Chapter 7
Complexity Risk and Modeling Disorder

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ABSTRACT

Despite 50 years of cost accuracy research, companies are generally unable to quantify the worst outcomes. In the process industries about 10 percent of large projects overrun their budgets by 70 percent or more. The system behavior of these blowouts often reflects disorder. For complex projects, the blowout proportion is 15 to 30 percent of projects. Many risk analysts ignore the worst outcomes as "unknown-unknowns" or "black swans"; but they are neither—we know the causes and their impact is somewhat predictable. Cost disasters start with a mix of systemic weakness and risk events. The cost of mundane projects may overrun by 20 to 40% which is bad but no disaster (financiers assume they will overrun by 25%). Add complexity and stress and the projects can cross a "tipping point" into disorder and chaos with cost overruns of 50, 100 or 200 percent−true disasters. This chapter describes complexity risk and the disorder it can lead to, practical measures of complexity and stress and how to incorporate those measures in non-linear risk quantification models.

INTRODUCTION

Accuracy is a measure of how estimates differ from the final actual outcomes. Empirical accuracy data of project cost and schedule duration has been thoroughly researched for over 50 years. However, most companies still lack basic understanding of accuracy reality and remain unable to quantify risks realistically. In Chapter 3 (*Systemic Risks and Parametric Modeling*) I point out that empirical-based parametric modeling of systemic risks is the start to realistic risk quantification. Beyond that, there are a number of reliable methods to quantify project-specific risk events and conditions. However, these methods combined still fail to predict the worst actual outcomes. What are the worst? Studies show that in the process industries about 10 percent of large projects overrun their budgets by 70 percent or more (Hollmann, 2012). The word "blowout" is often used to describe these projects; in technical terms their system behavior often reflects disorder. For complex projects, the blowout proportion is about 15 to 30

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percent of projects. Worse still, up to 5 percent of complex projects become "mega-blowouts"; i.e., cost overruns of 200 percent or more. Many risk analysts ignore project outcomes near or beyond the 90 or 95 percent confidence level as "unknown-unknowns" or "black swans"; but they are neither—we know what causes them and they are predictable to some extent. Project blowouts devastate owner profitability (and contractor's too if they go fixed price) and for public project blowouts they raise our taxes and prices for services; we must do a better job of forecasting the possibility of the onset of disorderly, non-linear system behavior and quantifying its potential impact so that decision makers can take mitigating actions.

Project cost and schedule disasters start with a mix of systemic weaknesses, risk events and poor practices of all kinds. The cost of projects with these mundane risks, which we can model with tools recommended by AACE International and others, may overrun by 20, 30 or 40% which is bad but no disaster (smart financiers assume that projects will overrun by 25% (Finnerty, 2013). Add complexity and stress to these risks and the project's behavior can cross over a "tipping point" into disorder and chaos. When that happens, costs overrun by 50, 100 or 200 percent or more−true financial disasters. This chapter describes complexity risk and the disorder it can lead to, practical measures of complexity and stress and how to incorporate those measures in non-linear risk quantification models.

PROJECT COST BEHAVIOR

My focus is on large projects involving construction; this may include:

- Process, power and utility plants,
- Mines,
- Civic and industrial infrastructure, and even
- Complex buildings.

For these and related industry sectors, cost estimate accuracy (i.e., actual outcome/funding estimate) is well documented and dismal. In the actual case, 10 percent of projects overrun by 70 percent or more after normalization for scope change and price escalation. (Hollmann, 2012). The average project overruns its' sanctioned amount by about 20 to 25% (as stated, smart bankers assume this). Industry's failure to realistically quantify nominal risks (e.g., overruns <50%) is addressed in Chapter 3 on systemic risks and in my book "Project Risk Quantification" (Hollmann, 2016); this chapter is focused on what causes and how to forecast the long tail at >50% overrun; the realm of complexity and blowouts.

Most depictions of cost overrun distributions are smooth curves (log-normal distributions are a good fit). However, actual cost growth distributions are not smooth; they are bi-modal (and sometimes tri-modal). Ed Merrow, founder of IPA, Inc. called this the "Jemima Principle" which posits that because very large projects are fragile "*They do* not tend to simply degrade toward poor outcomes; they tend to collapse instead (Merrow, 2011)." As an example, a study by IPA examined 462 actual projects and they overran their estimate by 15%, but there was a second mode at about 60 to 70% overrun for a group of about 15 percent of the sample projects with overruns ranging from about 40 to 100%). This bi-modal distribution results partly from a combination of large projects with orderly behavior and complex projects that cross a "tipping point" into a disorderly or chaotic behavior. There is not just a long cost overrun tail in reality but an overlay of the distributions of two types of projects.