Teacher Guide

Curriculum & Program Planning

ten80 Education

STUDENT RACING CHALLENGE™

NASCAR STEM Initiative

Toll free: 1-855-Ten80Ed · Email: info@ten80education.com

www.StudentRacingChallenge.com · facebook.com/Ten80Education

Curriculum Guides

Electronic versions of these booklets and additional resources are available on the Team Web Site.

Teacher Guide: Curriculum & Program Design
- Introduction
- Customizing the Curriculum
- Standards & Assessment Strategies
- Pre-Assessing & Reinforcing Fundamental Problem Solving Skills

#1. Team Guide: National STEM League Handbook
- STEM League Intro, Rules & Guidelines
- Points System
- Organizing & Running Races
- Challenge Tracks, Points Forms

#2. Certifications
- First Things First - Steps to Follow as a new Ten80 team member
- Certification Process & Requirements
- Certification: Driver, Mechanics, Ten80 Fundamentals

#3. Business Planning, Project Management & Public Relations
- Business Planning
- Introduction to Project Management
- Public Relations & Sponsorship

#4. Chassis Setup Investigations (CSI) - Procedures & Data
- Intro to Race Engineering
- Hitting Your Marks (Consistency via data)
- Gear Ratios & Track Mapping
- Traction (Friction Coefficients)
- Energy, Strategy & Scores
- Chassis Geometry (Caster, Toe)
- Suspension (springs & shocks)
- Tracks 1 - 10

#5. Aerodynamic Design
- Intro to Aerodynamics
- Plate Activity (Worst Case Scenario)
- Upside-Down Wings (Increase downforce, improve handling in turns)
- Design on the FastTrack (Reduce drag)

#6. Creative Engineering
- Project Requirements and Ideas
- Intro to Mechanical Engineering & Fabrication
- Lower Control Arm
- Chassis Underplate & Nose Cone
- Car-Wing System

#7. P.I.T. Now! Alternative Energy Projects
- The Challenge
- History & Future of Transportation
- Charging Your Electric Car
- Solar Power, Wind Power, Hydrogen Fuel Cell

#8. Math Lessons

#9. Science Lessons

#10. Robo RaceCar (Fall 2012)

Middle School Guide, 1 of 3

Middle School Guide, 2 of 3

Middle School Guide, 3 of 3

Middle School Curriculum

Print Pack

Wall Posts

Teacher Guide

#1. Team Guide: STEM League Handbook

Middle School Booklet 1 of 3

Middle School Booklet 2 of 3

Middle School Booklet 3 of 3

#2. Certifications

#3. Business, Project & PR

#4. Chassis Setup Investigations

Download from Resource Site

#5. Aerodynamic Design Projects

#6. Creative Engineering

#7. P.I.T. Now! Alternative Energy Projects

#8 and #9. Math & Science Lessons

#10. Robo RaceCar (Fall 2012)

Various videos, presentations, notes, etc.

High School Curriculum

Print Pack

Wall Posts

Teacher Guide

#1. Team Guide: STEM League Handbook

#2. Certifications

#3. Business, Project & PR

#4. Chassis Setup Investigations

#5. Aerodynamic Design Projects

#6. Creative Engineering

Download from Resource Site

#7. P.I.T. Now! Alternative Energy Projects

#8 and #9. Math & Science Lessons

#10. Robo RaceCar (Fall 2012)

Various videos, presentations, notes, etc.

Web Sites

Curriculum & Resource Website (Moodle)

http://mindbugs.mrooms.net

Purpose: Three online courses help you communicate with others, plan and implement your program and access additional resources such as videos, presentations and notes.

How to Access: Login using the username and password provided by Ten80 in a welcome email. Once at the landing page, you'll see several course categories. Yours are under Ten80 Student Racing Challenge: NASCAR STEM Iniatitive. Choose the sub-category and course to enter from those described below.

Course Category: Ten80 Student Racing Challenge: NASCAR STEM Initiative

Subcategories:

Ten80 Team & Region Organizers

Ten80 Team Web Sites

Category: Ten80 Student Racing Challenge: NASCAR STEM Initiative

Subcategory: Ten80 Team & Region Organizers

- *Starting a Team or Region:* First steps for new teams, online forms to schedule training and upload documents

Subcategory: Ten80Team Web Sites

- *Ten80 Student Racing Challenge 2011-12 (AKA Resource Web Site):* Electronic versions of the print pack, additional resources such as videos, presentations, notes & lessons
- *Get Started:* A step by step approach to beginning your program. It follows the suggested schedule #2 from the 'Teacher Guide'.

National STEM League Website

www.StudentRacingChallenge.com

Purpose: Using the login link in the upper right corner, you gain access to the National STEM League site where you create teams, interact with Ten80, learn about events and internship opportunities and participate in the National Points Race by uploading your team work for points.

How to Access: Go to www.StudentRacingChallenge.com. Click on the 'login' link at the top right corner. Login using the username and auto-generated password provided by Ten80 via email.

Welcome from Ten80's Team

Our society has been talking for decades about the fact that U.S. students are not pursuing engineering and science degrees at the same rate as in the past or in other countries. What we have to now address is the new finding that those students whom we consider success stories because they DO enter engineering and science programs in college are not prepared for what they find.

Roughly 40 percent of students planning engineering and science majors end up switching to other subjects or failing to get any degree. That increases to as much as 60 percent when pre-medical students, who typically have the strongest SAT scores and high school science preparation, are included, according to new data from the University of California at Los Angeles. That is twice the combined attrition rate of all other majors.*

Why? Because they thought science was fun but in college discover it is hard.
Think about that!

Though we are putting more and more emphasis on 'engineering' education at the middle and high school levels, we have to ask ourselves the question: Are we misguiding students about the true nature of what these careers require? In many cases, the answer is YES.

Our team of engineers and educators at Ten80 understand that engineering is not building and that building is not necessarily learning. Engineering and science require you have the skills to look at a complicated scenario, break it down into manageable parts and use sound scientific and data-driven methods to deal with it.

The Ten80 Student Racing Challenge: NASCAR STEM Initiative™ is the product of over a decade of research-based, student-focused, classroom-tested development that has yielded an exciting approach to project-based learning ... that doesn't forget the learning... and doesn't forget the common limitations of science, math and career-technology classrooms**.

We appreciate your partnership in showing today's students that possessing the skills to answer the hard questions and innovate a prosperous future are fun not despite the fact... but partly because of the fact...that they are challenging.

Sincerely,

Terri Stripling
ChE & President, Ten80 Education

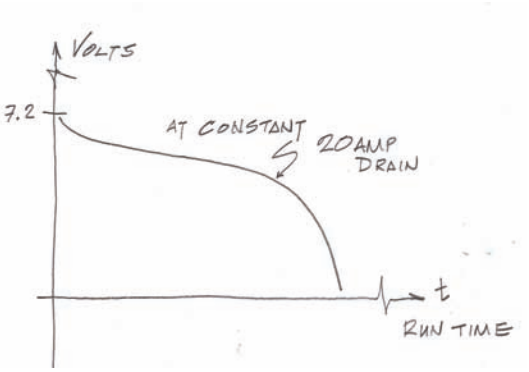
Teacher Guide: Curriculum & Program Design

Table of Contents

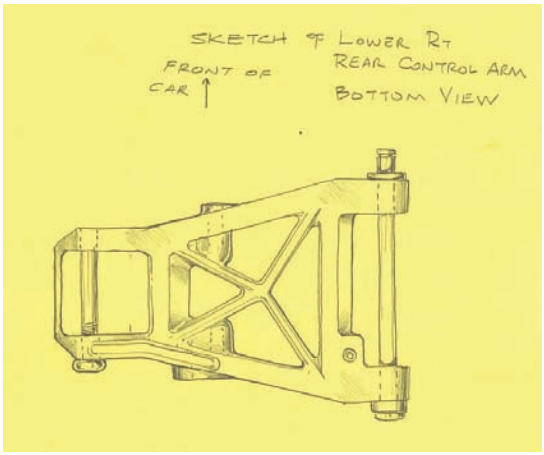
Curriculum Context

Engineering Performance

The ultimate challenge for a Ten80 Student Racing Challenge: NASCAR STEM Initiative team is to engineer performance and how you tackle the challenge depends on your definition of performance. For professional race engineers and competing Student Racing Challenge teams, it is to win races by designing an efficient car with exceptional cornering speeds, very low drag and the proper set up for track conditions. For a math teacher, it may be to see students apply a 2nd order equation to a data set (without prompting). Policy makers may want students to understand energy efficiency and real options for Petroleum Independent Transportation (PIT Now!).



Performance in the Student Racing Challenge means going further, faster. Going both far and fast is a matter of energy efficiency because the finite amount of energy in a battery supplies a finite amount of force. How much of that goes to forward motion depends on the car design and setup. Students improve the design and engineer the right set up to get the most out of every mAh[1].



The formal curriculum is set up in modules with suggested project sequences and schedules to meet a variety of educational goals. For example, if your goal is to introduce design through 3-D CAD in 6 weeks, you may focus on improving the lower control arm or chassis underplate. If you have a year-long STEM course or club, your students can divide into teams, tackle almost every project and be competitive in the National STEM League.

As you design your program, keep in mind two different team models that both have high performance histories.

1. Hendrick Motorsports: All 4 Cup teams work together by sharing data and ideas in the race shop; however, it is each team for itself once the hauler heads for the track. They collaborate and compete.

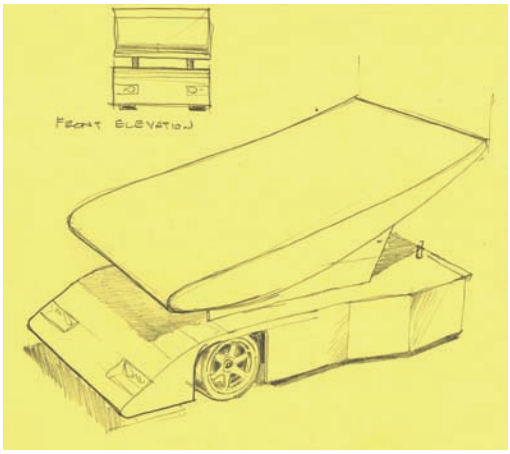
2. Roush Fenway Racing: 5 'Roush' Cup teams consider themselves competitors whether in the wind tunnel, race shop or track. There is no collaboration, only competition.

In your organization, groups of 2 - 4 students can work on different projects then share designs and data (Hendrick model) ... or not share (Rousch model).

1. mAh, milli-amp hour, describes in this use how much electrical charge a battery holds. It is equal to an electric charge transferred by a steady current of one milli-ampere (0.001 ampere) for one hour.

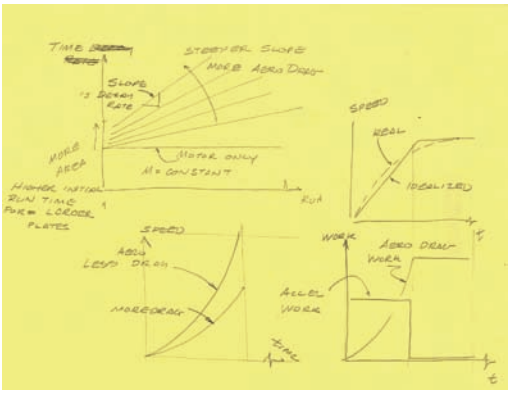
Engineering Perspective

A good engineer is a broadly experienced engineer who has a library of images, ideas and historical solutions to draw from when facing a challenge. As learners you probably don't have a brain full of SUCCESSFUL IDEAS, but hopefully you have a brain full of CREATIVE ones. With literature searches, creative ideas can become testable ideas. Once tested, they will become part of your own internal library of solutions (or disasters to avoid).



Another advantage an engineer has that a student won't have is higher math. As mathematicians will tell you, math is an end in itself, but it is also the language of science. Math gives you X-ray vision so you can see inside things and understand how they do or don't work. Ten80's curriculum handles math generally in 1 of 3 ways.

1. With guidance on how to apply it, you're expected to do grade-level appropriate math.
2. Realistically, trial-and-model will replace some of the higher level mathematics. Where an engineer would sit with a graphing calculator or spreadsheet, students will investigate empirically (systematically try things).
3. A lot of mathematics is hidden inside suggested designs and tools like SolidWorks. It is done for you.



Where to Begin...and Never End

A lab technician who contaminates samples makes it impossible for the chemist to reach conclusions about what works. Similarly a driver who can't drive consistently makes it impossible for engineers to figure out what works.

Once a driver can give 'good data' on handling and performance, the engineering team has an endless number of options for setting up and modifying the car. Based on the experience of thousands of professionals and billions of dollars, this curriculum guides student teams through the best ways to improve race performance. There's no end to the adjustments and improvements; that's part of the fun.

Speak the Language of Math

Being able to describe relationships between variables can help when talking about STEM, politics, social trends, business and sports. Understand these three relationships and you can discuss a lot of the things you'll encounter. For each one, use your finger to draw a graph in the air and discuss examples in the world around you.

- Linear: As one variable increases the other increases or decreases proportionally. F = ma is a perfect example. As the mass (m) increases, the Force (F) increases. Acceleration (a) is the slope of the line.
- 2nd Order (Quadratic Function): As one increases ... the other increases or decreases, hits a max or min then turns around. This is often called the 'Goldilocks Equation' because the max or min value is the one that's 'just right'.
- Exponential: If the independent variable, X, appears as an exponent then the relationship is exponential. The following is an exponential relationship: $y = 3 * 6^{2x}$. The following is NOT an exponential relationship: $y = 3 * (2x)^6$. Exponential relationships are everywhere. Populations tend to grow exponentially. When an object cools (like a pot of soup) the temperature decreases exponentially toward the ambient temperature. Radioactive substances decay exponentially. Money accumulating in a bank at a fixed rate of interest increases exponentially.

Curriculum Contents

The Ten80 Student Racing Challenge: NASCAR STEM Initiative is an integrated STEM[1] program and league in which students build teams around 1:10 scale cars that mirror professional motorsports teams in almost every way. Schools often start using the program as a STEM course or club and over time, evolve to include the lessons in science, math, management, business enterprise and art/design classes.

The curriculum is broken into a number of booklets, each booklet with a number of projects or investigations. Though you do have to make some early choices about how to use the program, the modular curriculum makes it easy to implement as a:

1. Middle Grades science or STEM class - There are not many choices here!
   Do the pre-assessment in this insert then follow the curriculum in booklets MS-1,2 and 3.
2. Math, Physics or Applied Science courses
3. Pre-engineering or STEM course
4. Pre-engineering or technology modules
5. STEM Club that competes over the web or face-to-face and earns points for integrating artists, writers, future business leaders.

1 STEM = Science, Technology, Engineering & Mathematics

Booklet #1 is the National STEM League Handbook that tells you how to earn points and run competitions. Practice internally, compete within your school or district or host a regional competition using the challenge tracks and scores provided.

This Curriculum Insert helps you plan how to organize and implement your program. It is suggested that you begin with Booklet #2, Certifications (aka 'Getting Started') which guides students as they learn how to drive, maintain and repair the car and to make data-driven decisions.

Booklet #3 is on Business Planning, Project Management (PM) and Public Relations (PR). It provides you with tips for presenting your team to sponsors with example materials and business plan. The PM section provides you with common planning tools like Gantt Charts an example project plan.

The Chassis Set-Up Investigations Booklet #4, Aerodynamic Design Booklet #5 and Creative Engineering Projects Booklet #6 are race engineering resources.

- Chassis Set-Up means optimizing race performance through modifying and adjusting the chassis
- Aerodynamics Projects improve speed and handling with more down force and less drag.
- Creative engineering can improve the strength and functionality of parts or your team systems.

Go green and charge your car's battery through alternative energies using Booklet #7, PIT NOW. Make a solar or wind charging station or turn your car into a hybrid hydrogen fuel cell car. Ultimately, learn learn how to take a major step toward Petroleum Independent Transportation, NOW.

Booklets #8 and #9 are collections of Physics and Math extension lessons. Share them with all science and math teachers in your school or organization.

The Middle School booklet integrates 'small' RC cars with the 'big' Student Racing Challenge cars for a grade-appropriate program that prepares students to excel in STEM through high school.

Resource Types

The Ten80 team of engineers and educators are constantly developing new resources to meet the needs of student teams. Contact us through the team web site to tell us what you would like to see.

- Printed Booklets 1 - 6 and MS1-3
- Team Web Site
  - » Booklets in PDF format
  - » Forum to talk with Ten80 and other student teams
  - » Handouts for specific activities (referenced in Scope & Sequences)
  - » Presentations, .PPT and .PDF formats (referenced in Scope & Sequences)
  - » Videos
  - » Articles and links to helpful resources
  - » Link to Professor Pi Blog on the science and math behind current racing events

Reprint content for your students by downloading electronic files from team web site. Your team receives its annual login upon registration.

YOUR Curriculum

A guide in the following section will help you customize the curriculum to meet your goals and work within the resources you have available. Take advantage of the webinar with Ten80 to guide you through the choices and plan your program. Sign up at the *Team & Region Organizers* course.

Assessments

There are six primary assessment strategies with rubrics provided in the *Assessment Strategies* section of this booklet. Specific assessment questions are provided with each project and investigation.

1. Traditional questions and paper-based activities
2. Project review of logbooks and products
3. Final reports that state goals and summarize process, design ideas, results and future plans
4. Online forum discussions
5. Team & individual presentations
6. Final products and how they perform

Projects, Investigations & Lessons

- The goal of *investigations* is to better understand how your car performs in certain circumstances. The product of investigations is data (tables, graphs and equations). For example, do the Gear Ratio Investigation on Track #1 (Chassis Set-Up) so you can choose the best gear set in the future.
- The goal of *projects* is to design then make or modify something. The product of a project is new or different parts. For example, in the Upside-Down Wing project students design a new wing for the car, use 3-D CAD to analyze its effectiveness then build and install their final design.
- By doing projects and investigations, students are touching on assessible math and science concepts. Appropriate lessons to reinforce these standards-based concepts are listed for each project and investigation. THese usually take 45 - 60 minutes and do not require actual driving.