



## Lean at the wheel: Pit crews in action

*NASCAR race teams continue to show maintenance & reliability best practices.* by Robert Williamson



NASCAR Nextel Cup racing has emerged as one of the best examples of “team-based” maintenance and reliability for modern manufacturing. Today’s pit crews demonstrate highly planned and scheduled maintenance during each and every pit stop.

While most pit stops are planned preventive maintenance, there are the occasional cases where emergency repairs command their attention. In either case their goals are to “do it right, and do it fast” — and never compromise doing things right to save time. Why? The consequences of doing things wrong are costly: accidents, injuries, NASCAR penalties, unplanned downtime, etc.

We have similar consequences in manufacturing, too. And, we can learn many ways to improve our maintenance downtime from the top NASCAR teams.

### **Anatomy of a pit stop**

No pit crew can execute a successful pit stop alone — it takes the entire race team working together from the start. For example, the crew chief calls the shots that define the pit stop strategy; the spotter tells the driver when it is clear to safely move out of traffic down pit road; the driver positions the car in the pits. Pit support crew members hold a sign board to attract the driver and show him exactly where to stop, wash the windshield, get a drink to the driver, clean the air intakes, hand tires and gas over the wall, and retrieve tires and gas cans. The pit crews we all see on TV and at the races are the “over-the-wall gang” and only one part of a successful pit stop.

### **PM on the fly**

Pit crews are the “preventive maintenance department” when the racecar is at the track. They have to arrive at the track fully prepared with tools and equipment, parts and supplies, skills and knowledge, and the plans and schedules to do it right, first time, every time.

The typical over-the-wall pit crew includes seven members: two tire changers, two tire carriers (front and rear), a jack man, a gas man, and a catch can or vent can man. Pit support includes five to six team members responsible for tires, fuel cans, cleaning, spotting the racecar in the pit area, and of course the crew chief who is providing strategic and real-time leadership.

So, what does a pit crew really do? In a normal pit stop they are tasked with changing tires, topping off the fuel, making chassis adjustments, cleaning off the windshield, cleaning the cooling air intakes, and providing refreshment to the driver, all of this in less than 14 seconds. Wow! And to think it used to take more than a minute.

### **Before and after**

But the pit crew’s responsibilities don’t end with the pit stop. They are also responsible for maintaining the jack, the race guns, the gas cans, and all their other tools between pit stops. They make sure the jack lifts to the right height with every pump and that the race gun operates properly, with the right torque, in forward and reverse. They check the nitrogen hoses, regulators and cylinders that power the race guns used to remove the lug nuts. They check the spring-loaded impact sockets that get slammed on each lug nut without stopping and eject the lug nut after each one is removed.

The fuel cans are filled with gas, weighed, and labeled before every pit stop. The dry-break nozzle that shuts off the flow of fuel is double checked to make sure it is functioning properly.

Attention to details never ends. Everything has to be in working order before the next pit stop — the signboard that shows the driver where to stop the car, the windshield washing tools and extension pole, the long brush used to clean off the radiator and brake cooling air intakes, and the cup holder used to pass cool liquid refreshment to the driver.

### **Timing is crucial**

Everything that happens in a pit stop is carefully timed. The driver, working with the spotter, positions the car on the

track prior to entering and leaving pit road. The slowest, and often the most dangerous, part of many pit stops is the “in and out time” when the car is decelerating coming onto pit road and then accelerating after returning to the track.

Everything that happens during the pit stop has to be done exactly as planned. Each crew member must execute his tasks flawlessly so everyone else can complete their tasks without conflicts or interruptions. Plan your work and work your plan as an individual, and as a crew. If you can't standardize it, you can't improve it.

An enormous amount of data is collected to measure the success of a pit stop — how long it takes is just one measurement. What actually got accomplished from the planned activities is also measured. Each race has a budget, and the team's actual expenditures are compared to the planned expenditures. This data is critical — if you can't measure it, you can't improve it.

### **Preparation**

Laying out both the pit road pit stop area and the behind-the-wall pit area are critical to pit stop success. Every tool, tire, fuel can, race gun, hose, pit cart and tire stand has a precise location to assure safety, efficiency, and accuracy.

On the morning of the race, the exact stopping point for the racecar is marked on the pavement in the pit stop area (pit box) with spray paint. This spot sets the location for everything in the pit area. A video camera is positioned directly over the pit box to record every pit stop during the race.

### **Communication is essential**

The pit crew is NOT an autonomous team that maintains the racecar. They are an integral part of the race team. Communication is key to their success — radios with headphones and microphones are standard equipment. At the race track, the pit crew is intently listening to the crew chief, the driver, and the spotter as they make last minute (sometimes last second) adjustments to their planned pit stop work.

The driver can also make or break a pit stop by where he positions the car in the pit area. Visual communications help make this happen every time.

The driver also communicates to the crew chief from the racetrack. This communication is essential if the pit stops are to be successful. The only way the crew chief and pit crew know what is happening with the racecar (other than lap times) is when the driver communicates over the radio. Effective communication demands that the driver knows his car inside and out. Oil temperature, oil pressure, water temperature, fuel pump pressure, alternator output, and engine RPM gauges all have to be monitored and interpreted by the driver— while he's driving.

He also has to monitor and interpret how the car handles turns and on straight-aways, in traffic and in the lead. The driver is solely responsible for communicating all of the conditions from the track and the racecar to the crew chief so the entire pit crew knows what must be done during the next pit stop. Without this critical information, the pit crew is just guessing.

### **The right tool in the right place**

In the pit, doing the right things the right way is crucial. Over the years, many changes have been made to facilitate efficient and effective pit stops in NASCAR racing. Mechanics, car designers, fabricators and engineers have all made modifications to improve the pit stop, including error-proofing and quick changeover modifications.

Lug nuts are tapped slightly oversize for ease of tightening, and they are glued to the wheels the morning of the race. Studs are modified to accept lug nuts quickly. The hub is modified to align the wheel and five lug nuts quickly.

Each gravity-driven 11-gallon fuel can (which weighs over 80 pounds) will empty its contents in about 5.7 seconds. Just this simple feat took many hours of design and modification back at the shop.

Pit crews have also researched new tools and developed modifications to the heavy-duty spring-loaded sockets, high-speed race guns (impact wrenches) and one-pump jacks they use during stops.

Transport truck (hauler) drivers assure that all of the necessary parts and supplies are inventoried and stocked in the truck and the pit carts before the truck leaves the shop. A “crash cart” contains all of the “quick change” parts that can be swapped out for damaged parts. Teamwork permeates everything.

## Training, training, training

Every pit crew member, pit support crew and driver must train and practice every move to perfection. Individual performance is the starting point. For example, a tire changer can touch each lug nut with his eyes closed.

Next, the pit crew has to perfect its coordinated effort. Lastly, the entire race team and driver must hit the mark and make everything happen as flawlessly as if one person were doing it all. This type of teamwork is only possible when everyone knows what everyone else is doing during the pit stop, and nobody changes their methods — standardized work.

Training and practice for every variable prepares the pit crew to respond quickly and accurately. Aside from a “routine” gas and tires pit stop, pit crews and support crews must be prepared for un-scheduled pit stops such as during caution flag laps (to top off the gas and change tires if needed) or after an accident when the car requires repairs.

## The business case

There is a compelling business case for efficient and effective pit stops in today's NASCAR Nextel Cup racing. A team can gain valuable track position by shortening pit stop time. Track position is important, especially when the checkered flag signals the end of the race. And, aside from pit stop efficiency, effectiveness is crucial. Getting the right adjustments made, replacing the tires with fresh tires with the exact air pressure, getting all the fuel into the fuel cell and assuring that all air intakes are clear add up to a longer running time before the next pit stop.

Race teams that finish in the top 10 get more than prize money; they get sponsor recognition during the televised broadcasts. And this is what NASCAR racing is all about — sponsors' advertising and entertainment. Without the sponsors and the fans, NASCAR racing would not be the advertising business that it has become.

## Lessons from the pit

What can we learn from NASCAR about maintenance and reliability?

*Recognize the reality.* The maintenance department alone cannot take equipment performance and reliability to world-class levels in a sustainable manner. Nearly 90 percent of major equipment losses are outside the direct control of the maintenance department.

Look at the context within which your maintenance is accomplished. All of the maintenance related, and interdependent, variables must be addressed just as they are in race team pit crews:

- Have a compelling business case for maintenance efficiency and effectiveness.
- Prepare the tools and equipment. Make sure everything is available and works.
- Plan your maintenance work carefully, well ahead of time.
- Have alternate plans to account for last minute changes.
- Communicate between operations and maintenance, and all involved personnel.
- Set clear expectations. Standardize all critical tasks.
- Train everyone involved. Practice, practice, practice!
- Coordinate all schedules to facilitate maximum effort in the time allotted.
- Debrief after planned maintenance downtime: what went well, what needs work.
- Gather data and continually improve as the business case dictates.
- Avoid blaming anyone. Look for root causes and corrective actions.
- Maintain the team's integrity.

Race team members and drivers have often told me, “We had a great car. We had a series of great pit stops. We brushed the wall but we came back strong. And we won the race, but we can't stop learning how to get even better.”

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