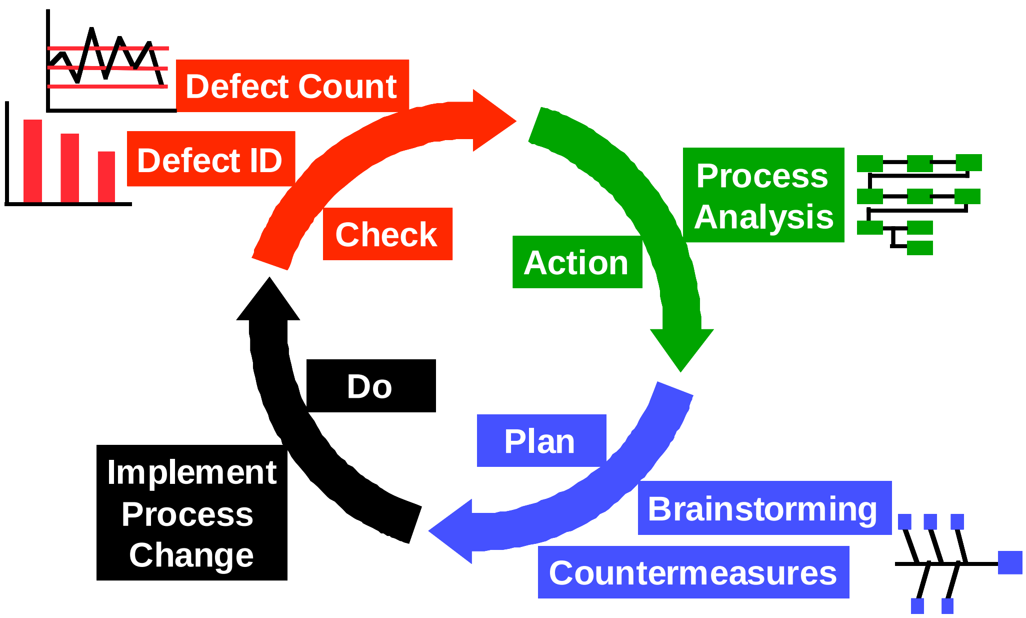
How to Increase First Time Quality by Reducing Dirt Defects



Kevin Lockwood
Director, Technical Services
PAINT PERFORMANCE CONSULTING

PAINT PERFORMANCE CONSULTING
35585 Pound Road
P.O. Box 103
Richmond, MI 48062

phone: 586-727-0066 fax: 586-727-2724
web: www.paintperformanceconsulting.com
e-mail: techservices@paintperformanceconsulting.com

Table of Contents

Dirt Control Philosophy:

What's the most common paint defect in practically every paint shop in practically every plant in the world??? It's that stuff that everyone calls **"DIRT"**.

Next question: What's **"DIRT"**? It's a cotton fiber or a paint chip or an overspray agglomeration. Usually, it's anything that doesn't fit into any of the other inspection categories that are on typical inspection sheets.

It's also something that every paint shop manager and their staff have to work together to **control**.

Here's our (and several others) philosophy on how to do that:

1. *Corporate, plant and paint area management must be committed to the Paint Defect Analysis, Training, and Reduction activities.*
2. *The paint shop must be treated as a separate, special factory environment.*
3. *All of the processes within the paint shop are constantly monitored for their consistency.*
4. *Changes are designed and implemented to continually improve the process.*
5. ***All** paint shop personnel are aware (and routinely reminded) of how important it is to implement their process correctly and how significantly it impacts the quality of the product when they don't.*

We cannot guarantee that all of these five things will be done. We can however, help to educate paint department personnel (at all levels) and help to increase their awareness of these five philosophies. We can also be part of the team whose goal is to ensure implementation of these philosophies.

Essentially, we can be part of the continuous improvement process.

The Paint Defect Analysis Program: The way we achieve this process is by implementing the Paint Defect Analysis Program. It's like a process within a process. It also has it's own set of goals and objectives. The goal is to:

Goal: *Increase the First Time Capability (FTC), First Time Quality (FTQ), Direct OK Rate, First Run, or whatever name is given to cars or parts that do not have to be repainted.*

Note: FTQ is usually measured *after* a polish or finesse process in which operators sand and polish out small defects in the paint film.

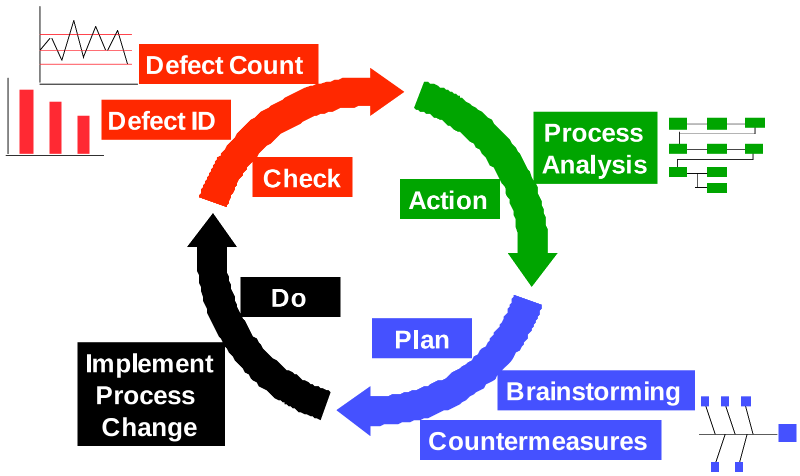
Objectives: This goal can be realized if we carry out the following objectives:

1. *Characterize the types of contamination causing defects in the paint finish.*
2. *Identify the sources of this contamination.*
3. *Relate the defects observed to the processes for which we are responsible.*
4. *Establish, as a team, appropriate corrective action to eliminate (or minimize) the problems that we can control.*

We can represent all of these steps in the Plan-Do-Check-Action Cycle for Continuous Improvement of Figure 1:

Paint Defect Analysis

Figure 1: *Plan Do Check Action Cycle for Continuous Improvement*



Requirements:

What are the requirements to make the Paint Defect Analysis Program work?

The first thing that's required is an **understanding** of what the process and the program are. This requires us, sometimes, to educate our managers and fellow employees, and to show them exactly what steps are involved, where the starting point should be, and how long it might take to see the first result.

Also required - and this is probably the most important requirement - is a significant **commitment** from plant and paint management. This means that they are willing to do all of the things necessary for the program to be a success.

What are those "things"? They include:

1. ***Investing in the program:*** *Dedicating an employee to be a Paint Defect Analyst and giving them the training and equipment necessary for the program.*
2. ***Developing a team*** *of employees and other members who are dedicated to solving the problems identified.*
3. ***Being willing to make the changes necessary*** *to improve the process. These include changes that must be made in the materials, methods, machines, people and environment of the painting process. Part of*

that is knowing how to justify those changes - by comparing the cost of making the change to the cost of doing nothing, and continuing to run at a low % FTQ.

4. ***Being willing to continue the program** even after short-term goals are realized. Too often there is an attitude developed that the painting process is at an "acceptable level of defects". But, what is "acceptable" for one process and one customer may not be for another. **Zero defects**, while seemingly a lofty and unattainable goal, should be everyone's target. As you get closer to this target, it becomes much more difficult to make and to see the incremental improvements. **This is where it takes the most dedication and commitment to continue**.*
5. ***Time**. Without a commitment of time by the paint manager; time for team meetings, time for process investigations, time for reporting and time to allow process improvements to be realized, this program will fail.*

The Paint Defect Analyst:

Also known as a Dirt Analyst, Doctor Dirt, Dirt Bag and a few other names that are way too rude to mention. The Paint Defect Analysis Program needs, as we discussed earlier, lots of things in order to succeed. The one essential "thing" we haven't said too much about yet, is the Paint Defect Analyst.

What (or who) is a Paint Defect Analyst? They (we) are the people that provide the information that the Paint Department Manager and the Dirt Team needs, to make the process changes, which result in process improvements. So what exactly does a Paint Defect Analyst do? And what skills does a person need to be a Paint Defect Analyst? Keep reading.

Key Responsibilities:

1. Implement the Paint Defect Analysis Program.
2. Do paint defect data collection (both dirt count and dirt identification) at various points in the paint process.
3. Use SPC guidelines to chart this data in a way that is understood and used by the Paint Manager and the paint department staff.
4. Establish and maintain a Paint Defect Reference Library specifically for the paint department.
5. Lead (and if necessary help develop) a "Paint Defect Reduction Team".
6. Solicit other vendor or department support for the team and it's dirt reduction activities.
7. Do special projects as necessitated by the needs of the paint department.

Key Skills and Abilities Required:

1. Knowledge and understanding of the paint process.
2. Ability to communicate with **all** personnel in the paint department.
3. Self-motivation.
4. Computer skills (Microsoft Excel©, Word©, and PowerPoint©, Computerized Imaging and Database System).
5. Basic math skills.
6. Basic writing skills (technical writing skills are a plus).
7. Basic SPC knowledge.
8. Paint defect analysis skills.
9. Basic problem solving ability.
10. The ability to present information in front of a group.
11. The ability to participate on a team.

Microscopy and Sample Preparation Techniques:

The type of microscope we use most often to look at paint defects is a "Shop Microscope", like the one in Figure 2. It's small, portable and, at $450.00, relatively inexpensive. We use it for looking at paint defects on-line, meaning we plop this thing down on a moving car on the e-coat sanding deck or the topcoat inspection line to try to identify the contaminant that's causing the defect. It's a very quick way to analyze these defects. But, initially, it's not very easy. Everyone who's used one says that it takes lots and lots of practice to use correctly. They're right!

Figure 2: *PPC 60X Shop Microscope*

It takes so much practice because the *image* of the thing we're looking at is upside down and backwards from the way it looks on the car. So, if we want to move the image to the right, we move the microscope to the left! If we want to move the image up, we move the microscope down. It's very confusing at first.

Another disadvantage of the shop microscope is that it has only one magnification, 60X. If we want to see things bigger we have to use another Shop Microscope with a higher magnification (they also make a 100X or 200X scope) or we use a Stereo Microscope.

Keep in mind, that, even with all of these disadvantages, the Shop Microscope is still used more often than any other microscope, mostly because of its portability.

Another type of microscope we use is a "Stereo Microscope". These types of microscopes are more expensive, ranging in price from $2,000 to $15,000 or more, depending on how many bells and whistles you want on them. We usually include a video camera system, like the one shown here, in Figure 3.

Figure 3: *Nikon SMZ1500 Stereo Microscope*

The biggest advantage of a stereo microscope is that it has an excellent depth of focus. This means that if you focus on an object in one plane, other parts of that object, which are in a different plane, are in focus also. In this way, you can see 3-dimensional defects, like fibers, quite well.

Another advantage is that the *image* is oriented exactly like it is on the panel. This allows us to work under the stereo microscope and perform the dissection techniques necessary to help identify the contaminant.

Still another advantage is that most stereo microscopes have zoom magnification capability. This means that we can look at a defect using low magnification (10X) and get a good overall view of the defect and then zoom up to a higher magnification (200X) to look at details of the contaminant, which might help us to identify it.

A useful lighting option for a stereo microscope is "polarized coaxial light". This technique shines a light beam, which can be polarized, through the optics of the microscope. The light beam reflects off the surface of the panel we're analyzing. The result is an excellent topographical view of the surface, showing us the distortion in the paint film caused by the contaminant. Often, this is the only way we can see the defect, especially if the defect is in the clearcoat. Figures 4 and 5 demonstrate the usefulness of this technique.

Figure 4:

Crater defect without polarized coaxial lighting.

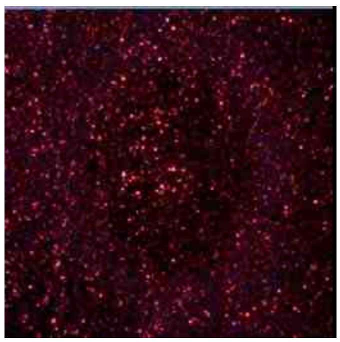
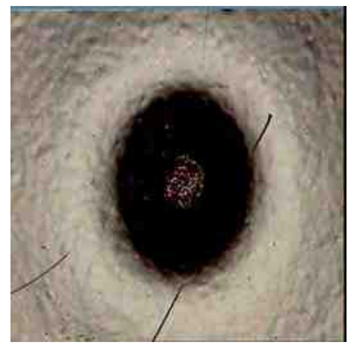


Figure 5:

Same crater defect with polarized coaxial lighting.



Digital Imaging Stereo Microscope System:

Some analysts also use another type of microscope system to help create and organize a Paint Defect Reference Library. The Computerized Imaging and Database System, is shown in Figure 6. It uses the same image from the microscope and video camera, then digitizes the image and stores it as a graphics file within a graphics database program. The program allows text to be stored with the image also. This means that information about all of our reference and defect samples and process photos (taken with a digital camera) can be archived and subsequently searched, when we want to compare an unknown with previously analyzed samples.

We can also use this system as an educational tool. A Computer Based Training (CBT) program is currently being developed, in which new analysts will be able to review process photos, and reference and defect sample images contained in the database. The sooner an analyst can recognize paint defects, the sooner they can start solving their paint shop's dirt problems.

Figure 6: *Digital Imaging Stereo Microscope System*

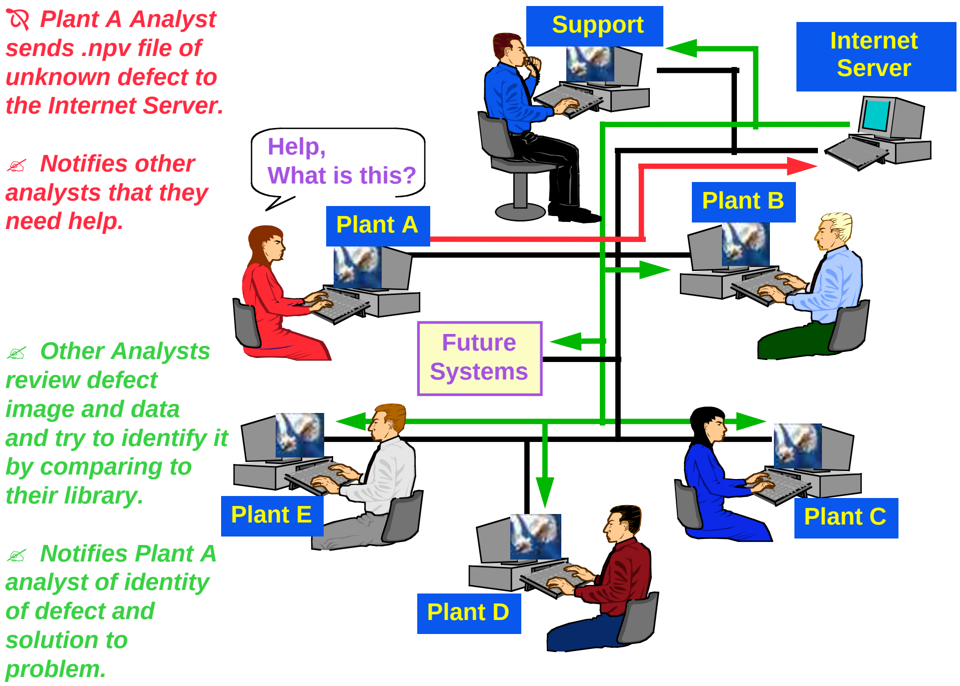
Paint Defect Analysis Network:

We have developed a plan to network these Digital Imaging Stereo Microscope Systems together, using the Internet and software supplied with the system.

Even now, all Paint Defect Analysts with similar systems can communicate with each other, about defects which they are having difficulty identifying. They can send the other analysts an image and record of the defect and ask for help. This is shown in Figure 7.

There are several ways in which to build a Paint Defect Reference Library using the Internet. Some providers, allow you to build a photo album and database on their website, and then allow selected users access to that data.

Figure 7: Paint Defect Analyst Network



Sample Preparation Techniques:

Unfortunately, it's very difficult to use a stereo microscope on-line. Imagine trying to carry all of the equipment you see in the picture in Figure 6 and using it on a moving vehicle. Fortunately, we have several sampling techniques that allow us to remove the defect from the vehicle and take it to a lab where we have our stereo microscope.

If a contaminant is covered with paint, it's usually impossible to determine what it is. We have to use some type of sample preparation technique to remove the paint or in some way uncover the contaminant.

Horizontal Cut: The technique we use most often is the ***horizontal cut***. For this we use a #15 scalpel blade attached to a #3 scalpel handle as shown in Figure 8.

Figure 8: *Scalpel with #3 handle and #15 blade*

Figure 9: *Horizontal cut*

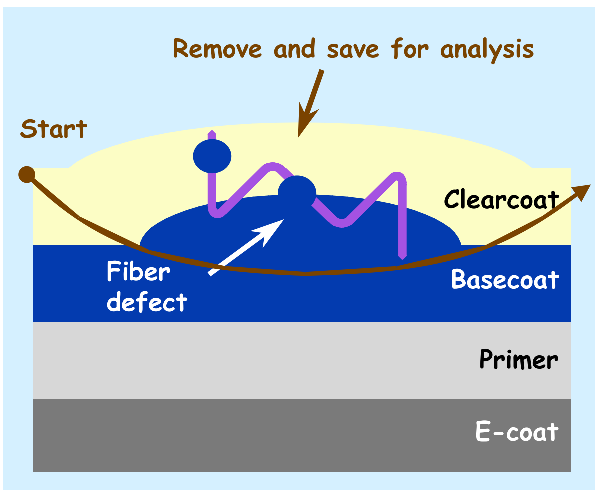
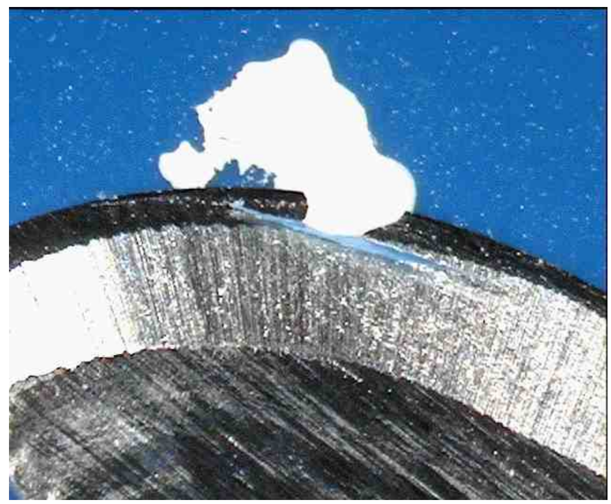


Figure 10: *Horizontal cut*



Beginning about 1-2 millimeters in front of the defect, make a horizontal cut through the paint film and into the defect. Continue the cutting beyond the defect another 1-2 millimeters. While cutting, keep the scalpel blade as flat as possible, so that it does not cut too deeply into the paint film. This is shown in Figures 9 and 10.

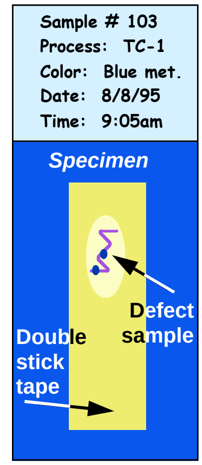
If you do this right, you've left behind a small cut that can either be sanded and repainted or, sanded and polished. It takes quite a bit of practice to do correctly. We suggest practicing on scrap panels first!

Figure 11: *Microscope slide with double stick tape and sample*

The sample, still attached to the scalpel blade, is placed onto a piece of clean double-stick tape, which has already been placed onto a clean microscope slide.

If you want the sample to look exactly like it looked on the panel, slide it off the blade, right side up.

If you want to see what's underneath the paint, put the sample on the tape upside down.



Vertical Cut:

Another sampling technique we use is called the ***vertical cut***. For this we use a #11 scalpel blade attached to a #3 scalpel handle as shown in Figure 12. We also must do this technique under the stereo microscope.

Figure 12: *Scalpel with #3 handle and #11 blade*

Beginning about 1-2 millimeters to the left of the defect, make a vertical cut through all of the paint layers, down to the substrate. This cut is at a 45° angle. Then make another cut at an opposite 45° angle from the first. In this way a wedge is cut out from the paint layers. Using the tip of the scalpel blade, remove this wedge and throw it away. This is shown in Figures 13 and 14.

Figure 13: *Vertical cut*

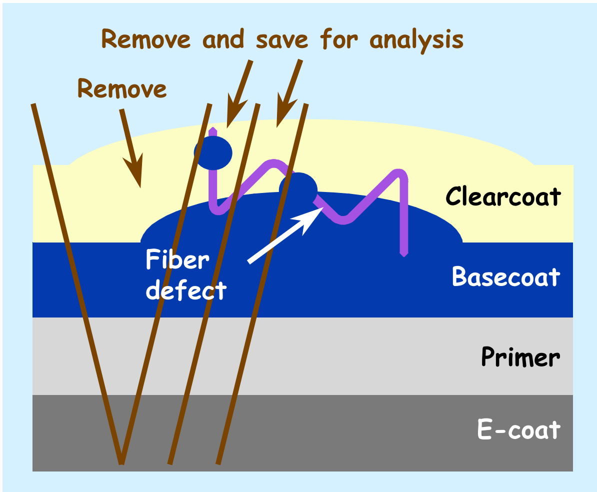


Figure 14: *Vertical cut*

Continue making very thin cuts along the 45° angle made from the wedge, toward the defect. As you start cutting into the defect, save the slices on double stick tape on a microscope slide. It's best to put them in order of slicing, from top to bottom on the slide. In this way, you have cross-sections of the contaminant, surrounded by the paint.

This technique also takes some practice to perfect. Again, it's best to practice on scrap panels.

Also, since you're cutting into the substrate, *the result is a scrap panel*. We only do this technique on panels or parts that can be easily removed from the vehicle and replaced, like gas doors or cowl panels (we've also done this technique on hoods, but it takes two people to remove it from the car body).

At a parts plant we do this on parts that will fit under the microscope easily, or on parts that will be scrapped, that we then cut to fit under the microscope.

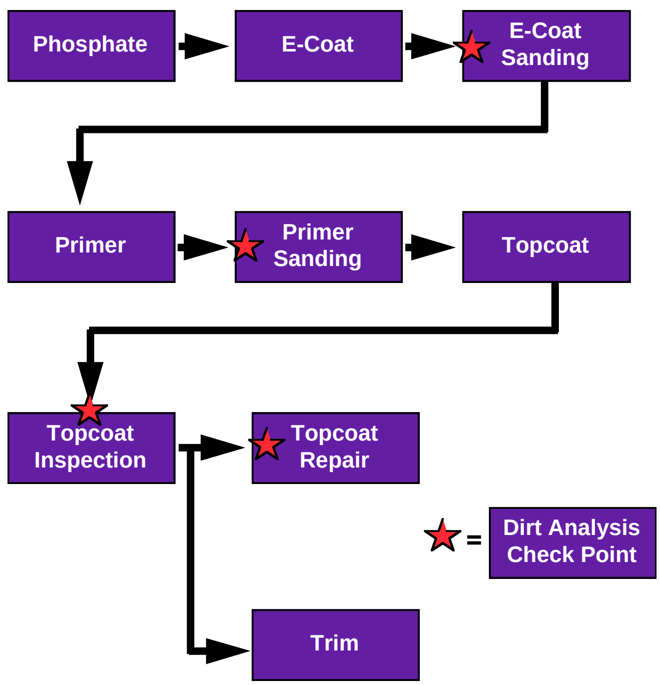
Setting Up a Process Monitoring System:

When an analyst begins the implementation of the Paint Defect Analysis Program, it's important to collect meaningful data. When monitoring the paint process for dirt problems, the analyst does a dirt count and dirt identification.

It's also important to choose the right areas of the process in which to do the analysis. This is one of the first activities for a beginning analyst; figuring out where to set up the data collection checkpoints. *For each site, this becomes part of the permanent documentation for the program.*

We've established several recommended points in the typical assembly plant paint process to monitor. Figure 15 contains a generic process flow diagram of a typical assembly plant paint process. After each painting process is a data collection checkpoint. It's here that we do the dirt count and the dirt identification.

Figure 15: *Process Flow Diagram of a typical automotive Paint Shop*



Establishing the number of vehicles or parts analyzed is based on:

- The production capability.
- The number of processes to be analyzed.
- How much time there is to do the analysis.
- How many parts the paint manager allows you to analyze.

It's important to note that in each plant the number of vehicles or parts analyzed will be different. We often try to count a minimum percentage of the cars or parts painted. In an assembly plant making 500 cars per shift, 20 hoods are 4% of production. At a mirror plant, 4% of its production of 5000 mirrors per shift is 200 mirrors. Can an analyst look at 200 mirrors per shift? No way! Do they need to? Again, no way!

The analyst chooses car bodies or parts randomly, to get a true statistical picture of the dirt problem. Some cars may have lots of dirt while others analyzed may have none; the analyst determines the average. Only in the topcoat process are cars analyzed that have already been rejected for dirt defects. These cars are often viewed on the repair line.

Depending on the plant layout, it's often easier to do the analysis during the break times of the workers on the sanding and inspection decks, where the analyst also must work. Good time management is essential!

In an OEM parts supplier plant, where many different types of parts are made each day, consistent data collection becomes more difficult. The analyst must rely on the scheduling department to notify them of the production schedule for a specific day, and these schedules often change.

The analyst must also rely on the inspection staff to quarantine parts that have been rejected for dirt, and these parts should represent all of the dirt problems for that process. This sometimes becomes a risky assumption.

Determining the number of parts on which to do a dirt count and a dirt analysis is based on the production schedule. An analyst in a typical OEM parts supplier plant analyzes between 40 and 50 parts each shift. There are usually 4 - 5 different types of parts and 4 - 5 different colors of paint used on these parts. All of the parts have been rejected for dirt defects, so the statistical picture of the paint process is skewed in that only rejected parts are analyzed - not randomly selected parts (which would include both good and bad parts).

Usually, the inspection staff will cooperate with the Paint Defect Analyst in identifying parts saved for analysis. Quite often it is necessary to stand in the inspection area and analyze parts as they are coming off the line. Skills with the shop microscope and sample preparation techniques are essential here, because, once analyzed, the parts usually have to go back on the line to be reprocessed.

Statistical Process Control:

Statistical Process Control (SPC) is a system for collecting data, using it to learn things about the paint process, then fixing the things that that need to be fixed....

...and then collecting some more data to make sure we fixed the right thing!

There are a lot of more complicated definitions for SPC, but the most important thing we need to know, is right in the definition above. ***We use SPC simply as a measuring tool for the paint process we are monitoring***.

What things do we measure with this tool? Dirt Count and the Dirt Identification are the most important. Another important thing we measure is FTQ. Related to % FTQ is the % Rejected for Dirt. For both of these, we are dependent upon inspection staff to impose, consistently, the quality standards set up by the paint department management.

Because of this dependency, an analyst doesn't rely as heavily on % FTQ and % Dirt data as they do on the Dirt Count and Dirt ID data, when monitoring the paint process. Regardless of the car company, it's very rare to see inspection staff ***not*** being influenced by other factors. They can be production pressures (it's against the law to "send air to trim", i.e. gaps in the line going to the final assembly), lack of attention to details, or simply logistics and plant lay-out ("If I send one more car to the Repair line, I'll stop the OK line!").

Variation:

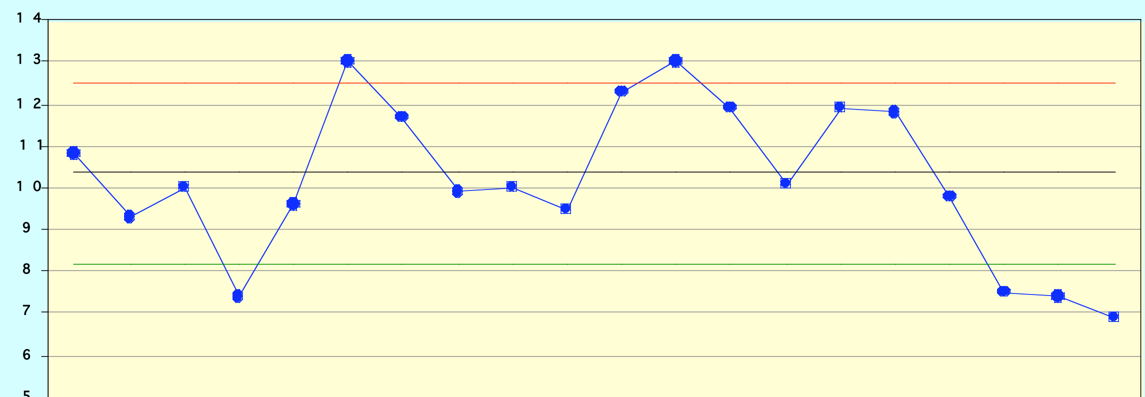
When we monitor the paint process, what is it we're actually measuring? We're measuring the *variation* in the paint process. How much variation is there among all of the equipment, materials, people, methods, and environment in the different areas of the paint department? If you guessed that there are millions of variables, you're probably right (I'm not sure anyone has ever counted them all!).

Does a Paint Defect Analyst have to monitor all of these variables? No way! It would be impossible and unnecessary. Again, the most important things for an analyst to monitor are the Dirt Count and the Dirt Identification.

The analyst has collected dirt counts on the required number of cars or parts, and has filled in all of the data collection forms. What's next? We have established a charting protocol that compiles this data into *U-Charts*, as shown in Figure 16. These are line charts that plot the average number of defects per vehicle or panel or part versus time. They are usually plotted daily, meaning that for each day we collect data, there is a point on the chart. If we look at the chart over a long enough period of time, we can figure things out about our process:

- How big the overall dirt problem is.
- If our process is stable.
- If our process in is control.
- When it was out of control.
- If the dirt problem is getting better or worse.
- If a process change helped or not.

Figure 16: *U-Chart for Defects per Hood*



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DPH	10.8	9.3	10	7.4	9.6	13	11.7	9.9	10	9.5	12.3	13	11.9	10.1	11.9	11.8	9.8	7.5	7.4	6.9
UCL	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Mean	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
LCL	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2

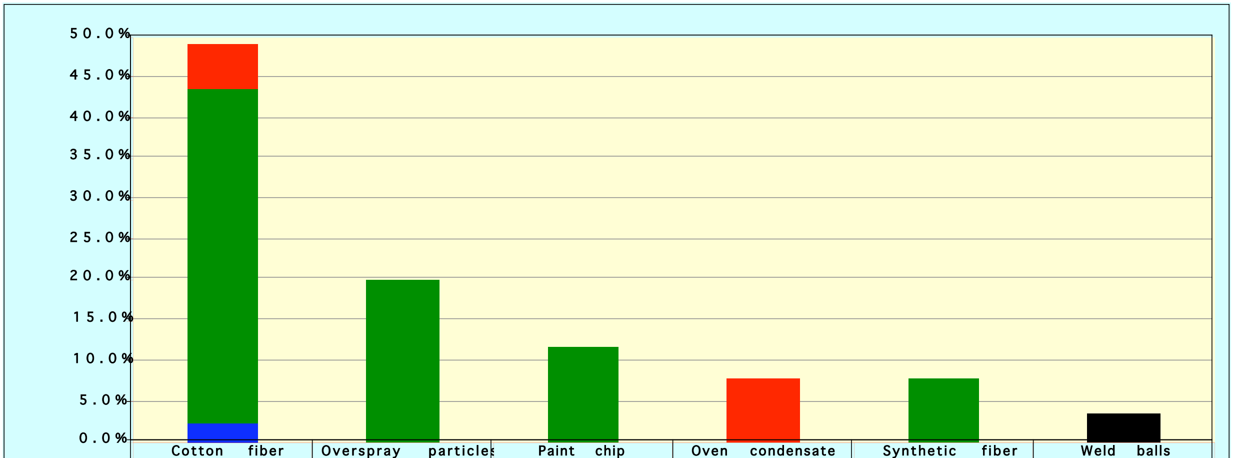
We can tell if a process is in control by calculating the:

- *Mean*: this is the average number of dirt defects per panel for the entire time period on the chart.
- *Upper Control Limit (UCL)*: this is the number that represents 3 standard deviations above the mean.
- *Lower Control Limit (LCL)*: this is the number that represents 3 standard deviations below the mean.

In a normal process, 99.73% of all of the data points should be between the Upper Control Limit and the Lower Control Limit. If they aren't, then the process is said to be "out of control" or unstable.

After collecting dirt identification data, the information is compiled into *Pareto Charts*, like the one shown in Figure 17. These are bar charts that plot each category of dirt that was identified versus how much was in each category. The idea is to *"separate the vital few from the trivial many".* In other words, to figure out what the biggest dirt problems are, by looking at the biggest bars on the chart. We also use Pareto charts to identify the coating layer that contains most of the defects and thus which process may contain the root causes of our problems.

Figure 17: *Pareto Chart summarizing Topcoat Defects*

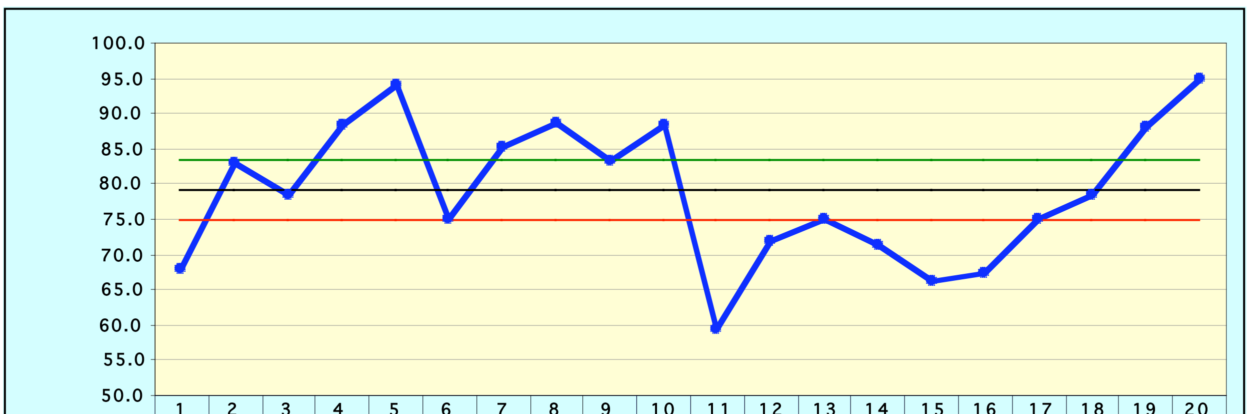


	Cotton fiber	Overspray particles	Paint chip	Oven condensate	Synthetic fiber	Weld balls
Clearcoat	5.7%	0.0%	0.0%	7.8%	0.0%	0.0%
Basecoat	41.2%	19.9%	11.9%	0.0%	7.8%	0.0%
Primer	2.3%	0.0%	0.0%	0.0%	0.0%	0.0%
E-coat	0.0%	0.0%	0.0%	0.0%	0.0%	3.4%

We use *P-Charts*, like the one in Figure 18, to compile the inspection data from our customer's inspection process. These are line charts that plot the proportion (or percentage) of good or OK cars or parts versus time (% FTQ). These are also plotted daily, so for each day we paint cars or parts, we have a point on the chart.

As cars or parts come out of the topcoat oven, inspectors look at the paint finish with a critical eye. They are supposed to compare the quality standards that they have been taught, to the quality of the paint they are seeing. If there's a problem with the paint finish, they identify what the problem is, mark the car or part as being rejected for that category of defect, and send it to the repair process.

Figure 18: *P-Chart of First Time Quality Percent (% FTQ)*



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
% FTQ	67.8	82.9	78.3	88.3	94.1	75.0	85.2	88.6	83.1	88.3	59.5	72.0	74.9	71.3	66.2	67.2	75.1	78.3	88.2	94.8
UCL	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1
Mean	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0	79.0
LCL	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8	74.8

In almost every paint shop of every assembly or parts manufacturing plant in the world, the biggest category for rejects is Dirt. P-charts are also used to plot the percentage of rejected cars or parts. In this case, we would plot the percentage of cars or parts rejected for Dirt versus time (% Dirt).

Process Analysis Tools:

Once we've collected and reported our paint defect analysis data, we know two things:

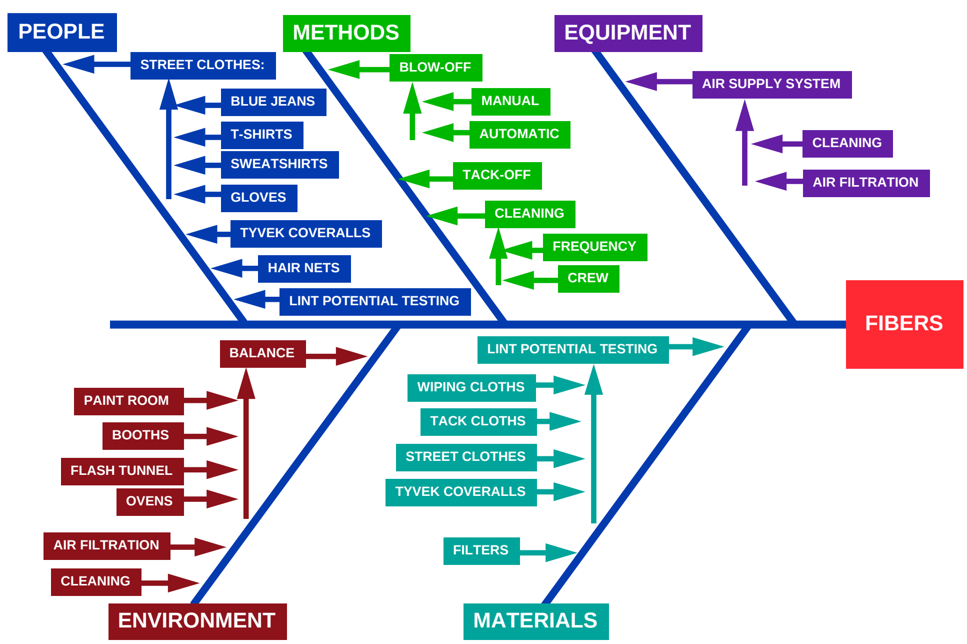
- How big our overall dirt problem is. (U-charts and P-charts)
- What all of our dirt problems are. (Pareto charts)

But we still don't know where these problems are coming from. We don't know *what* the sources are or *where* the sources are.

To find out the *"what"* and the "*where"* we use a couple of tools. The first is a *Process Flow Chart*. It can be as simple as the example seen already in Figure 11, or as complicated as a blueprint of the entire paint department. The important thing is that it will lead you to the part of the process that contains the root cause of the problem.

The other tool we use is a *Cause and Effect Chart*. (Also known as a *Fishbone Chart and shown in Figure 19)*.

Figure 19: *Cause and Effect Chart for Fibers*



The major components of any process are:

1. People
2. Methods
3. Equipment
4. Environment
5. Materials

If we ask (and answer) the question "Why?" several times (usually 5) then we should get to the root cause of the problem. Let's follow an example:

1	*Why* do we have cotton fiber defects?	Because of our people.
2	*Why* because of our people?	Because they are wearing street clothes.
3	*Why* because of the street clothes?	Because they are not lint-free.
4	*Why* aren't they lint free?	Because they are 100% cotton.
5	*Why* cotton?	Because it's cellulose and breaks easily.
6	*What do we do?*	Wear lint-free coveralls over our street clothes, and wear them correctly!!!

Organizing a Dirt Team:

It's impossible for one person, namely the Paint Defect Analyst, to identify and solve all of the problems in a paint shop. They need to be part of a team.

The Dirt Team or Paint Defect Team (or whatever name is given to this team) has to be composed of people from all parts of the painting process. Here's a list of typical Dirt Team members. Each team member is chosen for the knowledge and expertise they bring to the group.

Paint Defect Analyst:

- Brings paint defect analysis data.
  - Dirt count
  - Dirt ID
- Brings paint process analysis data.
- Ideas for process changes.
- Monitors results of process changes.

Production Hourly:

- Close to the paint process.
- Close to the problems in the paint process.
  - Sometimes is one of the problems!
- Can promote awareness of the dirt team and it's objectives and activities.
- Can help make a process change happen.

Production Supervisor:

- Close to the paint process.
- Close to the problems in the paint process.
  - Sometimes is one of the problems!
- Can promote awareness of the dirt team and it's objectives and activities.
- Can help make a process change happen.

Process Engineer:

- Close to the equipment, materials, methods, people and environment in the paint process.
- Can design process changes in any of the above.
- Can also promote awareness of the dirt team and its objectives and activities.

Maintenance:

- Very close to the paint process and equipment.
- Usually must fix those "things gone wrong" which effect dirt levels:
  - Booth balance
  - Oven balance
  - Conveyor systems
  - Filter changes
- Should rely on paint defect analysis data to determine preventive maintenance and cleaning schedules for spray equipment, spraybooths, ovens, etc.

Quality Representative:

- Close to the internal quality indicators for the paint process.
- Can also supply external quality indicators such as J.D. Power audit data.
- These indicators can be used as long term measuring sticks for the paint process improvements that are made, as long as they correlate with the paint defect analysis data.

Suppliers:

- Paint, filters, equipment, cleaning, etc.
- Can provide expert knowledge in their specific area.
- Supports the function of the Dirt Team.
- Attend meetings on an "as needed" basis, or become permanent members of the team.

Some of these people on the Dirt Team are **Core Members** - they go to every meeting, and some are **Support Members** - they go only when their expertise is needed. In this way, the meeting doesn't get too big and thus more difficult to control.

We've saved the most important member to discuss last:

Management:

- Must provide a strong and visible commitment for the Dirt Team, The Paint Defect Analysis Program and all of the process improvement activities.
- Is usually the final decision-maker for proposed process changes.
- Can provide the "focus" of team efforts.
- Can provide techniques for justifying proposed changes:
  - Quality improvements
  - Cost savings

The paint shop manager should attend as many meetings as possible as a **Core Member** and if unable to attend, should send a delegate.

In most plants with Dirt Teams, some members may talk to other members several times a day; there's always something going on that they may need to discuss. That's not to say that a Team Meeting takes place every day (although in some plants, they do!).

When the program is first being implemented, it's important for the entire team to meet at least *once a week.* Everyone knowing and understanding the paint defect analysis data, the status of preliminary trials or special projects and the results of process changes is a key factor to the success of the team.

As the process becomes more stable, and there are fewer process changes to make, the frequency of the meetings decreases to one every two weeks. There still may be a lot going on, it's just easier now to monitor.

Here's a typical agenda for a Dirt Team Meeting:

1. Review Paint Defect Analysis data.
    - *P-charts*, which tell us how big the overall dirt problem is and how well our process is doing.
    - *U-charts* that tell us how dirty each panel or part is, and whether we're improving.
    - *Pareto charts* that tell us what all of our dirt problems are and which ones are the biggest.

This should take 5 minutes.

2. Review status of previous process changes, material or method trials, etc. It's helpful to have a format in which to record all of this information. In Figure 16 is an example of a matrix form for doing this.

This should take 5 minutes.

3. From Pareto data, determine which problem in each process area to work on. Typically the biggest problems are solved first, but, if another, smaller problem is identified and easily fixed, then go ahead and fix it.

This should take 5 minutes.

4. Brainstorming to determine root causes within the paint process, using tools like the cause and effect chart in Figure 15. Doing this exercise is essential to get to the next step. It's also a lot of fun.

This should take 10 - 15 minutes.

5. Decision of which process change to test or which change to implement on a full time basis, based on previous successful tests. Again, using a version of the matrix form example in Figure 16, it's easier to keep track of all of the trials or tests, their results and their implementation dates.

This should take 5 minutes.

Total meeting time should be 30 - 35 minutes.

It's important for everyone attending the meeting to know what they are expected to do to improve quality. All activities or tasks of the Dirt Team are tracked using the form in Figure 20.

Figure 20: *Dirt Team Action Plan for Improvement Matrix Form*

Action Plan for Improvement				
#	**Task**	**Due**	**Responsibility**	**Status**
	Cotton fibers:			
1	Continually review and improve process materials	Ongoing	Reagan	
2	Repair plastic tunnel to color booths	1/01/01	Carter	
3	Increase the humidity in plastic tunnel to color booths	3/05/01	Carter	
4	Make the plastic tunnel to color booths "positive"	3/05/01	Carter	
	Paint chips:			
1	Begin "one use only" process for hood and deck lid props	2/05/01	Reagan	
2	Test new "ergonomic" hood prop	3/12/01	Washington	
3	Improve process for hood and deck lid prop cleaning	4/02/01	Kennedy	
	Synthetic fibers:			
1	Establish particle counting schedule	1/01/01	Reagan	
2	Implement melt-blown polyester solvent wiper in prime	3/26/01	Reagan	
3	Use polarized microscope to ID all fibers causing repairs	2/05/01	Reagan	
4	Test BS-20 tack cloth in topcoat tack-off	4/09/01	Washington	
	Oven Dirt:			
1	Continue oven charting analysis	1/01/01	Jackson	
2	Increase topcoat oven cleaning schedule to every 8 weeks	1/01/01	Kennedy	
3	Use polarized microscope to ID topcoat oven dirt by zone	2/05/01	Reagan	
			Legend:	
			Project completed on schedule:	
			Project in danger of being late:	
			Project late:	

Managing the Paint Defect Analysis Program:

Consistency is needed in the data that is collected, in the way data is reported and, very importantly, consistency in the way each analyst interacts and relates to their paint manager and other paint department employees *at their site*.

Each analyst will be responsible for managing the program. This includes performing all of the activities required to implement the program, as listed in their key responsibilities job description.

The paint manager is also responsible for the Paint Defect Analysis Program. The analysts report directly to them and, as such, they are responsible for the day-to-day administration of this employee. They are also required to make sure that they are getting all of the information they need, from the analyst, to fully implement the Continuous Improvement Process. This includes all of the information outlined in Figure 21 (for a typical assembly plant process):

Figure 21: *Charting Matrix*

	P-Chart (Inspection data)		U-Charts (Dirt Count data)			Pareto Charts (Dirt ID data)		
Frequency	**FTQ**	**% Dirt**	**E-coat**	**Prime**	**Topcoat**	**E-coat**	**Prime**	**Topcoat**
Daily	update	update	update	update	update	update	update	update
Weekly (Also used for dirt team meetings)	update and publish	update and publish	update and publish	update and publish	update and publish	update and publish	update and publish	update and publish
Monthly	update and publish Trend chart	update and publish Trend chart	update and publish Trend chart	update and publish Trend chart	update and publish Trend chart	update and publish	update and publish	update and publish

Analysts submit these reports to their Paint Manager. They also publish them for the Dirt Team and for a special “Dirt Bulletin Board” located near the paint shop entrance (or other strategic location).

Summary:

So, there you have it. The fastest and easiest way we know of to reduce paint defects - dirt - and improve the quality of the painted product - any painted product. Did you notice that there's no magic wand or silver bullet?

But, it's not rocket science either. There aren't a thousand different types of contaminants that you'll have to hunt down and eliminate before you start to see improvements. In any given paint shop, there's a finite number of sources to a finite number of contaminants and you will know what they are and where they come from once your Paint Defect Analyst identifies them.

If you approach them one-at-a-time, you'll win. You may never get rid of paint defects completely, but you will improve.

You'll improve so much, that things that were critical issues before, like:

- Thousands of hours of overtime to get your production numbers.
- Having to work Saturdays and Sundays.
- The need for flying parts to a customer.
- The possibility of shutting down an assembly plant.
- Being profitable.

won't be so critical anymore (except, of course, for the being profitable issue...).

The steps to take are in the flow chart below.