Fundamentals of Industrial Problem Solving

A Practitioner's Guide

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Section I
Overview of First Principles Industrial Problem Solving

1
Introduction

The authors have found complex problem-solving projects to be very stimulating, challenging, and rewarding work. We feel companies should plan to sustainably have complex problem-solving capabilities, and we have found that becoming an advanced problem solver is an excellent technical career. The successful resolution of complex problems is necessary for the optimum performance of the company and creates significant value. In this book, we will teach our collective experience on best practice in approaching these problems and resolving urgent complex problems permanently.

There are two target audiences for this book. First are the people who will learn and apply the methods and will work on advanced problems to solve them. The entire book is targeted predominantly at them – the problem solvers. Another, very important second audience, are the senior managers who need to accept the long-term need for advanced problem-solving capacity and therefore work to sustain it within their company. They must be sponsors.

1.1 A Familiar Story from Real Life, Or Why Do We Need FPS?[1]

“It was a dark and stormy night” … that was how my operations team felt. The plant was down again and we were bleeding money. This problem has been a reoccurring event for decades, but not at a predictable time. In the last year, K-403 had failed over and over, or fouled or plugged. Struggling through the many restarts was costing our plant over half the expected annual capacity of the plant each of the past two years. As the Technical Leader, it was my responsibility to fix the problem. We had lots of outside help from Corporate Engineering and Technology Experts. The Business Vice President has taken to calling my cell phone at home in the evenings for a status update. She wants to send in a consulting team from a famous business consulting firm, known for business turn-arounds. At the same time, the Continuous Improvement group has restarted a nested team of Six Sigma/LEAN Master Black Belt Leaders to try and fix this … again … the last fix apparently did not work. My people are overloaded with conflicting demands from their normal responsibilities and the added work to support the many nested and transient visitors and provide the boots on the ground for their work. It just felt hopeless.

Then after one of those late-night phone calls you remember when years ago a colleague told you of a similar experience he went through.

Wisdom Tidbit – Common sense, experience, and hard work are all required to solve many complex problems.

In the chemical and process industries, some problems occur or periodically reoccur in plants or in large projects that are very severe and valuable. These problems resist solution by more commonly used approaches and can grow to become central to the business' viability. We have collected and systematically organized our best practice that we have developed when faced with these complex urgent problems. By integrating science and engineering with our project management methods, seemingly unsolvable complex problems can be permanently resolved quickly and affordably. The fundamental problem solving (FPS) process is compatible with other well-documented and established problem-solving approaches including Six Sigma, LEAN, Theory of Constraints, and sound engineering and chemistry. Usually one or more of these approaches has been previously used on many of the problems that are subsequently worked on using an FPS approach.

1.2 When Does FPS Usually Get Involved?

The common experience in the occurrence and resolution of all problems is that the resource that ultimately solves a particular problem follows an exponential curve as depicted in Figure 1.1. With a competent staff of sufficient size, training, and experience, many problems are fixed or at least improved by the first person who recognizes the need for an improvement. Thankfully, this is true and must be true for a firm to be viable and continue to exist. However, a fraction of all issues are complex enough that they need to be escalated beyond the first person who originally recognized the problem. A good portion of these issues are in turn resolved by small informal teams who are collectively able to work on the problem. Again, there are a fraction of problems that prove difficult and must be escalated to a formal team. That team is normally chartered or formed by outside stakeholders, and the problems are often more complex, valuable, and urgent problems. At the end of the continuum are the severe or chronically reoccurring problems that have often been worked on and declared solved by earlier teams but have in fact not been permanently or acceptably solved to meet the long-term needs of the organization. Or the problems are high value, severe, and urgent. People working to more effectively resolve the problems in the far-right portion of the continuum are the primary subjects for this book.

However, many of the methods introduced can be helpful for more effectively resolving issues all along the continuum.

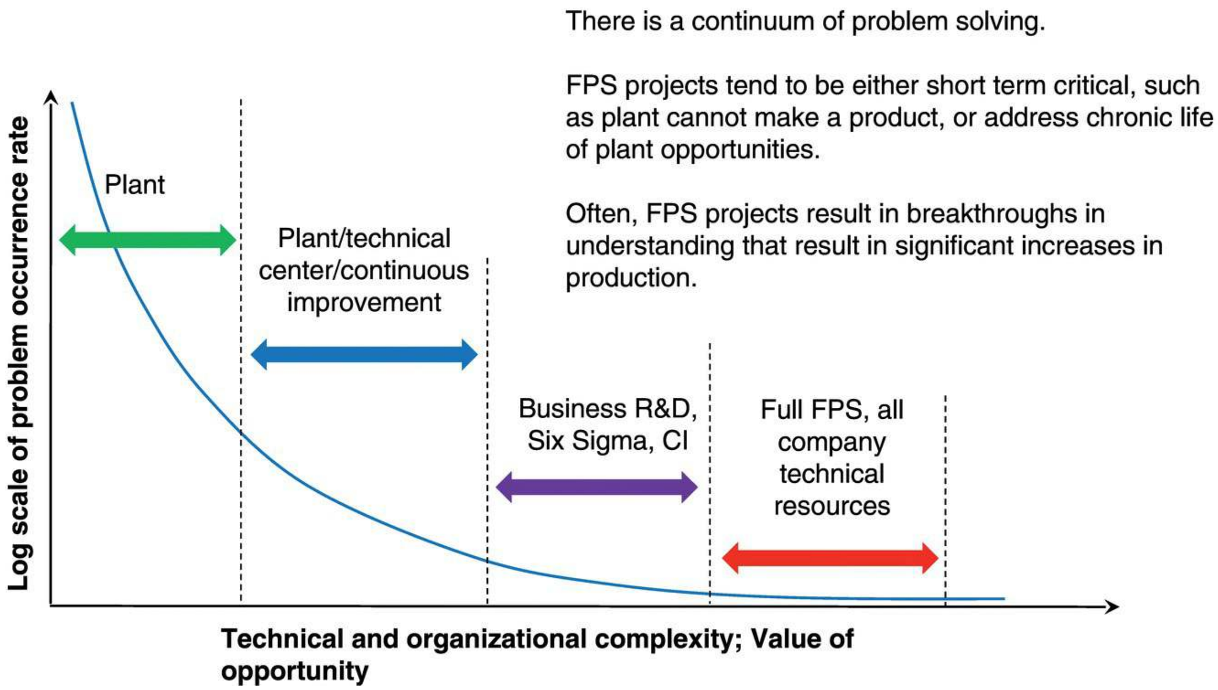

Figure 1.1 The problem solving continuum concept. (*See insert for colour representation of the figure.*)

The X-axis in the continuum for Figure 1.1 can be and usually is increasing simultaneously in many factors, going left to right. Normally, the complexity, the value lost per time, records of previously being worked on, urgency all increase moving to the right on the X-axis. The root causes are often found to have multiple factors and intermittent factors.

Examples of problems, which call for the use of the FPS approach, can include leakage, chronic problems or step change performance issues. Leakage here describes a gradual loss of knowledge where the performance has gradually declined of a period of time. Often this is associated with people turn over and the loss of experience and knowledge. The impact can be worsened if the discipline to document and retain necessary knowledge is not adequate. Chronic problems can include fouling, corrosion, poor quality issues where a work-around has been implemented. The work-around is preferable to the problem that was addressed since it gives a *step in the direction of goodness*. However, the root cause still exists. This is treating the symptom rather than curing the disease. Examples can include installed spare pumps, reactors, or columns, so unit A is in service while the fouled unit B is repaired. The whole process operates by alternating units A and B, while the failure rate of individual units continues without understanding or improvement.

The methods taught in this book were developed and are targeted at problems in the chemical industries, but the techniques and the overall approach can be used widely for manufacturing problems, outside work, diagnosis and treatment in medicine, and even political decisions. Overall key steps in the process are depicted in Figure 1.2. What and when to do the key activities are summarized in Figure 1.2, and how to do the work most efficiently and quickly are taught throughout the book using the tools and methods of the FPS process.

Wisdom Tidbit – Define success, don't describe the problem.

One distinguishing aspect of this process appears in the first step of Figure 1.2:

> **"Define Success"**

Which is much preferred vs.:

> **"Describe the Problem or Define the Defect."**

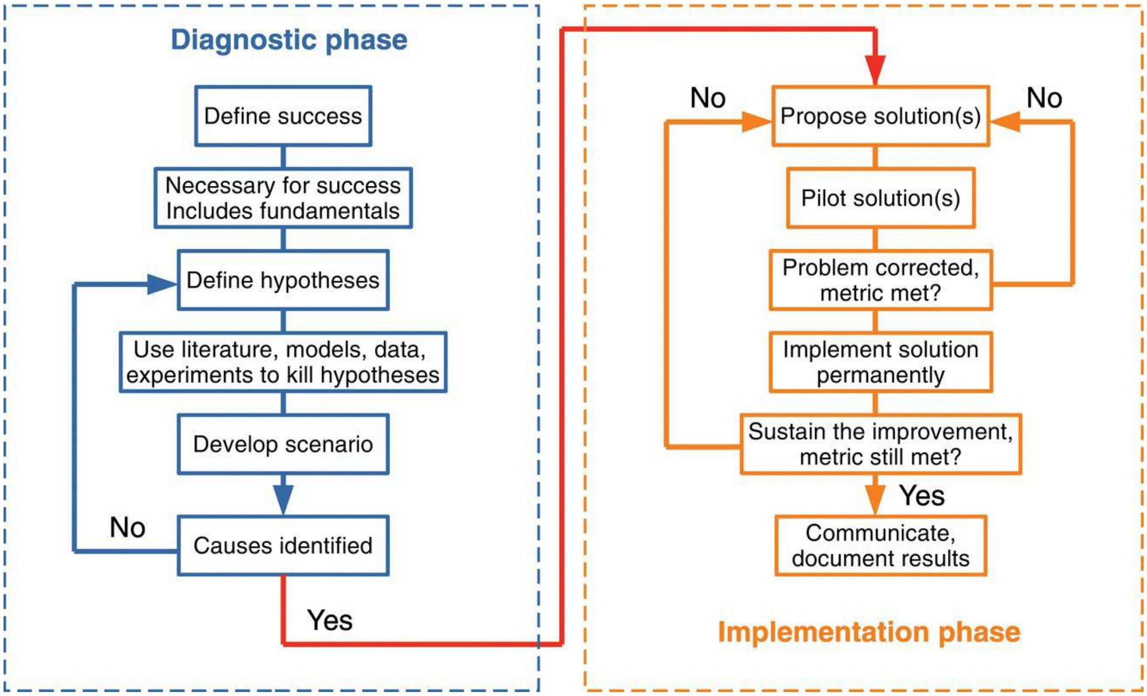

Figure 1.2 Phases of an FPS project.

Often, if people focus on a problem description, they limit the approaches considered and simultaneously they don't limit the deliverables to what is high value. Whereas a clear agreement on "what is success" helps focus the team on only delivering "gotta have" work and not working to deliver "nice to have" results. By using "what is success" in the chartering work, extra lower valued work can be minimized.

For example, compare the two descriptions below.

Describe the Problem – *The plant is running at 50% capacity and 180% of budget. K-403 is failing frequently*.

Vs.

Describe Success – *Within six months, the root causes for K-403 failures are known, and both short-term three-month remedies and long-term remedies are being implemented. Within one year, the plant is running at 100% capacity and on budget. There are no EH&S events during this work*.

Demographics and employee population changes within the chemical industry have resulted in a strong trend to less employees in most traditional roles and equally importantly with less work experience of the people in these roles when compared to earlier decades. With a minimally staffed and inexperienced technical staff, a company can maintain operations when there are no issues. However, the technical staff often lacks the ability to recognize and effectively respond to unplanned events as well as would be needed for the optimum long-term value of the firm. In some cases, inexperienced people create problems through their actions or inactions.

In industry, we have seen the buildup and subsequent decline of organizational capabilities and capacity to work on complex problems and quickly resolve them. The occasional occurrence of extremely urgent events, so-called Black Swan (Taleb 2007) events, lead to the transient development of more capable advanced problem-solving capacity within an organization. Since these very severe events are thankfully rare, when the company has not seen a Black Swan event recently, the advanced problem-solving capabilities decline through people change over and intentional reductions if the long-term value of complex problem-solving capability is not well understood and supported.

To illustrate this concept, Figure 1.3 shows a multiple-year trend of technical problem-solving capabilities and the occurrence of rare yet severe events. Also plotted on the second Y-axis is the cumulative value loss due to the severe events. As depicted, in response to the first event, a significant capability develops and the rate of loss declines as the problem is solved. Then if a short-term staffing cost focus is used, the capabilities will decline. If a second severe event occurs, the entire cycle of building capabilities and accepting losses will be repeated.

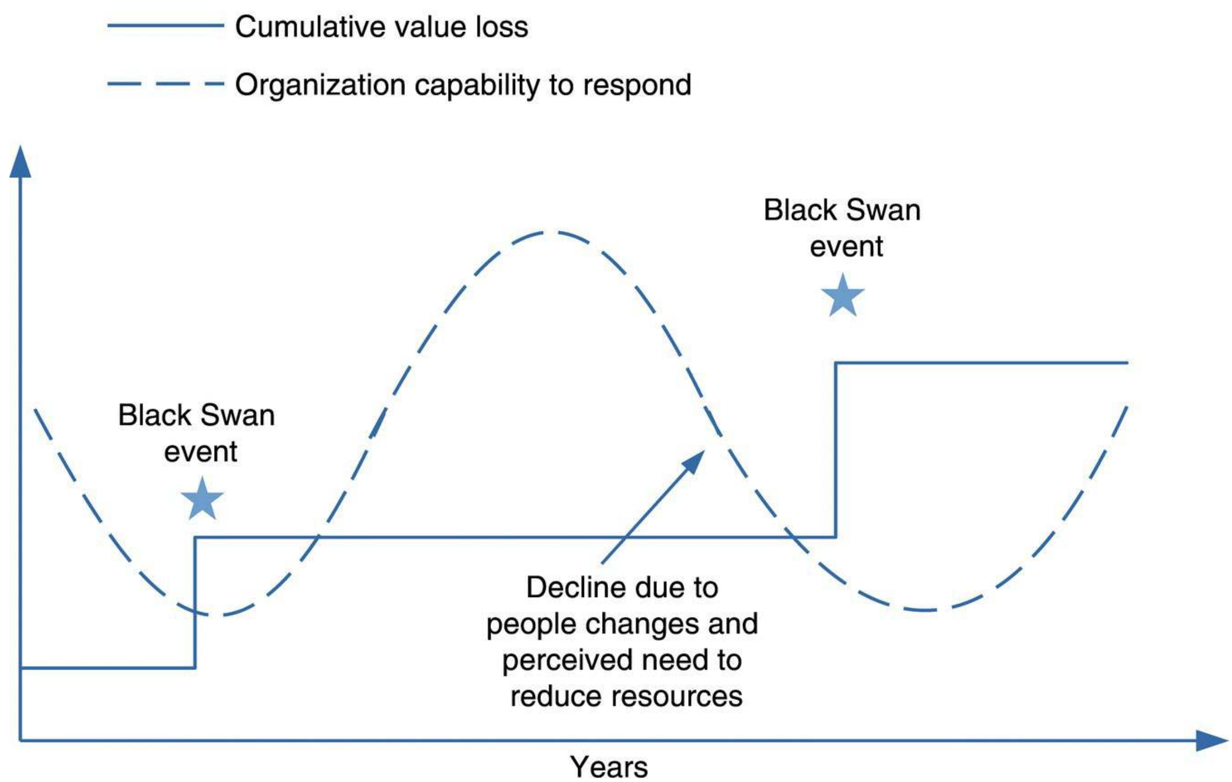

Figure 1.3 Present state – Black Swan events trigger transient development of problem-solving capacity.