How to avoid overruns and delays successfully
-- nine basic rules and an associated operable procedure

by Dr. Steen Lichtenberg

Abstract

Overruns and delays are probably the most important current problem issues for cost engineers and project managers, as well as for the image of the whole professional area of Cost Engineering/Project Cost Control.

Existing Cost Engineering methods of project cost estimating, planning and business analysis too often lead to overruns, delays, etc.

Commercial Risk Analysis[1] is therefore one of the basic sub-procedures used by cost engineers. In spite of this, relatively few papers have been written about this subject, and even fewer have been able to report a decade-long record of practical application and success.

This paper outlines nine basic rules of Commercial Risk Analysis. Used in conjunction, they have proved to be highly successful in preventing problems with overruns and delays.

A practical procedure known as the Successive Principle, which uses these rules, has been applied for 25 years to hundreds of challenging cases. It has demonstrated that overruns and delays need only materialise in the rare cases of major force majeure events.

Important additional benefits of the procedure are that potential areas for improvement or protection are identified in ranked order and in good time. It also dramatically strengthens the team-building process.

Index Terms

***Cost Engineering, Project Cost Control and Project Management, Risk Analysis, Risk Management, Statistical Theory, Group Psychology, Budget Overruns and Delays*.**

INTRODUCTION

The completion of projects without overruns and delays is probably the most important current problem area for cost engineers and project managers as well as for the image of the whole professional area of Cost Engineering / Project Cost Control – not to mention the owners/contractors and users themselves.

Commercial Risk Analysis is therefore one of the basic sub-procedures used by cost engineers. In spite of this, relatively few papers have been written about this subject, and even fewer have been able to report a decade-long record of practical application and success.

One of these is the recent paper by Kenneth K. Humphreys in ICEC's electronic journal, International Roundup. It expresses to a seldom degree the subject in plain English [15].

The paper presented here outlines nine basic rules which, applied in conjunction, largely prevent overruns and delays. These rules are the result of comprehensive, decade-long international research [3-7, 10, 12, 14], and are very much in line with the above-mentioned paper.

A practical risk analysis or rather a quality assurance procedure, known as the Successive Principle*[2], is then outlined as an example of the application of these basic rules. Over the course of more than two decades and applied to hundreds of challenging projects it has proved to be successful in largely eliminating overruns and delays.

The procedure gives the management user a sharper and far more realistic long-distance view of the prospects awaiting his/her project. A realistic quantitative result can now be predicted with substantially augmented realism for large, complex ventures.

It further identifies in ranked order the most interesting factors of the venture in

[1] Also known as Risk Assessment, Uncertainty Analysis or Quality Analysis

[2] An * indicates that the term is defined in the List of Terms.

question, and dramatically strengthens the team-building process.

Its primary professional areas of application are Cost Engineering, Project Cost Control, and Project Management, Risk Management, but also General Management. Users in fact consider it as an exciting multi-use management tool.

THE CURRENT PROBLEM

Severe overruns in cost and time frequently bedevil large programmes, projects, strategic ventures, etc., in both the public and private sectors.

Sydney Opera House, the Channel Tunnel and some of the Olympic Games are the most well-known examples but they are only the tip of the iceberg.

Sydney Opera House

The Channel Tunnel

Olympic Games

Several research projects have shown that among large IT projects only a small minority came out on budget, while average overrun was considerable [1]. Recent research by Professor B. Flyvbjerg into large infrastructure projects yielded a similar result [2].

This always causes severe problems. Where do we find supplementary funding? Might we end up with an unfinished shell, or at best with a sub-standard facility? Do we go bankrupt or at best find ourselves hamstrung in terms of the company’s future activities?

Cost engineers, planners and other professionals do complex, extensive and skilled work preparing a detailed basis for budgets and schedules, so why do we suffer these problems?

THE BASIC REASON SEEMS TO BE THE OLD NEWTONIAN SCIENTIFIC PARADIGM

A 300-year old scientific paradigm requires us to focus upon matters that can be documented and to avoid dealing with congestion and other subjective and fuzzy matters. This is still a strong feature of the higher education of engineers and economists and is of course valuable in many cases; however, it can be disadvantageous in some circumstances.

Working with plans for large projects and other ventures, the planners and estimators deal with incomplete project material, specifications, etc. when preparing the basis for a budget. The cost of the documented material is carefully detailed and skilfully calculated on the basis of historical data and other experience. In addition, they tend to assume that implementation will be relatively controlled, and unhampered by major problems. Finally, they apply a traditional dispensation whereby a somewhat arbitrary 10% is added for contingencies without any documentation.

THIS INEVITABLY CAUSES OVERRUNS

A still larger part of the project is not documented at the stage when the crucial decisions have to be taken. Add to this that a conventional budget estimate makes insufficient allowance for factors such as future added facilities, complications, requirements, unforeseen influence exerted by authorities, the owner, the users, local NGOs, nature’s caprices, human failures, etc., etc.: all typically – but not always – representing much larger amounts than the 10% contingency figure. No wonder we often experience large overruns.

Another consideration is that the many parties who have a stake in getting the project approved/authorised naturally wholeheartedly accept the aforementioned conventional and wholly legitimate budgets.

NINE BASIC RULES OF COMMERSIAL RISK ANALYSIS

1. The procedure must be conducted in group sessions by an appropriately constituted group of participants.

Individuals or a few people do not typically have the requisite breadth of experience and creativity. One or two individuals also run the risk of introducing bias into the many subjective evaluations. The group must comprise both experts and external generalists, youth and maturity, "both halves of the brain" and ideally a "devil's advocate".

2. A basic estimate should be drawn up beforehand on the basis of existing material.

Its prerequisites must be identified and meticulously detailed.

3. The participants must feel free to express their opinions without fear of being quashed.

Factors or contexts which involve risk or uncertainty can at times be perceived as veiled criticism on the part of dominant individuals; this can make some people hold back key contributions and thereby bias the result.

4. The responsible facilitator or analysis leader must be sufficiently well trained in the psychological and statistical framework for this type of analysis.

Uncertainty plays an ever-increasing role and requires statistical interpretation. There will also be intense interaction between the members of the group, which only knowledge and experience of group psychology can steer and manage.

5. The facilitator must have the ability to induce the analysis group to identify all the more significant sources of uncertainty and to classify them in sufficiently independent groups.

Major sources of error may be overlooked or misjudged if the facilitator does not have this acumen. Independent grouping dramatically simplifies subsequent statistical calculations.

6. The group's many necessary "guestimates" must avoid the many pitfalls which bedevil this area.

A scientific study [12] has identified 30 different pitfalls involved in "professional estimates". Such hunch evaluations represent a significant and increasing element of the total value of an estimate. This is particularly true in the critical early stages of a project. Sub procedures have been devised accordingly and have proved to be highly effective [10].

7. The statistical calculations must adhere to the fundamental rules for handling uncertainty.

These rules are consolidated in the Bayesian Statistical theory*. The most crucial point relates to statistical correlation between the individual items and factors, which is often overlooked in practical procedures: an omission which inevitably produces misleading results.

A well-known example of this is the classic PERT scheduling procedure, whereby the overall uncertainty can be progressively reduced at will, simply by breaking the schedule down into enough specific critical activities. This is clearly wrong. Other methods add up uncertainties, which again is fundamentally erroneous.

8. A set of suggested action plans for further safeguarding and optimising the project should conclude the analysis sessions.

At this juncture the analysis group is extremely well equipped to identify such a set. It will be of significant value to the forthcoming management of the project.

9. All information from the analysis must be documented in the form of a report without any substantial "black boxes".

This requirement allows for a higher level of quality assurance and general follow-up monitoring. Many Monte Carlo-based procedures in particular struggle to meet this requirement.

THE SUCCESSIVE PRINCIPLE

A brief history

The Successive Principle* is a somewhat unorthodox multi-use management procedure which brings you very close to a guarantee against overruns, except, obviously, in the case of major catastrophes.

The development was initiated at the Technical University of Denmark by the author in the beginning of the 1970s.

It focused on two features: (1) using the group synergy between knowledge, intelligence and intuition or common sense better, and (2) working top down, systematically focusing only on the few most important matters during successive steps of improvement.

An international research network was formed soon afterwards. It included Stanford University and MIT in the USA as well as universities in Loughborough (UK), Gothenburg (Sweden), and not least the Technical University of Norway in Trondheim [5, 6, 7].

The principle was originally a tool for fast, early cost estimating and scheduling in the construction industry and was soon known by users as “intelligent cost estimating”. Later it has developed into a multi-purpose management instrument.

From the 1980s onwards it has functioned as a Risk Management and General Management tool in most public and private business areas [8]. It has been used to analyse about a thousand large and medium-scale projects and other ventures in order to safeguard them against overruns, delays, etc. and to shed light on the essential factors.

Basic aspects

A key feature is to let a balanced group of key persons conduct a few analysis sessions together, during which they identify and then organise all possible sources of uncertainty – including fuzzy ones. They then operate top-down, systematically detailing and evaluating the most important issues in successive steps. The analysis group performs non-biased subjective evaluations of their impact on the result, currently producing a top ten list of the most critical remaining sources of uncertainty.

This allows the participants to keep an overview throughout the process, to focus on the really important aspects and to avoid wasting resources on the many issues of little or no importance.

Another important feature is the arranging of all uncertainties into discrete statistically independent elements and then working with the conditional uncertainty* of each of the elements. This allows simple yet sufficiently accurate statistical calculations.

Specific solution tools

- Basic Systems Economy and Cost Engineering tools, such as the Net Present Value concept*, Work Breakdown Structures, the Critical Path scheduling technique, etc.
- The Bayesian statistical theory* [9].
- The use of group synergy in a balanced and broad-based analysis group of competent people [11].
- Ensuring sufficient statistical independence* among the uncertain items and factors.
- Using the Group Triple Estimate technique*, an evaluation procedure which takes the many pitfalls into account.
- Using a top ten list of the most critical items or factors both during the successive process and as a key result.

THE PRACTICAL PROCESS

The procedure can only be briefly outlined below due to limitations of space. For a more explicit description and discussion. A similar procedure is used toward schedules [10].

The procedure is organised into the following eight steps.

Step A. Establish a suitable analysis group.
Step B. Clarify the goals and objectives, as well as any firm preconditions.
Step C. Identify all issues of potential importance.
Step D. Organise the issues into discrete groups, and define for each group a base case assumption and how it could change for better or for worse.
Step E. Quantify all uncertain elements - both “physical” and contingent -

using triple estimates* and good evaluation techniques.

Step F. Calculate a provisional overall result and draw up a top ten list of the most critical (i.e. uncertain) items or activities.

Step G. Specify the most critical elements in successive steps, guided by an updated top ten list.

Step H. Once a satisfactory result has been arrived at, complete the analysis work with a suggested action plan for subsequent management purposes and finally submit a comprehensive report.

IMPORTANT DETAILS

Step A. Establish a suitable analysis group.

An appropriate analysis group is appointed according to the specific purpose of the analysis. In addition to a number of experts representing the major key areas, the analysis group should include individuals who can provide the vital elements of creativity, flair and breadth. The analysis group should ideally include both young and mature individuals, both generalists and specialists and should represent “both halves of the brain". You will usually also need an individual who can play the role of "devil's advocate"; this is especially important in the case of a project whose project team generally wants a successful result, and whose judgement may therefore be over-optimistic.

It is also important to select an appropriate and agreeable location where the analysis group feels comfortable, and relatively undisturbed. The subsequent steps are performed in group sessions, using modern group psychology inspired by Robert B. Gillis [11].

Step B. Clarify the goals and objectives, as well as any firm preconditions.

The analysis management team will have prepared a draft to be sent to the participants before the first session. However, it is important to discuss it properly in the group and to make adjustments until full understanding and consensus have been reached.

Step C. Identify all issues of potential importance.

The identification of sources of uncertainty (possibilities or risks) is typically achieved by means of a brainstorming process. This usually identifies 50-100 issues.

It is important to verify specifically that a sufficiently broad variety of issues has been is identified, and not mainly technical issues, for example.

Step D. Organise the many issues.

The identified key words are grouped together into 8-12 statistically independent groups. A clear and simple base case assumption is defined for each group, as well as how it could change for better or for worse. The normal length of this description is four to seven pages.

Step E. Quantify, using triple estimates and good evaluation techniques.*

A master schedule network or a master calculation structure is chosen. Each main activity or main cost item is quantified from the highest level using the triple estimating technique*. In order to avoid evaluation bias, a specific ‘Group Triple Estimating technique’* has been initiated by N. Lange [12] much inspired by C.S. Spetzler and Stäel von Holstein [13]. Shortage of space prevents further mention here of the psychology involved, see [10, section 5.2].

As a variant a master schedule network or a master calculation is used[3]. The activities and related main items are evaluated under the aforementioned relatively firm base case assumptions. This ensures a sufficient degree of statistical independence. For each of the 8-12 groups of overall influences a correction figure is evaluated, also using the

[3] The above-mentioned base case assumptions in this case should correspond to those used in this network or calculation.

Group Triple Estimating technique*. It may be in absolute units or as a percentage evaluation.

Step F. Calculate the resulting total and a top ten list of the most critical items or activities.

Statistical independence* is thus largely achieved. To reduce any remaining dependencies further, the analysis group operates with the concept of conditional uncertainties*. This allows a simple yet sufficiently accurate statistical calculation to be made.

The result of the above evaluations is calculated. The calculation follows the natural laws of uncertainty, in this case the Bayesian statistical theory*. In addition to the total mean value* and its uncertainty, a top ten list is produced, showing the most important and critical local sources of uncertainty.

Step G. Specify the most critical elements in successive steps.

This preliminary estimate or schedule is now detailed in successive steps, with the most critical elements being specified at every step. The guidance in this "intelligent" detailing process is provided by the aforementioned top ten list. It actually leads to an optimal breakdown and evaluation of only those elements which warrant the attention.

Step H. After the final result has been achieved, the analysis work is completed with an action plan.

After a number of such cycles, the elements displaying inevitable uncertainty will increasingly dominate: after 6 to 10 cycles they usually account for 80 to 90% of the total uncertainty. Consequently, we are close to the minimum uncertainty of the grand total and similarly close to a successful conclusion of the analysis. At this stage, the degree of detailing usually involves fewer than a hundred items of which a considerable number are correction items.

The analysis group will usually be prompted by the final top ten list to draw up a suggested action plan by way of a conclusion to the entire analysis process. The aim is to identify actions which may either exploit opportunities, protect the task against risks, or simply reduce uncertainty. A brainstorming process at this point is a highly appropriate means of identifying such ideas. A report concludes the procedure.

EXPERIENCES AND RESULTS

Experiences

The statistical calculation procedure has been verified already during the 1970s and 1980s by professors I. Thygesen and P. Tyregod [14]. Scientific and practical experiments have verified the psychology behind the subjective evaluations and the use of the Group Triple Estimate technique [10, section 5.2].

Practical experiences are drawn primarily from the 250-300 full-scale tasks performed during the last 25 years which have demonstrated that the procedure has followed “the rules of the game”. They cover most business areas and all sizes up to the “mega” size and have been most satisfactory.

Three examples

One example is the complex high-tech, multi-purpose 10,000-seat arena, *Oslo Spectrum* in Norway. The original budget was $45 million. The use of the Successive Principle three years later, before the project was due to start, identified $125 million as a realistic cost. The project was then rationalised, after which an analysis process generated $80 million as a mean value* +/- approx. $10 million as the standard deviation*.

Oslo Spectrum in Norway

The project organisation was allotted the $80 million as a budget, while the official building committee was given the $10 million as a reserve. However, this reserve was never used because the official project account after the successful erection deviated by less than 1% from the calculated mean value [4].

Another example is the *Lillehammer Olympic Games.* The initial investment budget rose from $230 million to $385 million over the summer, more than four years before the games. A risk analysis showed an expected final total cost of $1230 million. This was of course politically unacceptable. The investment plans were then reorganised – in part supported by the analysis result – and followed by several updating analyses.

The Lillehammer Olympic Games

The expected investment figure was eventually reduced to $800 million as a mean value. This became the working budget, while the official committee was allocated a reserve of approx. $90 million.

However, the final official accounts equalled the analysis mean value of $800 million, so the reserve fund was saved and was used to operate the facilities after the games.

The telecommunications company Ericsson's first mobile or cellular phone is an example of the use of the Successive Principle as a support for making the right decisions. It was originally allocated relatively low priority among a set of new ideas in an R&D department at Ericsson.

Ericsson's first mobile cellular phone.

A Successive Principle analysis then revealed it to be a highly promising idea. Accordingly, it was upgraded in priority, developed and became *Ericsson's* greatest commercial success ever.

It might be said that the above three cases merely capitalised on coincidence or good luck. But over the course of more than 25 years, no negative feedback has so far been received from the sub-set of 250-300 cases which were analysed under controlled conditions. Surprisingly many ended close to the mean value*. But of course not all of the cases ended up quite so close to the exact mean value as the above mentioned examples.

Results

The primary result is a most realistic mean value of the actual future total result, whether in terms of cost, time, profitability, resource or consumption. This result is given in statistical mode, with a mean value* and a standard deviation*, or alternatively as the so-called S-curve, indicating the probability vs. the total value.

The top ten list of the resulting most uncertain aspects is also much appreciated by users. It is typically used to prompt the analysis group to draw up a suggested action plan for efficient improvements and risk reduction. Improved team building amongst the parties involved is also considered as an important side effect.

PRINCIPAL FIELDS OF APPLICATION

The Successive Principle is considered a multi-purpose management tool. It supports, for example:

* Quality assurance of budgets, bid or tender estimates, and schedules, profitability analyses and other financial analyses.
* Risk and opportunity analyses.
* Suggested action plans for improvements.
* Ranking of alternative solutions.
* Team building and consensus.

Classified by area, it is used as follows.

A. Senior Management, Quality and Risk Management

- Practical elimination of unpleasant surprises (e.g., overruns or delays).
- Risk-assessed corporate budgeting and planning.
- Greater certainty that key issues are being identified and actioned.
- Support for corporate contingency and risk management.
- Loss-making projects may be cancelled in good time.

B. Sales and Marketing
- Sales budgeting and planning.
- Consideration of opportunities as well as risks in competitive situations.
- Bid preparation and development. User companies have proved to be more frequently successful in competitions.
- Support of contract negotiations, not least the sharing of risks.

C. Project Management
- Project start-ups are significantly improved.
- Development of realistic plans and budgets.
- Reductions of costs or project duration during project implementation.
- Creative problem solving is supported.
- Team building is supported.

SOME LIMITATIONS

Only the overall result is reliable, not each sub-item or activity. Catastrophes and other major 'either-or' or force majeure events require supplementary procedures. The approach is limited to organisations with a modern, open management policy and acceptance of group work.

It supplements rather than replaces planning. It requires trained facilitators who know the “rules of the game”. Subjective uncertainty must be accepted. The implementation process requires effort, time and the support of senior management.

Finally, it must be admitted that the untraditional nature of the Successive Principle often hinders its proper use in more conservative environments.

SUMMARY

The paper focuses on the potential for largely eliminating the many fatal overruns and delays which hamper the involved parties as well as the image of the whole profession.

Nine rules are the result of a decade-long international research programme. It has been shown that, used together, this age-old problem of overruns and delays may now be solved.

The unorthodox Successive Principle is a practical example of using these rules. It has used newer scientific paradigms which accept that fuzzy issues and intuition must be more seriously dealt with. The end result is an integrated management and decision support methodology.

It relates well to contemporary post-industrial management principles and attitudes. The strengths and benefits of the approach include

- Enhanced grasp of an uncertain future.
- Consideration and handling of the turbulence and uncertainty of business in a systematic and scientifically sound way.
- Integration of objective and subjective aspects.
- Identification of and focus on the most important uncertainties (risks and opportunities).
- Proactive use of optimisation potential.

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The author also wants to extend his thanks to Michael G. Curran for his inspiration. With the Range Method Mr Curran successfully opened up years ago for the acceptance of uncertainty in itself among professionals in this area. Of a more recent date the author would like to acknowledge the most rewarding discussions with one of the fathers of Risk Management, Kenneth G. Humphrey [15].

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LIST OF TERMS

Bayesian statistical theory is a widely accepted theory, which includes subjective probability in contrast with the classic or frequentistic statistical theory, which only accepts sets of documented data. Both theories use the same set of formulae [9].

Conditional uncertainty is the uncertainty of a local variable on condition that all other uncertain parameters are within their mean value.

Correlation or dependence coefficient. A statistical concept denoting the degree to which two separate uncertain figures follow each other. One limit is full statistical independence.

Group Triple Estimate technique is a procedure aimed at obtaining a neutral result by avoiding a set of pitfalls linked to subjective

evaluations [10, section 5.2]. See also Triple Estimate.
IPMA, the International Project Management Association, a European and Asian-based professional organisation. See also PMI.
Mean value (also known as expected value or expectation value) is a central value of an uncertain figure.
Net Present Value, NPV, is a widely used profitability criterion. It summarises all in and outgoing payments in discounted form (discounted back to the present time) for a specific system in contrast to other alternative ventures.
PMI, Project Management Institute, an American based professional organisation. See also IPMA.
Standard deviation is a statistical measure of the dispersion or variation of numerical data from the mean value (see this term).
Statistical or stochastic independence, see Correlation coefficient
Successive Principle (also known as the Lichtenberg method) is a multi-purpose management and Cost Engineering tool used to identify a realistic future result of a venture (cost, duration, profitability, etc.) and the related primary uncertain issues.
Triple Estimate. The mean value* and standard deviation* of an uncertain figure is evaluated as a weighted sum of the extreme minimum, the extreme maximum and the most likely values. See also the Group Triple Estimate technique.

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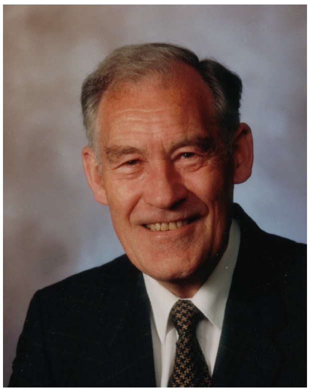

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