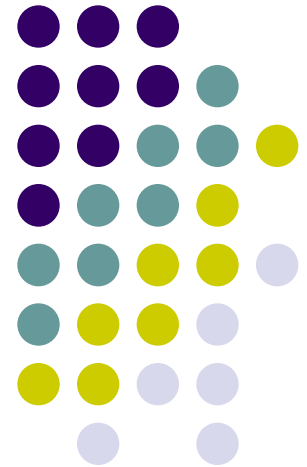
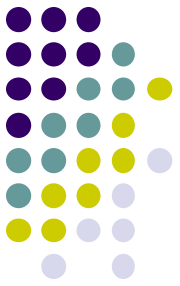


University of Kansas EcoHawks: Sustainable Automotive Engineering

Prof. Christopher Depcik
Chris Billinger
Jessica Lamb
Bryan Strecker

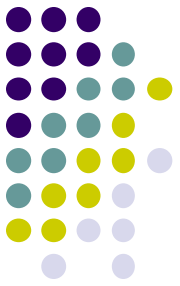


Tenth Annual Kansas Environmental
Education Conference
November 6, 2009



Introduction

- Presenter Backgrounds
- Automotive Trends
- Sustainability
- Environmental Sustainability
- KU EcoHawks Efforts
- K-12 Incorporation into Program
- Concluding Remarks

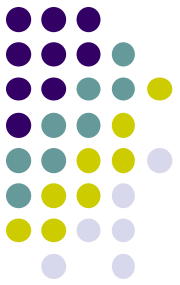


Presenter Backgrounds

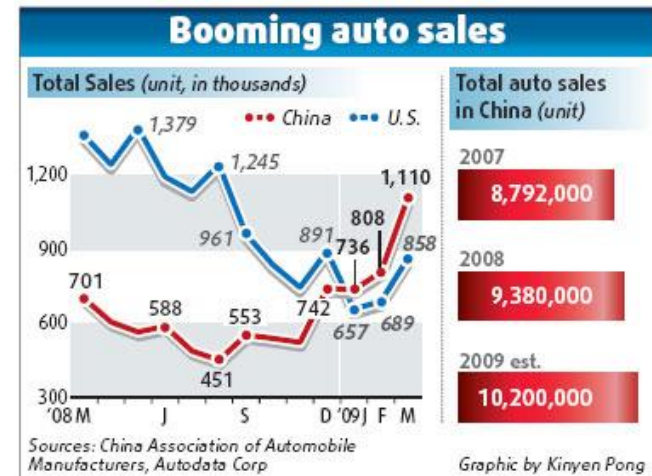
- Prof. Christopher Depcik
 - Assistant Professor at the University of Kansas
 - depcik@ku.edu
- Bryan Strecker
 - 4th year senior from Topeka, Kansas
 - streckb@ku.edu
- Chris Billinger
 - 4th year senior from WaKeeney, Kansas
 - cbill@ku.edu
- Jessica Lamb
 - 4th year senior from Prairie Village, Kansas
 - lamb878@ku.edu

Automotive Trends

- Car production is growing
 - China world's biggest auto market
 - Other developing nations increasing
- Main power plant of vehicle, the internal combustion engine, will not disappear overnight
 - Economic and societal impact
 - High power and energy density
 - Low specific cost
 - Robust and versatile
 - Well matched to available fuels
 - Has met performance, fuel economy and emission requirements to date



Passenger Cars Produced in the World

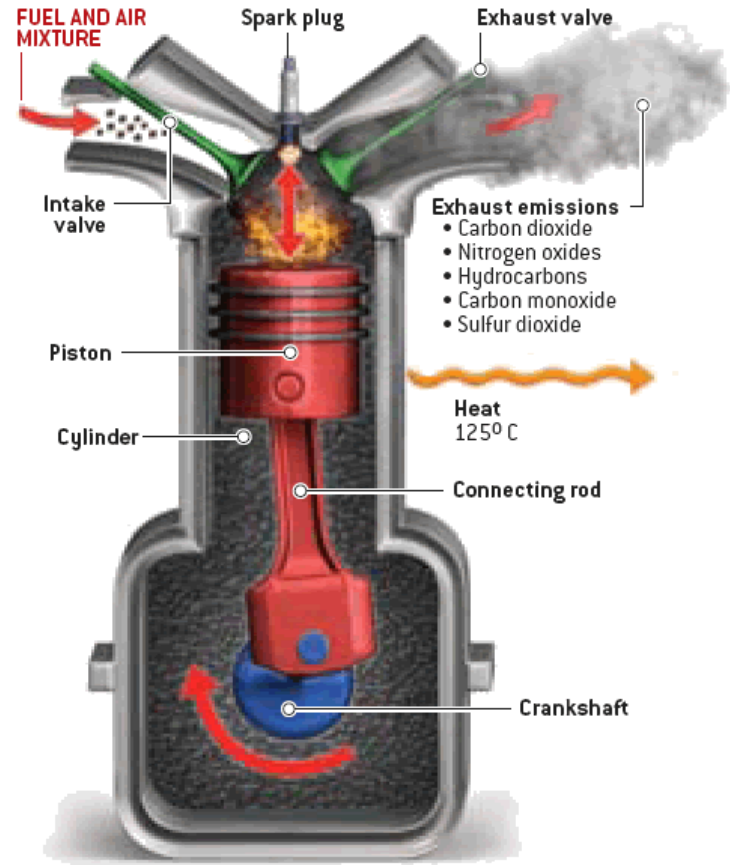


http://www.chinadaily.com.cn/bizchina/2009-04/21/content_7697905.htm

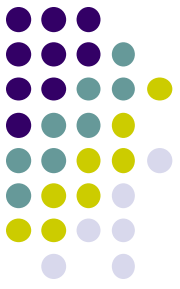
Internal Combustion Engine



- Fuel and air enter engine
- Power is produced
- Hazardous emissions leave
 - Catalysts in exhaust can largely handle
- Greenhouse gases enter atmosphere
 - Only way to reduce is use less fuel

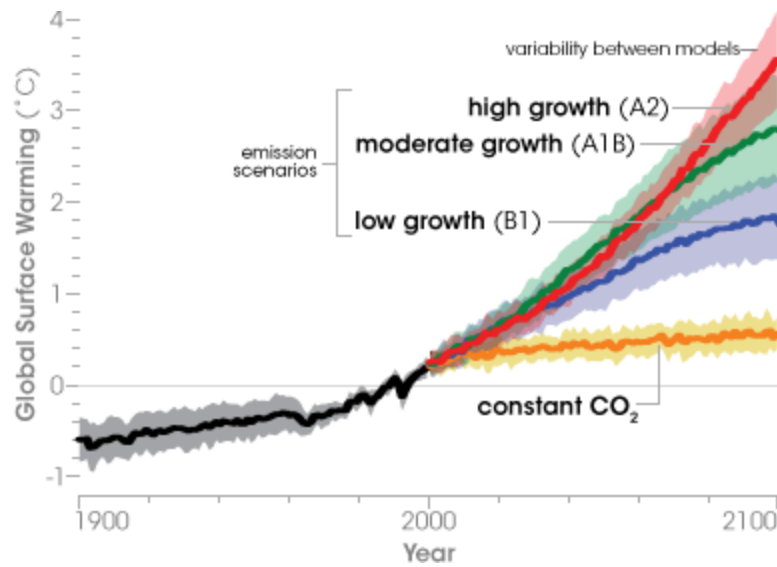


Burns et al., Scientific American (2002)

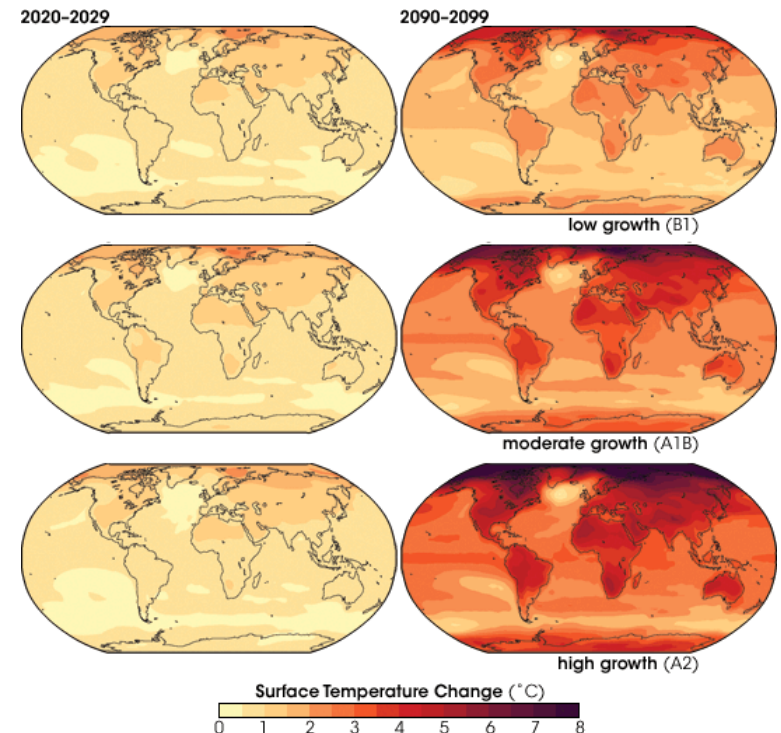


Not Sustainable Future

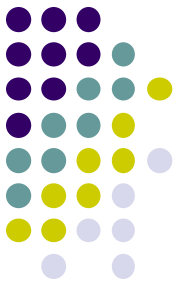
- Need to act now to prevent future issues
- Have to deviate from path we are on



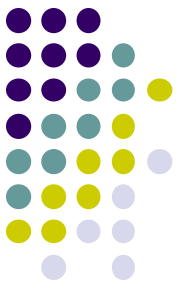
<http://epa.gov/climatechange/science/futuretc.html>



Sustainability



- Classic definition - “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (Bruntland Commission, 1992)
- More recently, discussion of “sustainability” has emphasized “the 3 E’s” of Environment, Equity and Economy
 - Known as the sustainability triangle
 - Or the triple bottom line
- Sustainability undoubtedly has different applications in different disciplines, fields of study and levels of education



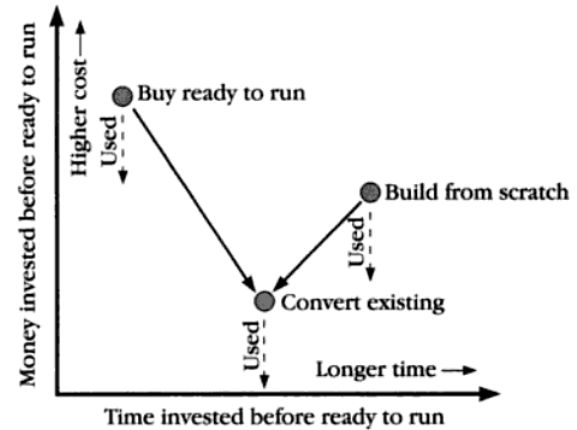
KU EcoHawks Definition

- Approach the situation from five vectors of success:
 - Environment, Energy, Economics, Education and Ethics
- Each concepts individually addresses specific aspects of sustainability
- Shaped by the confluence of the ideals of people, planet and prosperity
- K-12 incorporation
 - Based on classroom objectives, may be advantageous to develop own sustainability definition
 - Same concept, easier for students at different levels to understand



Environmental Sustainability

- KACEE objective
- KU EcoHawks reduce emissions by:
 - Recycling automobiles
 - Savings of between 3 and 12 tons of CO₂ emissions
 - Hybridization for increased efficiency
 - Alternative, low carbon fuels
 - Improving energy infrastructure
 - Smart grid technology
 - New vehicle design



Build Your Own Electric Vehicle by Bob Brant

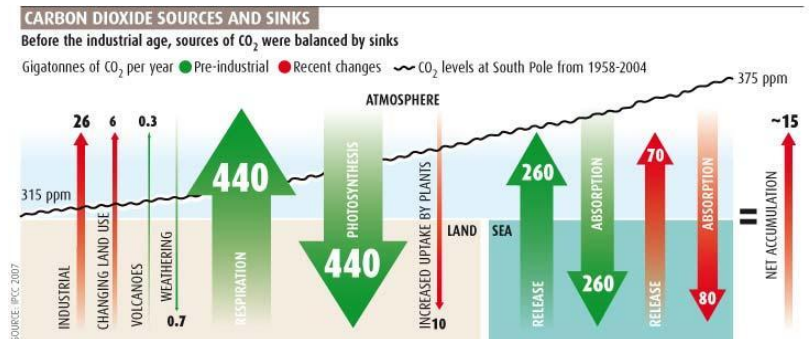
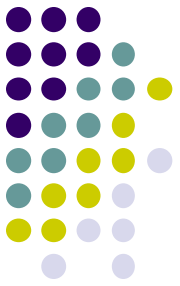
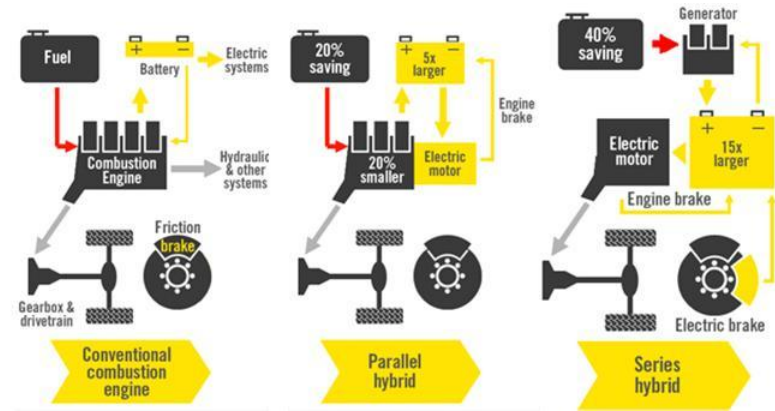


Image reference – [Climate myths: Human CO₂ emissions are too tiny to matter](#)



Hybridization of Automobiles

- Series hybrid design
 - Alternative fuel generator fills batteries
 - Batteries power electric motor
 - Motor moves vehicle
- Most efficient power plant
- 100% recycled fuel
- Reduced hazardous and CO₂ emissions



<http://www.theneutralgroup.co.uk/22.html>



100% biodiesel generator in area of original trunk

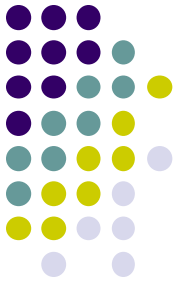


10 Advanced Glass Mat (AGM) lead-acid batteries



NetGain Warp 9 motor connected to original transmission

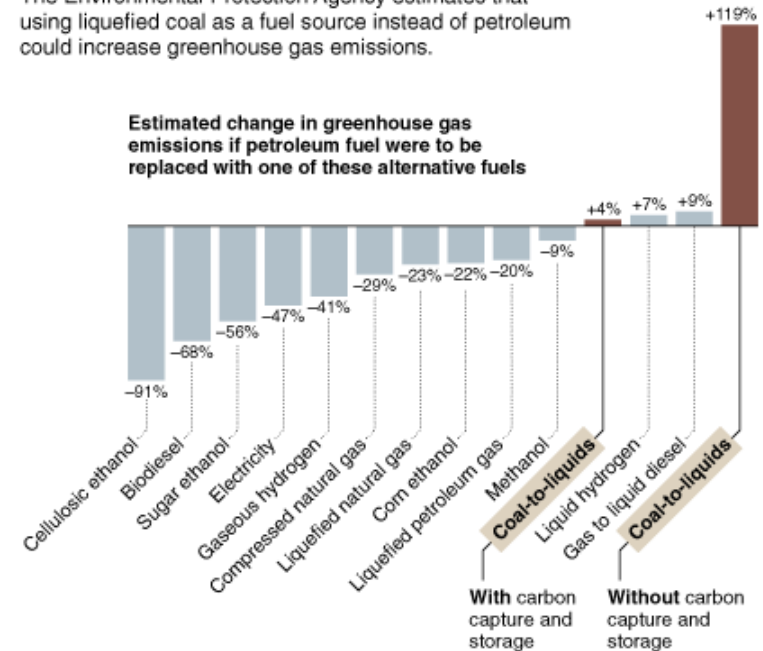
Alternative, Low Carbon Fuel



- KU Biodiesel Initiative
 - Students from multiple disciplines make fuel from used campus cooking oil
 - Educational and feel good opportunity for KU students
- Provides second best reduction of greenhouse gases
- Currently available!

Comparing Fuels

The Environmental Protection Agency estimates that using liquefied coal as a fuel source instead of petroleum could increase greenhouse gas emissions.



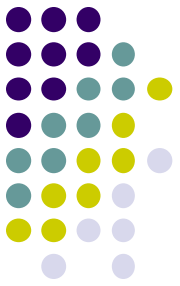
Note: The estimates include emissions from all parts of the process of making the fuels including fossil extraction, feedstock growth and distribution as well as averaging for the different methods of producing the fuels.

Source: Environmental Protection Agency

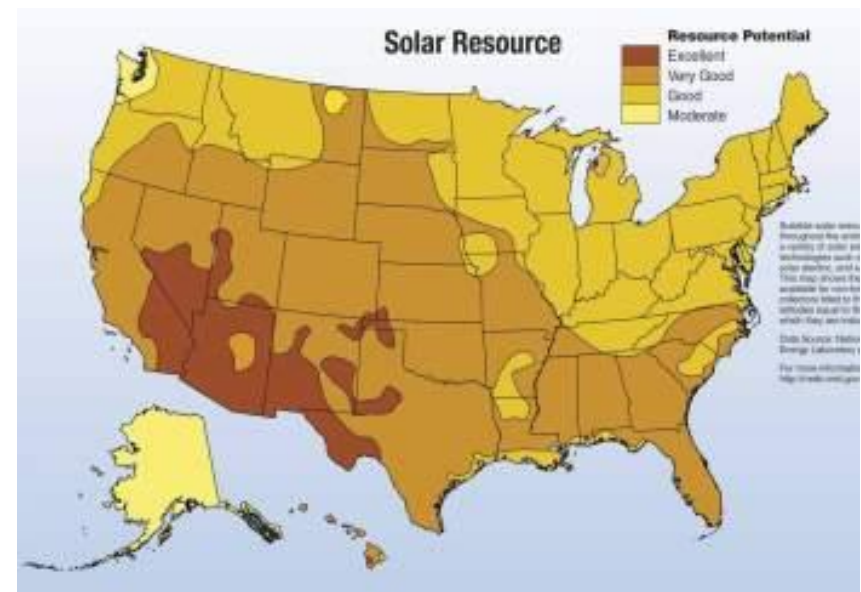
The New York Times

<http://www.epa.gov/OTAQ/renewablefuels/420f07035.htm>

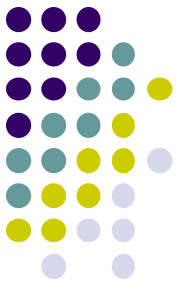
Energy Infrastructure



- Current infrastructure
- Our objectives
 - Make vehicle plug-in hybrid
 - Build solar energy filling station
 - Apply smart-grid technology
- Solar energy positives
 - Eco-friendly
 - Abundant source of energy
 - Easily expandable for small- or large-scale applications
 - Long-term use



Stan Bull, National Renewable Energy Laboratory, University of Kansas Seminar (11/10/08) "Renewable Energy and Energy Efficiency: Status and Potential"



Smart Grid Goal

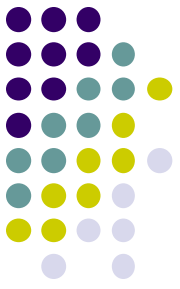
- Incorporate grid energy savings with more efficient automobiles
- Understand when to:
 - Charge battery pack
 - Provide power to grid
 - Use battery pack for high load demands
- Integration with heating and cooling of buildings





New Vehicle Design

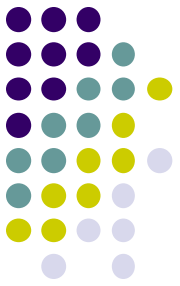
- KU EcoHawks gives students freedom to shape sustainable automotive future
- Accomplished through Remote Control cars on 1/8th scale
 - Power plants: IC engine, batteries, super capacitors and fuel cells
 - Materials: eco-friendly, recyclable, energy efficient
 - Design: reducing drag using wind tunnel testing
- Advanced technology at reduced costs



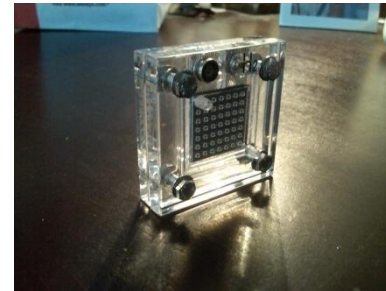
Six EcoHawk Teams

- Team CellMates
 - Hydrogen fuel cell powered vehicle using metal hydride storage
- Team Slayer
 - Parallel hybrid using E-85 or biodiesel fuel in IC engine
- Team AMP
 - LiFePO₄ batteries and on-board battery charger
- Team Redline
 - High efficiency batteries and motor into low drag design
- Team CranoFran
 - Incorporating recycled materials into highly efficient daily driver
- Team Electric Slide
 - Inexpensive plug-in electric vehicle

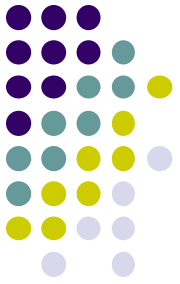
Team CellMates



- Driveline (PEM H₂ Fuel Cell)
 - Power plant of vehicle
- Body (Taxicab)
 - Vehicle outer shell
- Chassis (Bathtub style)
 - Vehicle frame
- SST (Tweel)
 - Steering, suspension, and tires
- Solar (Electrolyzer)
 - Recharging/fueling station



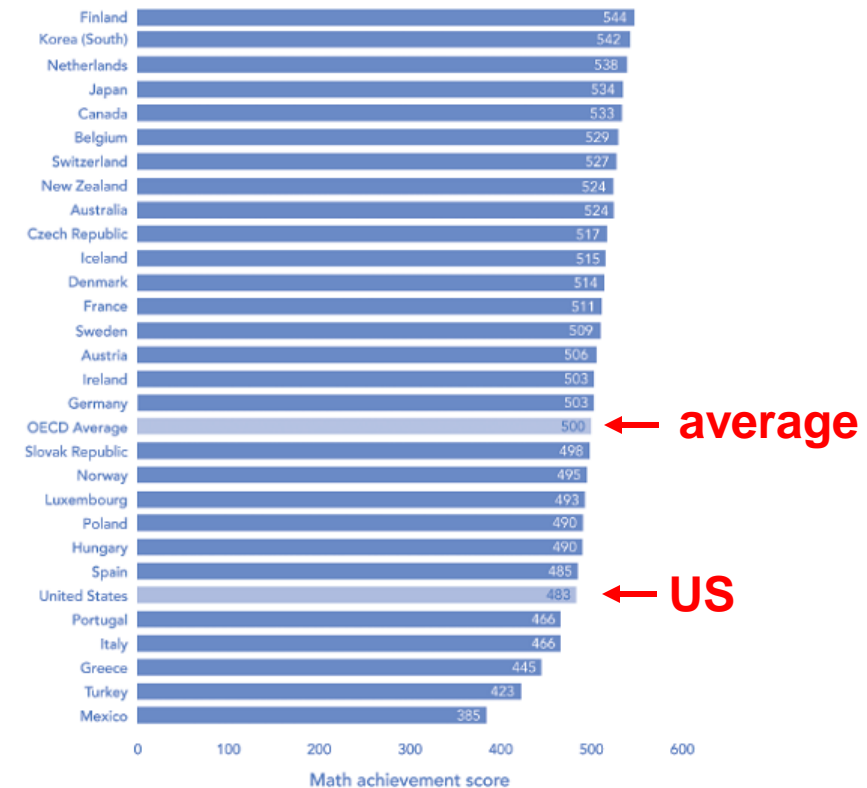
Incorporating K-12



- Current state of US illustrates STEM shortage
- How can the KU EcoHawks support, help and foster development on K-12 level?
 - Enthusiastic KU students
 - Work with teachers to create projects to demonstrate principles
- Incorporate into sustainable tenets
 - Not just for engineers
- Following slides show progression of expertise

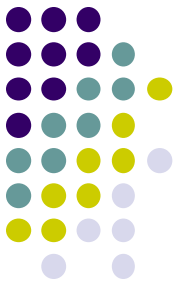
MATHEMATICALLY LAGGING

On international tests of performance, 15-year-olds in the United States, on average, trail behind their peers in many other developed nations. Out of the 30 countries taking part in the 2003 Program for International Student Assessment, or PISA, the average mathematics achievement of U.S. students was higher than that of students in only five countries.



SOURCE: Organization for Economic Cooperation and Development, 2006

Gravity Derby

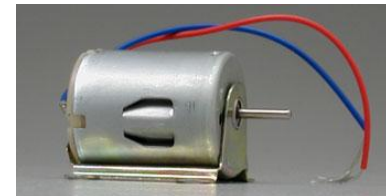


- Ramp race
 - Gravity based power
 - Make from recyclable materials
- Easily constructed
 - Scalable difficulty for any grade level
- Concepts taught:
 - Potential and kinetic energy, rolling resistance, wheel inertia, others?

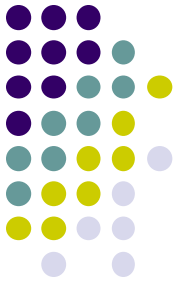


Powered Vehicles

- CO₂ compressed air vehicles
- Batteries and motor
 - No speed controller, on/off switch only, AA rechargeable batteries
 - Motor on right \$2.45
- Solar energy powered
 - Kit seen on right \$28
- Drag tests possibly accomplished at KU
- Concepts taught:
 - Fuels, aerodynamics, center of gravity, gears, others?



Remote Control Car Kits



- Kits

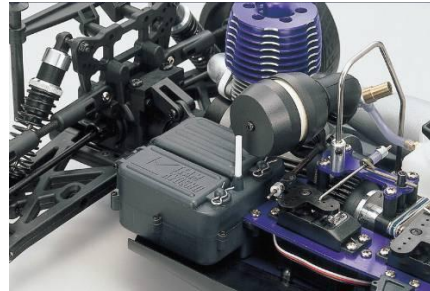
- IC Engine
- Fuel cell
- Battery motor
- Solar energy

- Build your own

- Keep it simple
- Wood chassis and add components
- Parts readily accessible

- Concepts taught:

- Vehicle manufacturing, fuel/battery technology, suspension, motors, others?



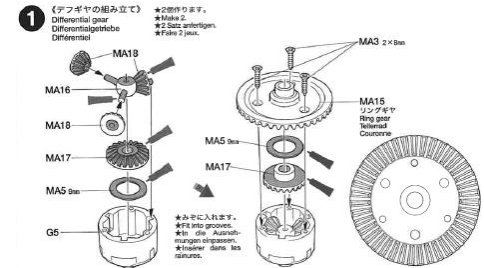
IC engine, transmission, full suspension



Reversible fuel cell, water electrolysis



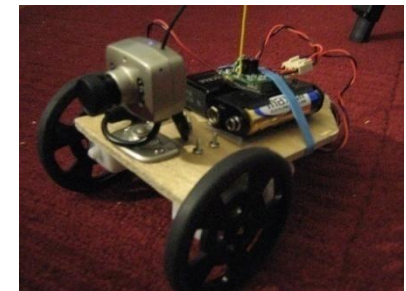
Solar kits or build your own



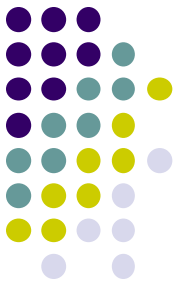
Vehicle manufacturing



Batteries, motors, tires



Build your own battery/ICE/fuel cell version

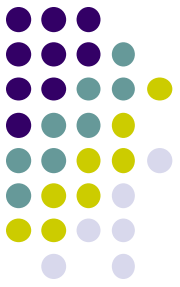


Infrastructure

- Use solar panels or wind power to charge AA recyclable batteries for powered cars
- Creating hydrogen through electrolysis
- Build own solar panels or wind
 - Varying levels of difficulty
 - Start small (1.5V AA batteries)
 - Unlimited possibilities
- Smart grid technology on lower level

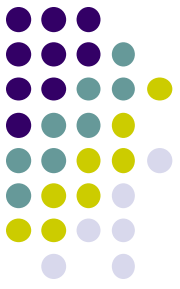


EcoHawks Willing to Assist



- Engineering Expo
 - February 19th and 20th
 - www.kuesc.engr.ku.edu/expo.php
- Competition
 - This year: gravity powered
 - Next year: two divisions
 - Add additional track each Expo
- Instructional blog
 - Teams build own car to compete
 - <http://ecohawks.org>

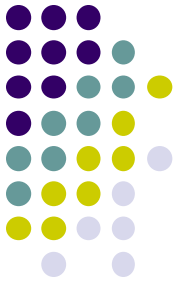




Concluding Remarks

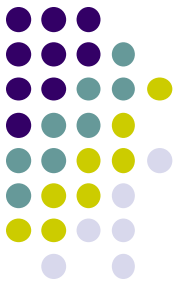
- Current automotive industry and infrastructure is not sustainable
- US is behind in STEM testing
 - Simple ways to instill complex concepts
- Green market is booming
 - Marketable skill set
 - Projected 431% growth for renewable energy in a decade versus 26% growth for oil in two decades
 - Applicable to engineering, sciences, business, journalism and much more

Special Thanks



Georges Hobby House
1411 W 23rd Street, Lawrence, KS 66046
785-843-5087





Any Questions?