



# Finding the Root Cause

An Online Continuing Education Course for Engineers

**Course Number: F-6004**

**Credit: 6 Hours / 6 PDH / 6 CPD**

FINDING THE ROOT CAUSE:  
Statistical Solutions for Problems  
In Engineering Systems

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My career includes thirty-three years at Tektronix, Inc. working in Design Engineering, Manufacturing Engineering, and Management. Several years at Tektronix involved programs for solving quality problems in the development of color printers. Since retiring, I have taught courses for engineers in the high-tech industry to improve their efficiency in solving quality problems for new products or processes.

Prologue

Whether in electrical, industrial, or mechanical systems, problems always seem to pop up at the worst time. Engineers are often seen as resorting to “shot-gun” methods to find solutions. There are few, if any, classical tools available to help them. This material is designed specifically to address the needs of problem solvers in this situation.

# FINDING THE ROOT CAUSE

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# PART I - FUNDAMENTALS

## Introduction

**Scenario #1:** A consulting firm has designed and supervised the construction of a water supply system for a large residential/commercial development. This hillside project spans over 500 feet difference in elevation. During fire hydrant flow testing, the upper and lower sections met all specifications, but a middle section hydrant failed to make minimum flow. The Chief Engineer has three days left to pass all tests before contractual penalties kick in.

**Scenario #2:** The Air Force had contracted with the county PUD to design and install a dedicated load switching network which would insure uninterrupted power for their new missile defense control center. Acceptance testing uncovered an under-voltage problem occurring sporadically for 100 to 800 ms periods, as the load was switched from the main supply node to any one of several back-up nodes. The PUD engineering team is under pressure because they are already two weeks behind schedule.

**Scenario #3:** Because of a bountiful local coal mine, the huge new pulp and paper mill elected to build a CHP steam plant. The extraction turbine would provide steam at various levels for all the internal process needs, while the 15 Mw generator would supply all its power needs, as well as co-generate power back into the local grid. After the plant was in operation a few weeks, the 450psig X 500°F steam supply line developed large random pressure fluctuations. If the problem isn't corrected in a few days, damage may occur to the pulp process equipment.

\*

While these scenarios are fictional, engineers face similar situations all too often during their professional lives. Very few have been trained to deal with these kinds of problems. In fact, their education and instincts typically work against them as they search for solutions. This course is intended to help engineers solve these problems reliably and efficiently.

## Introduction

**Course Objectives:** Below are the four main areas of knowledge and skill which the student can achieve through this course:

- Learn the natural pitfalls which lead to divergent problem solving investigations
- Learn how to conduct a convergent investigation
- Learn how to design simple statistical experiments that work on small sample sizes
- Be able to solve problems in engineering systems more reliably and efficiently

**Case Study Format:** Many of the strategies and methods taught in this course are developed in a case study format from actual experiences of the author as a design and manufacturing engineer of computer printers. While the cases are not directly connected with the experiences of the vast majority of Professional Engineers, the technical nature of the stories should be relatable to this group. As you see how the principles of good problem solving develop in these stories, you gain insight on how they might apply in your own engineering system. No matter how different the technologies, there is a universality about engineering systems and the human minds that create and improve them. It is the author's hope that telling his story about one small piece of this universe can benefit a much larger part of the engineering community.

## Natural Pitfalls

**Conventional Wisdom** - Many times during my career, I found myself in a large conference room in a session lasting many hours. Seated around the table would be the most creative technical minds in the organization. Lively conversations and friendly arguments would draw onward as a list slowly grew on the newsprint. It was an action item list to fix the latest problem with the company. The list would eventually be assigned to a team assigned to solve the problem.

After the meeting, I would review the list and invariably find the most friendly and least likely to leave work items.

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