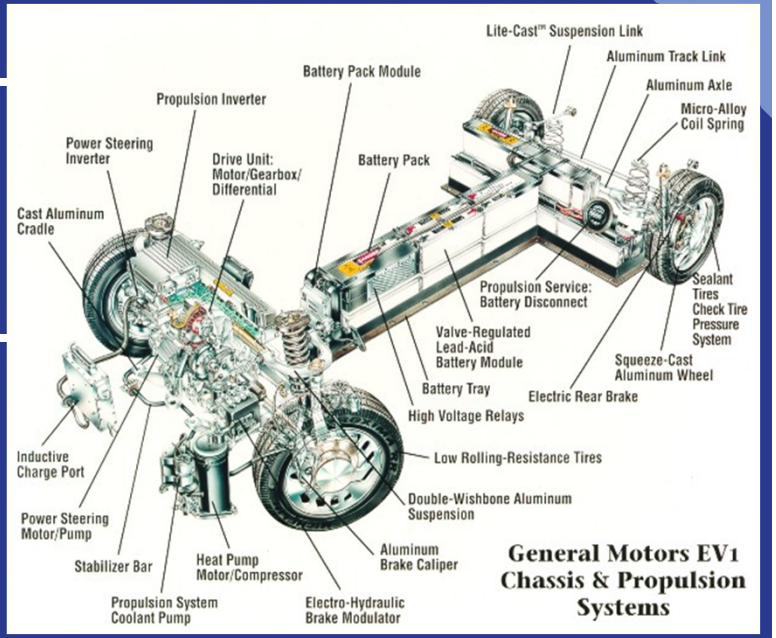
EV 2.0

SOLUTION DESIGN PRESENTATION

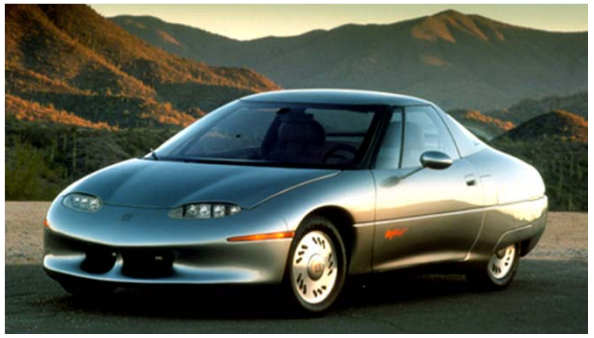
GOODNESS FOWORA
IKENNA ONYENZE
ARINZE UDEH
OLANIYI NAFIU

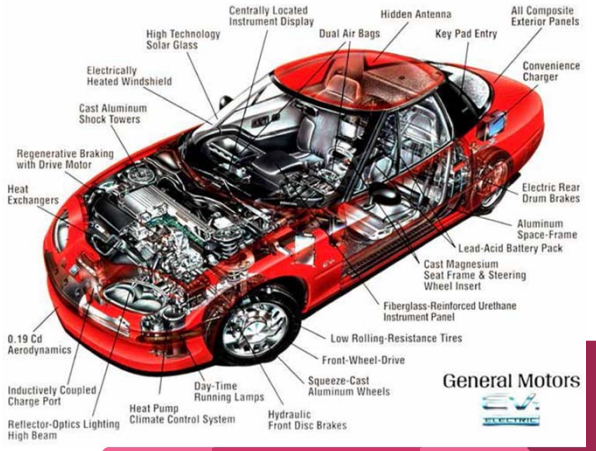
Advisor: Dr. Emmanuel Glakpe (ME)



BACKGROUND

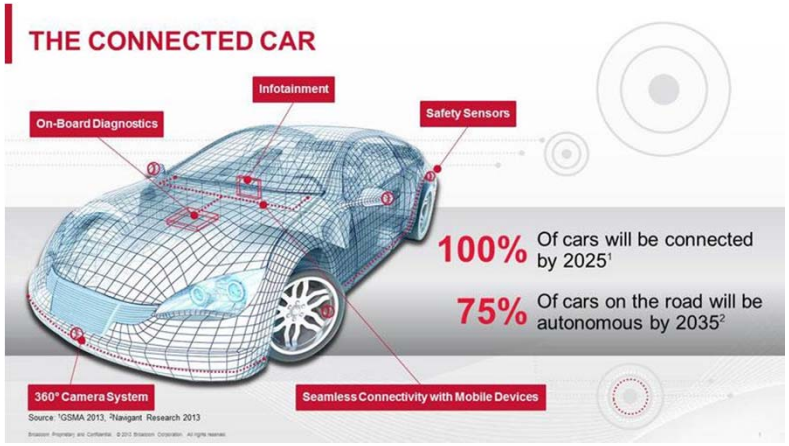
- The EV1 was produced by General motors from 1996-1999
- Fully electric vehicle with a range of 70-90 miles
- Discontinued and recalled because of lack of profits
- Donated to CEA for research purposes by CEA professors
- Converted from an electric car to a hybrid car by Dr Ganley in 2003
- VIP Project led by Dr Glakpe began in 2017 to convert the EV1 to an autonomous electric car





BACKGROUND

- Research into real world electrical and mechanical systems
- Electric vehicles are the future of road transportation
- Electric vehicles are relevant to the advancement of the internet of things



PROBLEM FORMULATION

Problem Definition

- The hybrid vehicle has an inefficient internal combustion engine (ICE) that emits greenhouse gases which pollute the air and cause global warming

Primary Goal

- Replace the series hybrid system of the EV 1.0 with a more efficient propulsion system that does not emit toxic gases to the environment.

CONSTRAINTS

Financial
- Estimated cost - $8750

Intellectual
- Large learning gap for undergraduate students
- Unable to access vehicle

Socio-Cultural
- Lack of charging stations
- The range per full charge is low
- It is still a relatively new technology

Political
- The current U.S. administration is not in full support of the growth/potential of renewable energy
- Tax credits for EV have been repealed

COMPLIANCE

- SAE Standard J2293/1_201402, "Energy Transfer System for Electrical Vehicles”
- SAE Standard J2344_201003, "Guidelines for Electric Vehicle Safety”
- SAE Standard J1772_201710, "SAE Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler”
- SAE Standard J1715_201410, "Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology”

DESIGN REQUIREMENTS

Objective (Problem)	Design an electric propulsion system to replace the series hybrid system of the EV 1.0	
Performance	• Life span of battery pack - at least 2 years • Driving cycle range - 75 miles • 0 - 60 mph in 13 -15 seconds. • Motor efficiency – min. 70% • Maximum motor torque - 149 Nm • Motor Power - 103 kW	
Cost	The cost for the electric propulsion system is estimated to be $8,750	
Safety	• The electric propulsion system in the car should meet the sound standards set by the NHTSA • The autonomous system put into the car must adhere to all NHTSA standards and not interfere with already pre existing standards	National Highway Transport Safety Administration

DESIGN REQUIREMENTS

Energy, Power, and Environment	The electric propulsion system should meet the environmental requirements as stated in the most recent version of the following SAE standard: • SAE Standard J1455, “Joint SAE/ Technology and Maintenance Council (TMC) Recommended Environmental Practices for Electronic Equipment Design”. • SAE Standard J2293, "Energy Transfer System for Electrical Vehicles” • SAE Standard J2929, "Safety Standard for Electric and Hybrid Vehicle Propulsion Battery Systems Utilizing Lithium-based Rechargeable Cells”	SAE International
Intellectual Property	Our system will be based on a limited, open-source patent pool from EV manufacturing companies	
Size and Weight	• Battery pack weight – max. 1175 lbs • Payload - 500 lbs • Curb Weight - 3000 lbs • Gross Vehicle Weight - 3500 lbs	
Deliverables	A design and implementation plan to replace the existing series hybrid propulsion system with a fully electric drivetrain.	

CURRENT STATUS OF ART

Tesla Model S

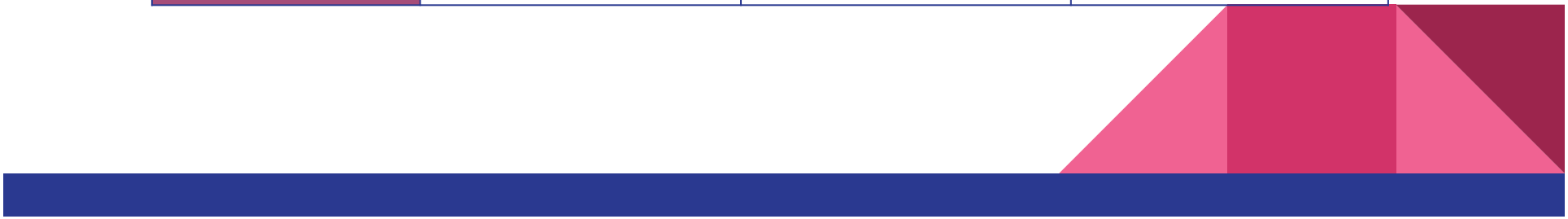
Nissan Leaf

		2011	2017
Battery Technology (Lithium Ion Battery)	Driving range	Below 100 miles.	Over 200 miles.
	Energy density	90 Wh/kg	130 Wh/kg
	Cost	$800/KWh	$162/KWh
DC Power Distribution Network	400V - 450V		800V

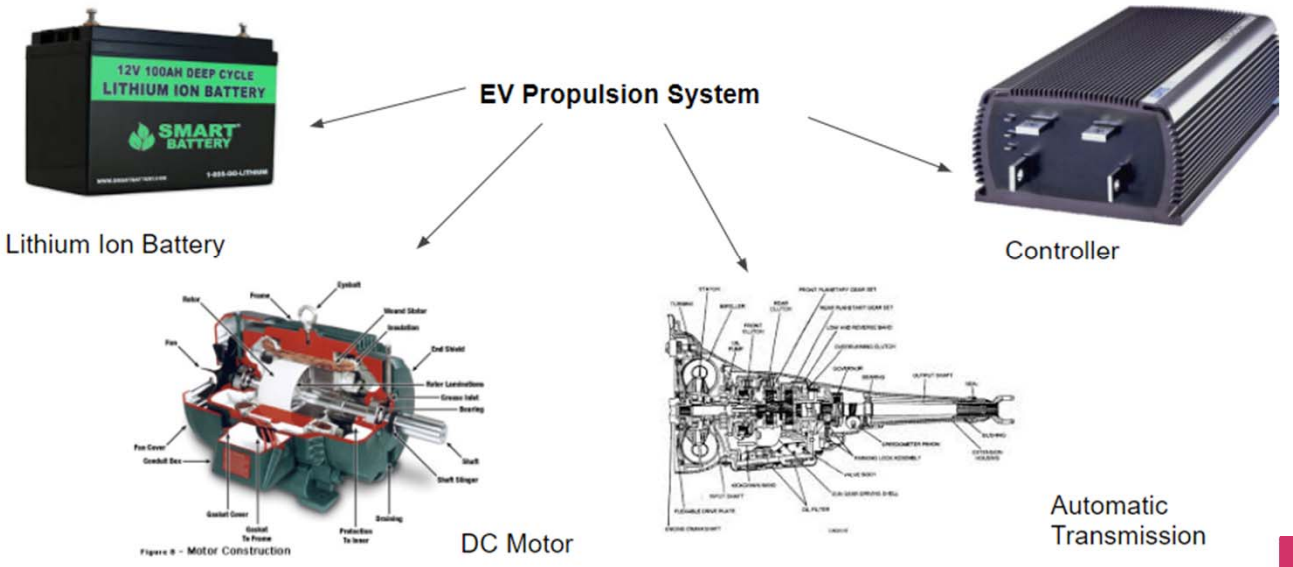
Challenges

1. Lithium ion Batteries lose about 20% capacity every year
2. Higher distribution voltage is needed for lower losses in wiring.

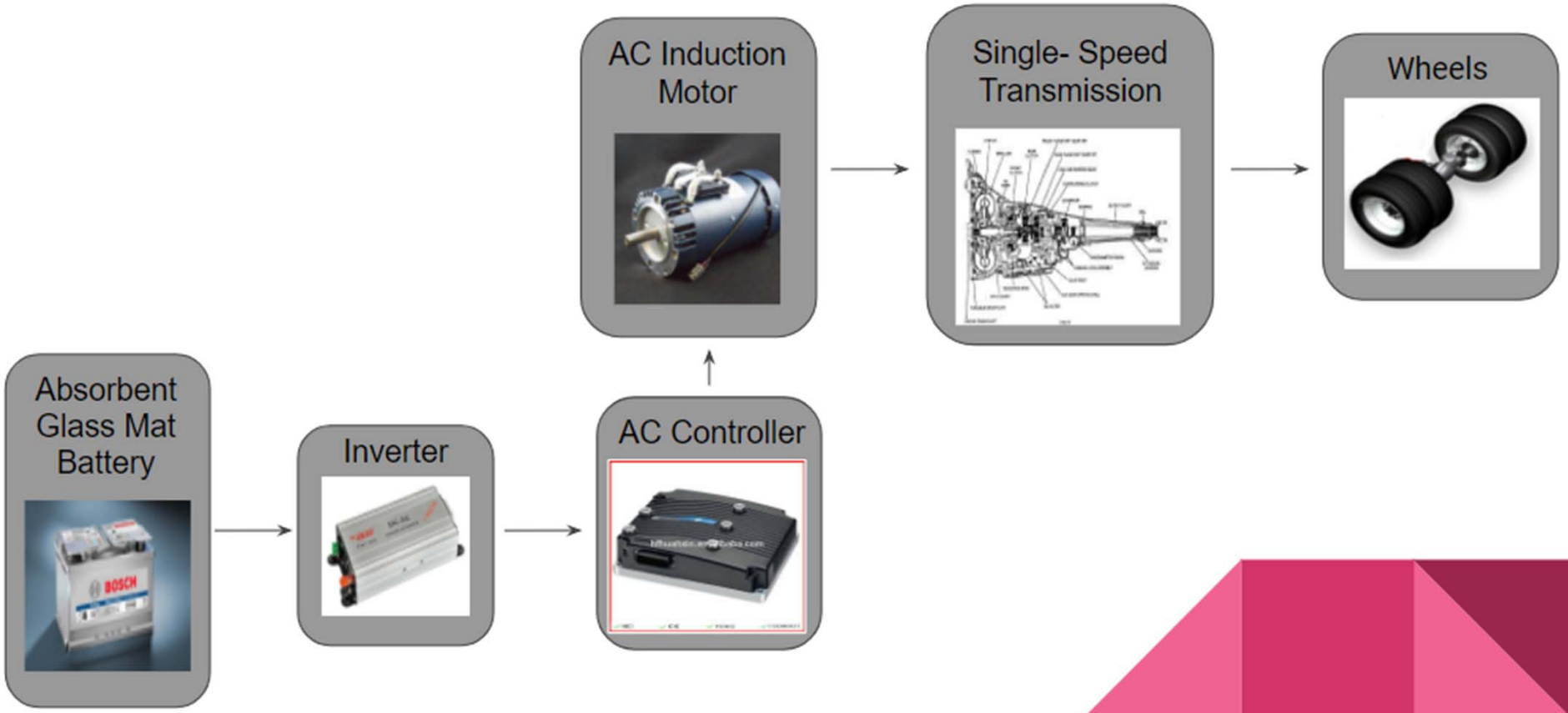
Electric Vehicle	Tesla Model S	Nissan Leaf	Ford Focus
Price	$68,000	$30,680	$17,860
Range	210 miles	107 miles	118 miles
Battery	75 KWh Lithium Ion Battery	30 KWh Lithium Ion Battery	35 KWh Lithium Ion Battery
Motor/HP	AC Induction motor/382 HP	AC synchronous motor/107 HP	Permanent Magnet Electric Traction Motor/150 HP



INDIVIDUAL CONCEPT DESIGNS



CONCEPTUAL DESIGN #2



MOTOR

PMAC MOTOR	AC INDUCTION MOTOR

• Hyper 9 IS kit
  ○ PMAC Motor
  ○ Controller
  ■ 100V 750A HyPer-Drive X1
  ○ Main Contactor
• It is capable of producing 173 ft-lbs. of torque at 0 rpm.
• Designed for use in light to mid weight automotive application, i.e. curb weight of 4000 lbs or less
	• AC 51 kit
	  ○ Motor
	  ○ Controller
	  ■ 72 - 96V 650A Curtis 1238E-7621
	  ○ Tyco Contactor
	• It is capable of producing 88 horsepower and 108 ft-lbs. of torque.
	• Designed for use in an automotive application with a curb weight of 4000 lbs or less

MOTOR SELECTION DESIGN MATRIX

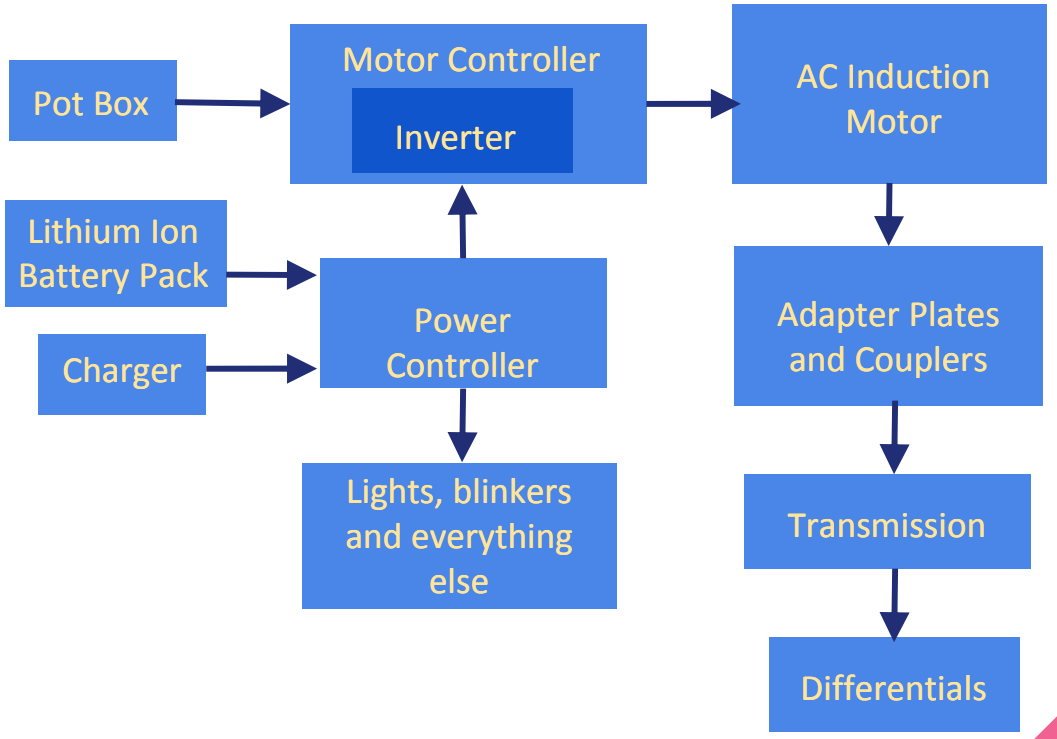
	Weight	PMAC Motor	Score (1 - 5)	Aggregate Score	AC Induction Motor	Score (1 - 5)	Aggregate Score
Peak Efficiency	5	95% at 6500 RPM	5	25	89% at 6500 RPM	4.5	22.5
Cost (motor + controller)	5	$4,305.00	3	15	$4,258.00	3	15
Longevity/ Maintenance	4	10 years or more	3	12	15 years or more	5	20
Max RPM	3	8,000	4	12	12,000	5	15
Weight	2	129 lb	4.5	9	115 lb	5	10
Total				73			82.5

BATTERY SELECTION DESIGN MATRIX

RATING - 96V, 100AH

	Weight	Lithium Ion Battery	Score (1 - 5)	Aggregate Score	AGM Battery	Score (1 - 5)	Aggregate Score
Weight	5	212 lbs at 96Vdc	5	25	572 lbs at 96Vdc	2.5	12.5
Charging Time	4	4 hours	4	16	6.67 hours	3	12
Price	3	$2000 at 96V 100Ah	3	9	$1560 at 96V 100Ah	4.5	13.5
Peukert's constant	1	1.00 - 1.09	5	5	1.05 - 1.15	4	4
Cycle Life	3	Over 3000 cycles	5	15	700 cycles	2.5	7.5
Total				70			49.5

TOP DESIGN


Pot Box
Motor Controller
Inverter
AC Induction Motor
Lithium Ion Battery Pack
Charger
Power Controller
Lights, blinkers and everything else
Adapter Plates and Couplers
Transmission
Differentials

TOP DESIGN

Lithium-Ion Battery:

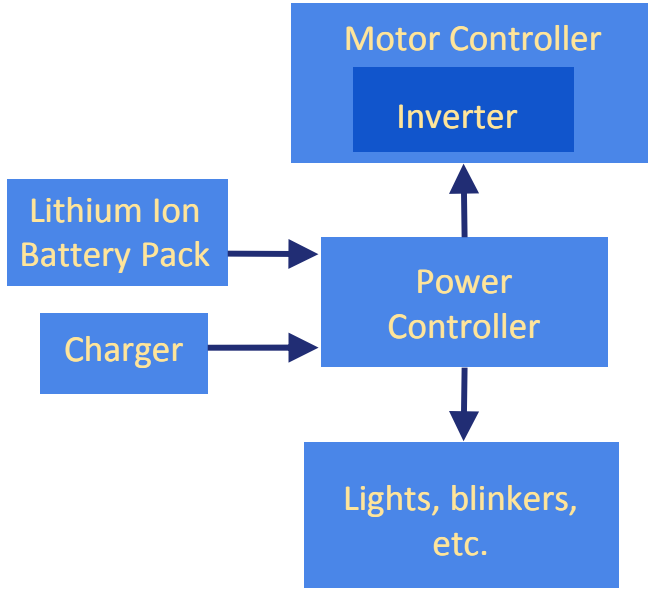
- Power supply of the electric vehicle
- Maximum voltage of 96V

Charger:

- Charges the battery pack by connecting it to an external power source

Power Controller:

- Distributes the power to the motor controller and other components



TOP DESIGN

Pot Box:

- Tells the motor controller how much power to deliver to the AC induction motor

Motor Controller:

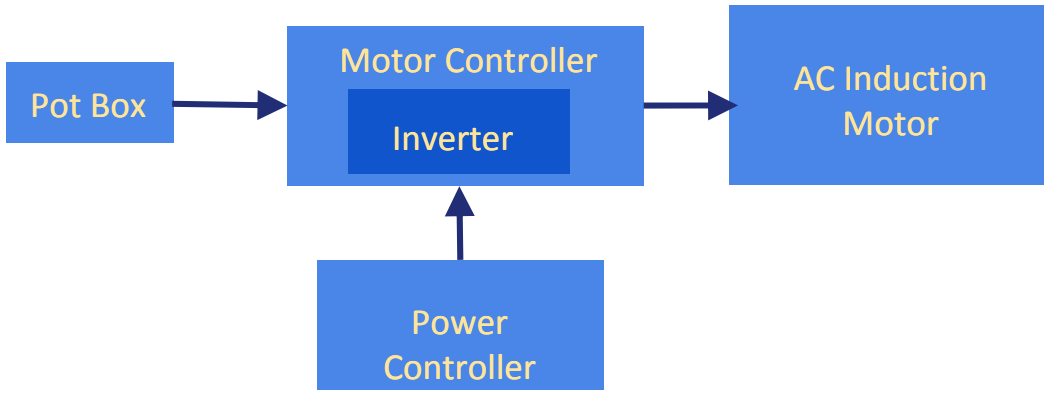
- Varies the power delivered to the motor.

Inverter:

- Converts DC from the battery pack to AC needed by the motor

AC Induction Motor:

- Works as a drive
- The speed of the rotor depends on the ac supplied from the battery



TOP DESIGN

Adapter Plates and Couplers

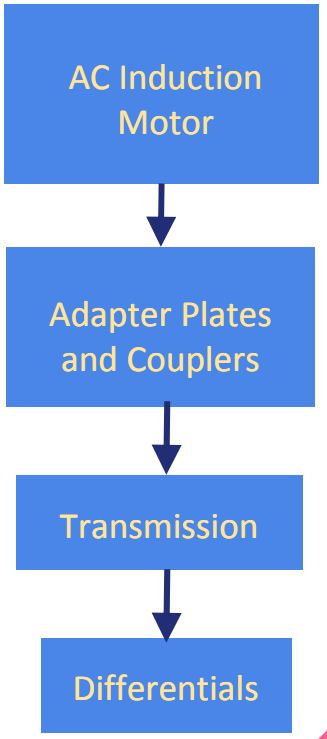
- Transfers torque from motor to transmission
- Designed to be car specific

Transmission

- Transfers motor power to the driveshaft and rear wheels.

Differentials

- Drives the wheels



SUMMARY

- EV1 was donated to CEA by General Motors.
- Converted to a series hybrid vehicle by Dr Ganley as part of his research.
- Goal for the year is to create a design and implementation plan for the electric drivetrain.
- Long term goal is to create an autonomous electric vehicle.
- EVs like Tesla Model S & Nissan Leaf are paving the way
- Conceptual designs focus on the most important components
    - Motor
    - Motor controller
    - Battery pack
- Design Matrix Result
    - AC induction motor
    - Lithium-ion battery

ACKNOWLEDGMENTS

- Team Members
- Dr Emmanuel Glakpe
- Classmates

QUESTIONS?