AACE INTERNATIONAL RECOMMENDED PRACTICE

41R-08

UNDERSTANDING ESTIMATE RANGING

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UNDERSTANDING ESTIMATE RANGING

TCM Framework: 7.6 – Risk Management

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1. INTRODUCTION

1.1. Notice of Revised 41R-08 Scope and RP Purpose

In 2021, the scope and title of RP 41R-08 was changed from "Risk Analysis and Contingency Determination Using Range Estimating" to the current recommended practice (RP) titled "Understanding Estimate Ranging". The RP now describes and provides considerations for a general class of *estimate ranging* quantitative risk analysis (QNRA) methods. It also directs readers to other estimating ranging related references and QNRA methods. AACE® International (AACE) RPs are living documents that evolve. At times an RP no longer addresses industry expectations and needs and/or is superseded by industry or practice changes that are best addressed in new RPs rather than editing an existing one. Such is the case for the former RP 41R-08, *Risk Analysis and Contingency Determination Using Range Estimating* [1].

This RP documents the basis for the AACE decision to change this RP's scope and to no longer recommend "range estimating" as covered in the original RP 41R-08 as a specific estimate ranging practice in support of risk analysis and contingency determination. However, this RP also recognizes the valued contribution of the original 41R-08 author and contributors, provides a brief history of the original range estimating method, and provides references to the original method for those still interested in it.

In addition, this RP defines estimate ranging as a general class of QNRA practices with multiple variants (including the "range estimating" methodology); i.e., estimate ranging is still in the AACE QNRA toolbox. Based on this, the decision was to rename this RP to refer to the concept of "estimate ranging" as it describes the general method approaches, typical variations and typical use cases. The RP also assesses the method variations in respect to industry research findings and established QNRA principles and good practice. Some content of the original 41R-08 is not applicable to or addressed in other QNRA RPs; in particular, the concept of *critical cost* item grouping which does not apply to explicitly risk-driven methods. However, the concept and guidelines for *critical risk events* are now covered in RPs on the expected value method [2] [3], and the original RP 41R-08's discussion of probability distributions and their use in determining contingency is now addressed by RP 104R-19, *Communicating Expected Estimate Accuracy* [4]. The purpose of this RP and its assessment of variations is to improve industry understanding of estimate ranging and to guide AACE RP development and improvement.

Those seeking alternate recommended QNRA methods to the original RP 41R-08 should refer to the AACE Professional Guidance Document PGD-02: *Guide to Quantitative Risk Analysis* [5]. The closest analogy to range estimating is RP 118R-21: *Cost Risk Analysis and Contingency Determination Using Estimate Ranging for Inherent Risks with Monte Carlo Simulation* [6]; however, that RP is limited to quantifying inherent risks only and should not be used for projects with significant systemic or project-specific risks. PGD-02 will guide users to more integrated methods.

1.2. Range Estimating and RP History

In 2008, a task force was created by the AACE Technical Board and Decision and Risk Management (DRM) Subcommittee to develop project decision and risk management and QNRA RPs. These RPs formed the technical basis of the original Decision and Risk Management Professional certification examination (DRMP). The first of the risk-related RPs to be developed was 40R-08, *Contingency Estimating—General Principles* for the purpose of supporting decisions as to which risk evaluation practices to recommend for use and to guide method development [7]. After agreeing on the principles, the first QNRA RP developed was RP41R-08, *Risk Analysis and Contingency Determination Using Range Estimating*.

This original version of RP 41R-08 recognized that range estimating had been in active use for cost risk analysis since

at least 1975 when it's originator, Mr. Michael W. Curran, described it in an article titled "A Scientific Approach to Bidding" [8]. Later articles broadened its suggested range of application. Early articles reflected Mr. Curran's QNRA developments as he started a company called Decision Sciences in 1968 to leverage the power of Monte Carlo simulation (MCS) in business and project applications. He has been credited as a pioneer of project cost risk analysis and introducing MCS to common practice in the pre-personal computer era [9]. By 2008 (and while Mr. Curran was chair of the AACE DRM Subcommittee), range estimating had been in use for over 30 years with MCS being available for spreadsheet applications for over 20 years[1]. The original RP 41R-08 was authored by former AACE executive director Kenneth K. Humphreys who had worked closely with Mr. Curran.

Range estimating, as addressed in the original RP 41R-08, had the following key steps/heuristics:

- Identify or develop *critical* cost items (usually 10 to 20) to focus analysis effort and to minimize MCS correlation problems that Mr. Curran labeled an *iatrogenic* (i.e., self-inflicted) risk.
    - In lieu of applying MCS correlation, "combine items that are strongly related" (i.e., critical cost items are often sums of estimate items selected for their relatedness in respect to risk behavior for the purpose of the analysis without regard for the estimate breakdowns and summaries).
- Determine low and high-cost ranges for the 3-point distributions that replace the fixed critical item costs (estimate sub-elements were not ranged) based on team consensus developed in a workshop(s).
- Facilitate the workshop in a way that pushes the team to true *extreme* cost ranges (this is intended to overcome optimism bias).
- Facilitate the workshop in a way that assures that all risks are considered by the team in determining the ranges for the combined groupings of critical cost items (i.e., discussions refer to the risk register).
- Facilitate the workshop in a way that assures that historical data and benchmarking are considered in the analysis.
- Run MCS and use the probability-based cost outcome to support contingency and reserve determination.

Range estimating was the first practical MCS application for quantifying uncertainty of project cost estimates. That it produced a probabilistic cost output capturing the project team's varied inputs was unique and sufficient justification for its use despite acknowledged shortcomings in range estimating's total reliance on the facilitator and team's intuitive understanding of uncertainty and risks (i.e., potential for introducing bias). The main alternate probabilistic method for cost risk analysis at the time was regression-based parametric modeling that had an even longer history being introduced in 195[illegible] by an AACE founder John Hackney [10]. Hackney's method had the advantage of being based on historical data but it did not address specific risk events or other unique risks, implicitly or otherwise (the original version of RP 41R-08 suggested the use of parametric modeling for Class 5 estimates). While MCS and regression remain the two primary inferential statistical techniques used in project QNRA methods, the specifics of how they are applied in QNRA methods and models have evolved to counter shortcomings and align with RP 40R-08 principles such as addressing team bias (i.e., employ empiricism in various ways or structured elicitation), covering all risks (i.e., be risk driven), and so on.

In 2008, when the RP 40R-08 QNRA principles were approved and published, the shortcomings of range estimating were just being recognized. In particular, RP 40R-08 called for QNRA methods to be risk driven (identify risks and then explicitly quantify them), employ empiricism (bring historical experience to the method and/or analysis), and to be integrated (consider cost and schedule impacts). Range estimating was challenged in respect to all these principles. Adding to concern was a then recent 2004 research study by a benchmarking firm that found that estimate ranging (the traditional MCS method at the time without identifying the variant) was a *disaster* in respect to project funding decisions when significant systemic risks were present [11]. Also, behavioral scientists were pointing out that optimism bias was not being properly addressed in major project cost forecasts [12]. Both research channels pointed to the need for empiricism (or the outside view) in QNRA methods. In response to these

[1] For those seeking other references to the method, see the 1976 AACE Transaction paper [17], the 1989 Cost Engineering journal article [19] and the chapter on range estimating in a 1996 industry text [18].

shortcomings and challenges, the RP elaborated (in bold text) on the need for the facilitator/analyst to overcome team biases by pushing *extreme* range inputs. It also included bringing historical data and benchmarking learnings to the table. With these assurances, confidence in and respect for the 30+ years of proponent experience, and a somewhat limited repertoire of probabilistic, empirically-based, commercial software-supported QNRA methods at the time, the original RP 41R-08 was approved.

It is important to note the RP heuristic relied on what might be called "extremism" in range elicitation that required facilitator skill, knowledge, independence, and aggressiveness. The original proponents of range estimating were such facilitators: however, in practice few risk workshop facilitators achieve the same level of aggressiveness or extremism in range determination. In addition, given that specific risk drivers were not explicitly identified or quantified, identification of aggregated "critical cost items" as cost accounts is more of an art than a science on the part of risk analysts (but highlighted the proponent's significant concern for correlation challenges in MCS). The method itself struggles to overcome bias. However, more importantly, the industry progressed towards data-driven methods to identify the ranges associated with risks and uncertainty (e.g., big data, machine learning, artificial intelligence, and so on). Total reliance on facilitators to counter team bias and to bring deep experience to the table became increasingly less acceptable as the basis of QNRA practice. Methods such as risk-driven CPM-based QNRA (fully aligned with the principles espoused in RP 40R-08) and software to support it were developed and implemented. In addition, practices and tools for practical project historical data capture and analysis became widely available (e.g., RP 114R-20*, Project Historical Database Development* included input from multiple commercial database software vendors). Tools for parametric QNRA also became available. Finally, the DRM Subcommittee completed a robust series of RPs for QNRA methods that addressed different levels of project scope definition and planning, and concerns for different risk types (these are documented in *Professional Guidance Document PGD-02* [5]). In short, range estimating and its identified shortcomings limit its acceptability as a risk analysis and contingency determination methodology relative to the other methodologies now available. Range estimating is no longer considered a recommended practice for risk analysis and contingency determination.

1.3. Is There a Place for Estimate Ranging QNRA Methods?

While range estimating was the first estimate ranging QNRA method, many variants have evolved, particularly after MCS for spreadsheets was introduced in the 1980s. Estimate ranging can be considered a general class of QNRA methods that involve identifying distributions (e.g., 3-point or uniform) on estimate elements for some uncertainties and risks at some level of detail as inputs to a MCS model. The MCS model can then produce cost probability distributions for various cost groupings and for the overall cost. It is important to realize that estimate ranging is not MCS (i.e., it is not *the* Monte Carlo method). MCS is a simulation technique that can be applied on a wide variety of QNRA models.

Range estimating, as recommended in the original version of RP 41R-08 attempted to quantify all cost uncertainty and risks by examining artificially created item cost groupings and trusting the facilitator/analyst to reliably push their identified cost ranges to extremes without bias. A question addressed by this RP is whether among the ranging variants, to be defined in the next section, there are practices that reasonably align with the RP 40R-08 principles? Are there estimate ranging methods that:

- If not risk-driven, then are limited in application to only certain drivers of uncertainty;
- If not integrating cost and schedule, then are focused on inherent cost uncertainty and not risk events for which schedule delays are a significant cost driver; and
- If not directly employing empiricism, then minimizing bias by looking at estimate items in more focused ways (and only for certain risks)?

The rest of this RP describes common estimate ranging method variants and use cases noted in practice and suggests which method variants, and under what conditions, may be used.