# The Case of the Successful Root Cause Analysis of Plating Defects

*Because of the sensitive nature of military aerospace programs, the client's and vendors' identities and product and process details are not provided in this case.*

This case involves the application of systematic root cause analysis methodology to identify the root cause of a problem that had plagued a client's program for nine months. Among other products, the client manufactures cables for communications and weapons systems in fighter jets. The cables must meet stringent and demanding FAA requirements and military specifications and regulations.

The client called Quality Support Group about a problem with cable connectors for one of its customers in a military aerospace program (hereafter "Customer A"). Blisters and bumps had been detected on connector pins nine months previously, and despite numerous changes and attempts at corrective action, the problem had not been solved. QSG asked me to visit the plating vendor to meet with their people and facilitate an analysis of the problem.

This project demonstrates the ability to help clients to apply a systematic approach to clearly define problems, analyze possible causes, and develop strategies for appropriate corrective actions. It also demonstrates expertise in delivering consulting services and guidance in a format that can be directly applied to clients' real problems.

Prior to my involvement, the client had been working with the plating plant's personnel for months to try to solve the problem. 8D, brainstorming, fishbone diagrams, and various tests had been deployed without success. I had recently delivered training in systematic root cause analysis to some of the client's engineers and they wanted the same technique to be applied in the plating vendor's plant.

I flew out to the plating plant in the Midwest. The company had an excellent reputation and specialized in electroplating and heat treating services for the medical, automotive, aerospace, military, and RF/microwave industries. They had been very open and cooperative in the QSG client's and Customer A's efforts to get the problem solved, and had even agreed to several changes and actions requested by Customer A's metallurgists – even though the plating plant didn't think those actions would solve the problem. (They were right; even after taking Customer A's recommended actions, the defects remained.)

## The Methodology

Systematic root cause analysis methodology is a structured, systematic approach to problem solving that has been successfully and effectively applied in a wide variety of problems, processes, products, services, and industries. Easily adapted to support Eight Discipline (8D), Design of Experiments (DOE), and other techniques, systematic root cause analysis is made up of six steps:

1. Name the problem
2. Describe the problem in detail (i.e., construct a detailed problem specification)
3. List possible causes
4. Test possible causes (against the facts noted in the problem specification)

5. Identify most likely cause
6. Verify true cause

After the critical first step of *Naming the Problem*, step two of the procedure seeks to clearly define the problem; if you will, to construct the problem specification. The problem solver uses a series of controlled questions to describe the problem within the dimensions of WHAT, WHERE, WHEN, and SIZE. The controlled questions help to describe the problem not only in terms of what the situation is, as observed, but also in terms of what the situation could be but is not.

Carl Jung, the late Swiss psychologist, once said that it would be an expansion of knowledge to know what isn't affected. "This leads to another set of facts that is useful, but often ignored, in describing a problem – namely, the contrasting data." Once the problem is clearly defined, theories of possible causes of the problem are generated via brainstorming at step three of the six-step procedure. At step four, the theories are tested against the facts noted in the problem specification. (i.e., "Does this theory *explain* the facts noted in the problem specification?") All theories brainstormed at step three of the procedure are possible causes. What the problem solver is trying to determine at step four is the answer to the question, "Is it a *likely* cause" (given the facts at our disposal)?

Testing theories of causes at step four leads to step five: Identifying the *most likely* cause (or causes; more than one may survive the test). Finally, at step six of the systematic procedure, the problem solver seeks to *verify* (or refute) that the most likely cause is the true cause in the cheapest, quickest, easiest manner possible. In other words, before proceeding to corrective action, one seeks to verify (or refute) that the most likely cause is indeed the *true* cause. Once the true cause is verified, we can move on to effective and lasting corrective action.

## The Problem

I met with the client's Program Manager, Quality Director, and several staff members who had been involved in the problem-solving efforts to date. I then joined the Quality Director and Program Manager on a conference call with the plating plant manager and several members of his staff. This kind of preparation is critical to the delivery of effective consulting that's focused on the client's concerns and the real problem at hand.

When I arrived at the plating plant, the plant manager provided a quick tour of the plant and a walk through the actual process that's used to plate the connector pins. Next, the consultant met with the plant management team and others to provide a quick introduction and overview of the systematic root cause analysis process that would be applied for the balance of the day to clearly document the problem, list and test possible causes, and develop a plan for "next steps."

After the introduction and overview, I stepped over to a large whiteboard and started asking and recording the group's responses to the controlled questions that are used to construct the problem specification. Throughout the discussion, the client's Program Manager typed up the resulting summary, using the electronic Root Cause Analysis Worksheet. (Download a PDF copy of the worksheet.)

The management team expressed surprise that the resulting matrix so clearly defined their problem. I reminded them that they had been dealing with the problem for months; they had a lot of knowledge about it. All the matrix did was to provide a very organized summary and documentation of their experience and knowledge gained to date.

Included on the worksheet are the controlled questions that are used to describe a problem in detail within the dimensions of WHAT, WHERE, WHEN, and SIZE. As noted previously, within each dimension is documented not only what the situation is, but what is also logically could be but is not. Next, the “IS” and “IS NOT” entries are compared to note what is different or distinct about the “IS” information versus the “IS NOT” information. Finally, each row of the worksheet is completed by noting any changes that had occurred in and around those distinctions.

For example, look at the very first row of the attached worksheet. The item with the defect (blisters and bumps) was the pin used in Customer A’s adapter (“IS”). The same defects were not observed on any of the thousands of other parts plated in the same plant (“IS NOT”). A distinction was that this particular pin design was used only in Customer A’s connectors. Finally, the client learned about a change that had occurred in February 2016; i.e., Customer A introduced a wash and bake operation prior to installing the connectors in their final assembly process. (Neither the client nor the plating plant was aware of this change.)

## A Common Problem-Solving Pitfall – Jumping to Action!

A very interesting element of this case is how people will often fall prey to a common pitfall in problem-solving; i.e., “jumping to action”. Take a look at the “Changes” column in the WHEN dimension of the attached worksheet. Between February 2016, when the problem was first reported by Customer A, and November 2016, when I arrived on the scene, the following actions and changes occurred, among others:

- The client introduced a wash-bake cycle to mimic Customer A in February.
- Plated and unplated part numbers were separated in March.
- At Customer A’s insistence, a new plating vendor was brought on board in March.
- At Customer A’s suggestion, the thickness specification was increased in March.
- At Customer A’s suggestion, the thickness spec was changed to double the original thickness specification two weeks later.
- Six different process plans were introduced between March and August, including testing methods, handling methods, plating and cleaning methods.
- The wash-bake cycle was adopted in the client’s receiving and final inspection areas in February.
- Wash-bake was introduced after plating in the plating vendor’s plant in May.
- The cycle was expanded to bake-wash-bake in the vendor’s plant in July.

Now take a look at the last entry in the “IS” column of the SIZE dimension on the attached worksheet. Despite all of these actions taken, the trend of the blisters and bumps defects remained “steady at 2-5% levels” throughout the nine month period!

## Analyzing Possible Causes

After I finished documenting the problem on the whiteboard, I facilitated a brainstorming session is response to the question, “What are the possible causes of the blisters and bumps on the pins?” All of the ideas on the resulting brainstorming list were possible causes of the problem. The next question that must be answered is, “Is it a *likely* cause?”

To answer this question, each of the brainstorming items was tested against the facts noted in the problem specification. In order to be a likely cause, the item must be supported by those facts. Some of the suspects that were analyzed are listed on the attached worksheet. Take a look at the first entry: The bake-wash-bake cycle was noted as a possible cause of the defects. After all, the wash-bake step was introduced by Customer A right around the time that the blisters and bumps were first observed.

But in the WHEN dimension of the worksheet, the defects were observed post-plating both before and after the bake-wash-bake step in the process. Therefore, this possible cause does not explain the fact that the blisters are observed before going into the bake-wash-bake cycle.

Current disruption could certainly cause blisters and bumps on plated parts. That theory of cause, however, did not explain that the defects were observed on only 2-5% of the pins. A current disruption would result in a much higher percentage of defects in a lot.

## Verifying the Most Likely Cause

After analyzing all of the possible causes, the team agreed that the most likely cause – the suspect that best explained the facts noted in the problem specification – was contamination of incoming parts from the machining supplier. The plating plant manager declared, “That’s exactly what we’ve been saying all along!” I reminded him, however, that they had a pre-plating cleaning step in their process, “But clearly it’s not working.”

I asked the plant manager if there was an alternative to the cleaning process that they’d been using for the past nine months. The plant manager said that they could try vapor degreasing instead of the current approved and validated cleaning procedure. Having agreed that the contamination was the most likely cause, the team developed a plan to verify and address that likely cause. As noted on the attached worksheet, their plan had three steps:

1. Institute better inspection for contamination and cleanliness of incoming parts from the machining supplier.
2. Assure that the supplier performs a proper cleaning protocol prior to shipment.
3. Adopt vapor degreasing of pins prior to plating.

They were able to quickly test one of these three steps. Before I headed back to the airport to catch my flight, the team took one lot of pins and plated them after vapor degreasing. Even though the other two steps of their verification plan hadn’t yet been implemented (better incoming inspection and machining supplier cleaning protocol), 100% inspection after the plating run found zero blister defects.

Systematic root cause analysis helped the plating plant nail the root cause of their problem that had been hanging around for nine months!