle redesign. Okay. So what was it? Utilize green manufacturing techniques to redesign cars. Okay.

So, which are the cars? Okay. Those are compact and mid-sized cars. Okay. That use gasoline or diesel. So, the main name was utilized green manufacturing techniques to redesign the cars, okay. That was the first thing, which are the compact and mid-sized cars that use gasoline or diesel.

Then came what he called as another one is, it's called ULSAB AVC, okay. This was a new thing that came which was stands for 'Ultra Light Steel Auto Body Advanced Vehicle Concept'. Okay. So, the Ultra AVC is what is called as the Ultra Light Steel Auto Body Advanced Vehicle Concept. It started in 2002. So, if you remember the previous slide, we saw that in 2001, the PNGV died and the Freedom Car (FCVT) started in 2002.

And same time, the ULSAB AVC also started. So, another parallel thing, right. So, an example of, and instead of the American manufacturers, Japanese manufacturers also joined in this. So, the Toyota wanted to reduce, reduce the footprint of the automobile, the footprint of the automobile. Okay. That was a Toyota's aim in this regard. Okay.

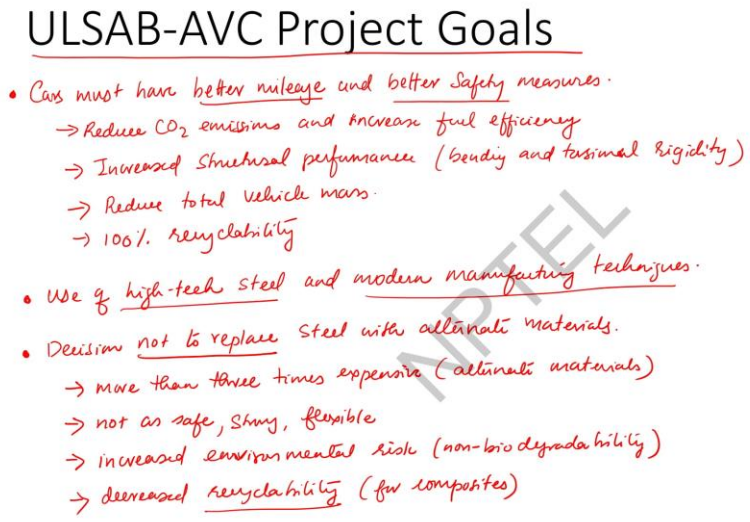
And that was like less material, less emissions, etc. Global steel industry, because steel industry is extremely polluting, global steel industry also takes environmental responsibility. So, the idea was that we use ultra-light steel auto body, reduce the steel requirement in the auto body, create that advanced vehicle concept, AVC. ULSAB AVC stands for that. So, the footprint of the automobile wanted to be reduced, that Toyota proposed this idea.

And global steel industry should be stepping in to take the environmental responsibility. Because if they reduce the steel production, then obviously, if you reduce the steel required for an automotive, or an auto body. Then the material requirement reduces, that will reduce the revenues of the steel industry. So, they should step in for that purpose. That was one thing.

So, what happened was, they also proposed stringent criteria for design evaluation. This was more of a design problem, okay. Stringent criteria for design evaluation, okay. And what are the main criteria aspects? Reduce emissions.

Reduce fuel consumption or better mileage, okay. Save energy. Okay. And reduce fuel consumption, this is at the time of operation, save energy. It's at the time of manufacturing and meet safety criteria. Before this program, almost all auto body were thick gauge heavy steel to withstand the impact.

Whereas, after this program, the safety criteria is crash safety, passenger safety, etc. So, this ULSAB or ULSAB-AVC was a very ambitious project where the focus was on reducing the materials.



So, what were the project goals? Okay. This ULSAB-AVC, what were the major project goals? Let us list them down.

And we said there are stringent evaluation criteria. So, if we write down the goals, it will be easy for us to understand that, right. The main goal was cars must have better mileage, better mileage, and better safety measures. To that point, it was seatbelts and two airbags. So, they started adding more safety measures as part of it.

So, the primary was better mileage and better safety, okay. And so, among these, that is reduce CO_2 emissions and increase fuel efficiency, okay. So reduce the emissions and increase fuel efficiency, increase the structural performance. What is structural performance? That is bending and torsional rigidity. Okay.

So bending and torsion rigidity should be improved, increased. Okay. Then it was reduced total vehicle mass. Okay. Reduce the total vehicle mass. Okay. And 100% recyclability. So everything should be, you should be able to recycle.

So, the better mileage and better safety measures combined together, the CAR goal, the ULSAB-AVC goals came down to this major four. Then came the other goal is use of high-tech steel and modern manufacturing methods or manufacturing techniques. So, second part was use high-tech steel and modern manufacturing techniques. So, that your steel, the ultra-light steel auto body, even though you are using lesser steel, but the steel should have better strength. And more manufacturing techniques, better modern manufacturing techniques, that is the other part.

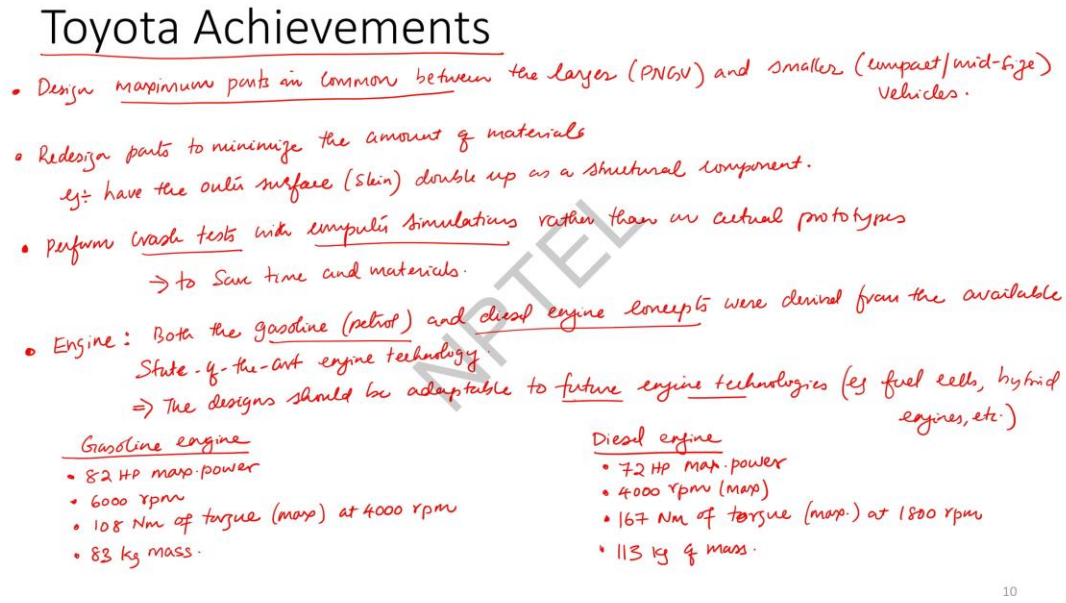
Then, third one was critical also, decision making, not to replace steel with alternate materials. So, not to replace. That was another critical aspect. The program decided not to replace steel with alternative materials. And that was the reason.

That's because of the cost aspect. That's because it's more than three times expensive. Who is more than three times expensive? Alternate materials. They are more expensive.

More expensive than steel. Not as safe, strong, flexible. So, steel is safe, strong and flexible, easily bent, welded, formed, etc. So, steel, that is not possible with the alternate materials. Increased environmental risk.

That is non-biodegradability. That was one other issue. Increased environmental risk was the third portion that drive it. The fourth one is decreased recyclability for composites. Okay. So, the composite materials we could not create the recycler.

The recyclability was not good in that regard. So, this was the ULSAB-AVC project goals as part of it. Now, some of the achievements.



One of the major players in this was Toyota and Toyota achieved some things. So, let us see how they achieved something.

So, what Toyota did was, Toyota was, because this earlier thing was there. So, design maximum parts in common between the larger, okay. Which is the P and GV, and smaller vehicles. Smaller was, if you remember it, it is the ALSA, compact and mid-size, okay. So, you can say compact slash midsize vehicles.

So they wanted to redesign maximum parts in common, maximum parts in common between the PNGV which is a larger vehicle and the smaller compact midsize vehicles. Second one is redesign parts to minimize the amount of material. The amount of material. Okay. So, they wanted our amount of materials. We want to reduce the amount of materials.

Example, What are some of the examples? Have the outer surface surface or the skin, okay. The skin of the car, okay. Now, surface doubled up as a structural component. Structural component, okay.

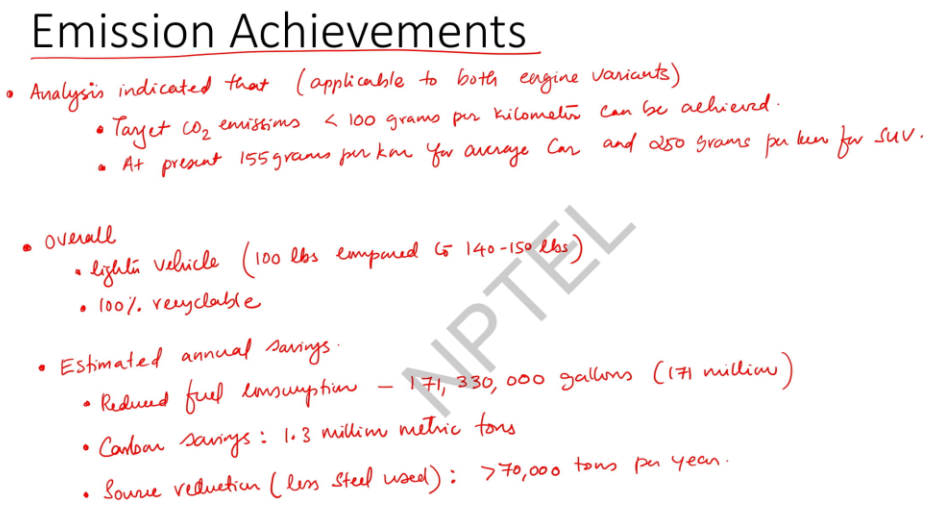
So, that is the one other thing that they ended up doing. The outer surface skin should be doubled up as a structural component. Then, perform crash tests with computer simulation rather than on actual prototypes. Okay. So that is you use computer simulations, the crash tests are done with computer simulations rather than actual prototypes. Why? To save time and materials.

Because after crash test, this entire car is thrown away. So, if you do more computer simulation, then the actual prototype, then using the actual prototypes, then you can save time and materials. Okay. Then, they also had something that they focused on engine. Okay. Both the gasoline and what you call as petrol, gasoline and diesel engine concepts. Engine concepts were derived from the available state of the art of the art engine technology. Okay.

So, the gasoline and diesel engine concepts were derived from the state of the art technology. Okay. And the criteria was, important criteria was, the designs should be adaptable to future engine technologies. Example, fuel cells and fuel cells, not an hybrid engines. So, they said the design, the engine designs should be adaptable for future engine technologies. Future engine technology should be easily integrated with the petrol and diesel engine concepts.

So, what they did is, in this regard, if you look at the gasoline engine that they proposed that Toyota was aiming at, okay. One was, it is about 82 HP, HP max power, okay, about 6000 RPM, 108 Newton meters of torque, which is max torque then at 4000 rpm in 83 kg mass. The weight of the engine is supposed to be 83 kg. In the other hand, if you look at the diesel engine that they proposed at that time, that was the 50 sorry 72 hp max power okay. That is at the 4000 rpm maximum, okay.

And then also, this is the max RPM and 167 Newton meters of torque, okay. That is max at 1800 RPM. And then 113 kilogram of mass weight. So, these are the gasoline and diesel engines that Toyota was proposing for the lightweight system or lightweight cars or the compact and midsize, right.



So, now, what was achieved and what were the emission achievements that was part of this. And that will be a good point for us to stop the lecture or conclude the lecture here. So, what were the emission achievements as part of this? So, first, analysis indicated that, it is not that Toyota did not make the engines, okay. This is applicable to both engine variants. The analysis indicated that target CO_2 emissions be less than 100 grams per kilometer can be achieved.

That is the number one, the first part. At present, 155 gram per km for average car and 250 gram per km, 250 grams per km for SUV, okay. So that is the current one, but you can reach the 100 grams, easily, right. Then, overall, lighter vehicle, vehicle can be lighter, 100 lbs compared to 140, 150 lbs, okay. And 100% recyclable. Okay.

These two parts are achievable, part of it. So, estimated annual savings. Okay. What are the estimated annual savings? Reduced fuel consumption. Okay. Because the fuel consumption is reduced, that is about 171,330,000 gallons.

That is about 171 million gallons reduced fuel consumption was estimated annually. Carbon savings was estimated to be 1.3 million metric tons. Okay. And source reduction means less steel used. That is greater than 70,000 tons per year. So these are the achievements that was estimated out of the Toyota's plan that was created and they have achieved a lot of it at this point.

So with this, now we can see how the current hybrid, smart hybrid, electric, all those vehicles that we talk about were all part of a research and development project that started in 1993, went through different phases. And even though initially started with a better fuel efficient car, but then overall analysis, the steel reduction of source materials, all those kinds of things got added in. And then overall, we were able to achieve a better automotive system as part of it and how the energy security and also ensured better mobility can be ensured as part of this. So thank you for your patient hearing and we will catch up in the next class with a European version of this and go from there. Thank you very much.