The Indianapolis Motor Speedway Museum preserves and shares one of the world’s premier collections of automotive and motor racing vehicles and artifacts, with special emphasis on the Indianapolis 500-Mile Race. Located within the famed 2.5-mile Indianapolis Motor Speedway oval, the IMS Museum collection encompasses automobiles and artifacts representing more than a century of Indianapolis 500 culture, drama and competition, plus vehicles representing NASCAR, Formula One, American short-track racing, drag racing and motorcycles.

TABLE OF CONTENTS

4 THE OFFENHAUSER
5 HOW AN ENGINE WORKS
6 INDYCAR V. YOUR CAR
7 TIRES
8 DESIGN YOUR OWN FLAG
9 FAST FACTS #1
10 FAST NINE SHOOTOUT
12 BORG-WARNER TROPHY
13 MUSEUM SEEK AND FIND
14 SAFETY
16 FAST FACTS #2
17 INDYCAR CUTAWAY
18 WHAT WE SEE AT THE RACE

This workbook has been made possible through a grant from Indiana Humanities in cooperation with the National Endowment for the Humanities.
Fred Offenhauser, born in 1888, worked on race cars and engines for years before he officially designed his own brand of engines named after himself, the first one being released in 1933. Nicknamed “Offys,” Fred’s engines were extremely popular with Indy 500 drivers. It is estimated that Fred built about 150 racing engines. Offys were winners at not only The Indianapolis Motor Speedway, but many other courses and races. From the time Fred debuted his designs until the late 1970s, Offys would become the engine that powered the most winning cars at Indianapolis. In 27 years, the Offy won 24 victories at The Speedway. Horsepower and reliability made the Offy successful.

KEY TERMS

Horsepower: a unit of measure; the rate at which work is done
Turbocharger: A device that increases an engine’s power output; powered by exhaust from the engine
Combustion Engine: An engine where the controlled explosion of fuel happens on the inside; this explosion powers the engine
USAC: United States Auto Club; the sanctioning body for the Indy 500 from 1955 -1996

How an Engine Works

A combustion engine ignites fuel to create mechanical work, or energy. Fuel and air enter the combustion chamber of the engine and are put under compression by the piston moving up. The spark plug ignites the fuel and air mix, causing a small explosion. This explosion pushes the piston downward, creating power (work). The exhaust is forced out of the combustion chamber, through the exhaust valves, which allows for more fuel and air, repeating the process. The camshaft opens and closes intake and exhaust valves. This work powers the different parts of the car.

The number of pistons in an engine, and the way that they are positioned, is often shown as something like “V6” or “V8.” The “V” refers to how the pistons are positioned in the engine, in this case a “V” shape. The number is how many pistons there are; in this case there are 6 or 8.

WORD SCRAMBLE

FTCNKARASH
KBCIRYDAR
NGIEEN
KSRAP PGLU
TSIONP
YEENGR
IndyCar v. Your Car

<table>
<thead>
<tr>
<th></th>
<th>2019 NTT INDYCAR SERIES CAR</th>
<th>2019 CHEVROLET EQUINOX</th>
</tr>
</thead>
<tbody>
<tr>
<td>MILES PER GALLON</td>
<td>4 mpg</td>
<td>32 mpg</td>
</tr>
<tr>
<td>TOP SPEED</td>
<td>240 mph</td>
<td>130 mph</td>
</tr>
<tr>
<td>WEIGHT</td>
<td>1,620 lbs</td>
<td>3,660 lbs</td>
</tr>
<tr>
<td>HEIGHT</td>
<td>40”</td>
<td>65.4”</td>
</tr>
<tr>
<td>WIDTH</td>
<td>76.5”</td>
<td>72.6”</td>
</tr>
<tr>
<td>HORSEPOWER</td>
<td>550-700 hp</td>
<td>170 hp</td>
</tr>
<tr>
<td>AVERAGE COST</td>
<td>Up to $3 million</td>
<td>$23,800</td>
</tr>
</tbody>
</table>

Firestone tires have been an important part of the Indy 500 since the first race in 1911. As of 2019, 70 cars will have won the race on Firestone tires, more than any other tire brand.

Engineers and chemists are constantly testing and experimenting to find the “best” racing tires.

Racing tires are different from the tires on our everyday cars. Racing tires used at the Indianapolis 500 are smooth, and are often called “slicks,” while the tires on our cars have treads. Tire treads help give wheels grip and traction in all weather and road conditions; racing tires are smooth so that they can better grip a smooth racetrack.

One of the problems with smooth tires is they can’t grip very well in the rain or when there is any kind of liquid on the track. Tire tread patterns are specially designed to help tires push water from the tire surface and allow grip while reducing slipping. The Indy 500 is always stopped if there is rain. The GMR Grand Prix, also held in May, uses rain tires on the road course.
Design Your Own Flag

Flags help race officials communicate to the drivers. Every color has a different meaning.

- **Green** flag means start or go.
- **Blue** flag means allow a faster car to pass.
- **Yellow** flags mean caution! The car should slow down.
- **Black** flags mean drivers should return to their pit.
- **Red** flags mean stop the race.
- **White** flag signals there is one lap left in the race.
- **Checkered** flag means the race has finished!

If you could design your own flag for the Indy 500, what would it look like and what would it mean?

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Fast Facts #1

1. **The road course section of the track required 20,000 tons of asphalt to pave.**

2. **There are over 200,000 seats in the grandstands.**

3. **An Indy car engine produces more horsepower than a semi tractor-trailer.**

4. **There is one non-winner’s face shown on the Borg-Warner Trophy. It belongs to Tony Hulman, the man who purchased the track in 1945. And it’s 24-karat gold!**

5. **Milk has been the traditional drink for the winner of the Indy 500 since 1936.**
In the weeks leading up to the Indianapolis 500, there are a few days at The Speedway that are very important for the drivers. All drivers must qualify for the race. This means that they must try out by driving four laps to see if they are fast enough to race. Qualifying also determines where a driver will start for the Indianapolis 500. There are 33 spots available in what is called the “field.” After the first day of qualifying, the drivers who qualified in positions 10-30 are locked in, and they will not qualify again the next day. The top nine fastest cars, called the “Fast Nine,” and cars in positions 31 and above will qualify the next day to determine their final starting positions. If more than 33 drivers qualify, “bumping” will occur, and positions 34 and above will be “bumped” out of the race.

Help set the field by figuring out which racers should be in the top three spots! Each car’s four lap speeds are listed in the chart below. Find the average lap speed for each to determine where they should start.

To find the average lap speed, add the four-lap speeds together and divide by the number of laps (4).

**CAR A**
Average Lap Speed:

- LAP 1: 32 seconds
- LAP 2: 35 seconds
- LAP 3: 31 seconds
- LAP 4: 37 seconds

**CAR B**
Average Lap Speed:

- LAP 1: 36 seconds
- LAP 2: 35 seconds
- LAP 3: 33 seconds
- LAP 4: 32 seconds

**CAR C**
Average Lap Speed:

- LAP 1: 33 seconds
- LAP 2: 32 seconds
- LAP 3: 35 seconds
- LAP 4: 33 seconds

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**Fast Nine Shootout**

Format current as of 2019 NTT IndyCar Series season

**1ST POSITION (POLE)**

**2ND POSITION**

**3RD POSITION**

**ANSWERS:**
Average Lap Speeds: CAR A–33.75 seconds (2nd position), CAR B–34 seconds (1st position), CAR C–33.25 seconds (3rd position)
Automotive company BorgWarner commissioned the design and manufacture of this trophy, first unveiled in 1936. The Borg-Warner Trophy is presented to the winner of the Indianapolis 500 and has on it the sculpted faces of every winner since 1911. The trophy is sterling silver, standing at 5’4” tall, and weighing in at 110 pounds. There have been a few additions and changes made to the trophy, including the base. This base was put on so that more winners can be added. There are enough spaces on the base to include winners until the year 2034.

How would you want your face to look if you won the Indianapolis 500? Draw your face on the Borg-Warner Trophy! You can include a helmet, goggles, sunglasses, or anything else you might want!

1. Who has won the Indy 500 four times?

2. Who drove the oldest, yellow car?

3. What brand of tire was used on the first winning car?

4. How many laps are driven in the Indy 500?

5. What is the tallest building at the track called?

6. Who was the most recent winner of the Indy 500? What was his finishing time?
Helmets – All IndyCar drivers wear helmets that are designed specifically for racing. They are made from a mix of materials that provide protection against fire, wind, debris, or a crash. Every helmet has a microphone and ear piece inside so drivers can communicate with their pit crews.

Fire Suits – Drivers wear a suit that protects them against fire. Drivers also wear clothing underneath these suits that is fire and heat resistant, made from a material called “Nomex.” Nomex can withstand up to 700°F (370°C) and is used throughout a driver’s safety gear, including helmets, gloves, and shoes.

SAFER Barrier – The Steel and Foam Energy Reduction Barrier (SAFER Barrier) was first installed at the Indianapolis Motor Speedway in 2002. It’s designed to absorb and reduce the impact damage of a crash. This helps keep the drivers safer. The barrier is made in three parts, with steel tubes and thick foam sections attached to a concrete wall. The SAFER Barrier has been so successful in keeping people safe that it has been installed in other racetracks around the United States.

Nose Cones and Chassis – Race cars go through a lot of testing and altering to make them safer. The main body of a race car is called a “chassis” and the pointed section that extends forward from the chassis is called a “nose cone.” These two sections of a race car are important in protecting the driver during a crash. The chassis used during the Indy 500 are made from layers of carbon fiber sheets with aluminum honeycomb in between. These materials keep the chassis lightweight but super strong. The nose cone is designed to absorb the impact energy if the car runs into anything. Both pieces protect the driver by absorbing energy and maintaining shape.

What is another safety feature that drivers might need?
6. Since 2007, Indy cars have used ethanol, instead of gasoline. Ethanol is made from corn.

7. Pit crews at the Indy 500 can change all four tires and refuel a car in 8 seconds on average.

8. The original Speedway track was paved with about 3.2 million bricks, earning the nickname “Brickyard.”

9. The Speedway track is 2.5 miles long.

10. The area inside the oval track covers 253 acres of land—including a golf course.

What’s inside the cutaway?
As you look at the Ganassi cutaway race car, located inside the museum, you can see a lot of what’s inside an Indy car. There are some things that are harder to see though, like what’s inside the walls that make up the tub (where the driver sits). If you look at the section that has been cut away, you can see that there are several layers inside the walls. At the center of those layers is a lightweight, hollow layer made of honeycomb-looking aluminum. This layer provides a lot of structure, while not adding much weight to the overall car. Drivers don’t want extra weight when they are trying to go the fastest!

Tubs of Indy cars are also called “safety cells” because they are designed to keep the driver safe, in case of a crash. Other layers that can be found in a tub are carbon fiber, Kevlar and Zylon. Zylon is a material like Kevlar, which is lightweight, super strong, and also holds up in high heat levels. Some tennis rackets are also made out of Zylon.
Winner’s Wreath: Winning the Indianapolis 500 gets you a lot of things. Not only do the drivers who win get their face on the Borg-Warner Trophy, a glass of milk, and bragging rights, they also get a big wreath to wear. Debuting in 1960, a wreath has been placed on the shoulders of every winner since. The wreath is sponsored by BorgWarner and features 33 ivory-colored orchids with burgundy tips and 33 miniature checkered flags, intertwined with red, white and blue ribbons.

Yellow Shirts: When Tony Hulman purchased the track in 1945, a Board of Safety was set up to create the track’s own Safety Patrol. Dark blue wool uniforms were issued to the patrol, with pith helmets finishing the outfit. The uniforms were uncomfortable and extremely hot, especially in May. In the early 1970s, some of the senior staff members switched to wearing more comfortable short-sleeved yellow shirts on weekends. By 1975, all of the blue uniforms had disappeared completely and the term “yellow shirt” had come to be the common term for the track’s safety patrol.

Yard of Bricks: In 1909, the track’s original surface of crushed rock and tar was paved over with 3.2 million bricks. These bricks served as the racing surface for a number of years until asphalt started to make its way into the loop. In 1936, the first patches of asphalt went down and then gradually more was applied over the next 30 years. In 1961, all bricks had been covered over with asphalt except for the 3 foot section at the start/finish line. The entire 2.5 miles of the track has been resurfaced several times, always with a fresh batch of original bricks inlaid at the start/finish.