Decision Facilitation
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Four Simple Questions – The Decision-Centric Approach to Projects and Project Management

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Abstract

A decision-centric approach to projects creates confidence, improves value, and shortens time to revenue. A straight-forward objective based approach to managing project decisions is presented in the form of four primary questions. Those questions are:

1) Does the issue/threat/opportunity make a material difference to the project? (Materiality)
2) Can anything be done to affect the outcome? (Influence)
3) Can you afford to do anything about it? (Value)
4) What if you are wrong? (Confidence)

Materiality – An issue/threat/opportunity must make a material difference to a project decision to be worth receiving attention. The concept of materiality will vary in size and consequence from project to project, so it is important to maintain a decision focus. Understanding the variability in the project with respect to decision thresholds can provide an indication of materiality. We must also ask how different our current assessment of the project, or its environment could get before we would like to change our decision.

Affective ability – Accepted risk-management options of avoidance, mitigation, transfer, and acceptance present the decision options within this category. In considering the consequences the options, decision tools such as Indifference Assessment and Pain and Regret Assessment.

Avoidance, Mitigation, or Transfer – while most projects can benefit through risk reduction, such effort must make economic sense. Risk reduction paths must add value to the project through added upside or elimination of at least a portion of downside threat. The value of these efforts is aided by use of tools such as Value-of-Information, Value-of-Control, and Value-of-learning.

Being wrong – Making a regretful decision is always a possibility but the source of the “wrongness” and its likely impact is often overlooked by teams.

In project planning and execution, decision-makers are often presented with a plethora of issues, threats, and opportunities. From development planning through implementation significant time and resource waste can be cut by prioritizing effort to the issues that matter. Understanding the issues in the context of materiality and then what to do, if anything, about an issue, becomes key to maximizing success. This approach cuts waste and focuses the attention on what matters.

Decision Intelligence not only increases the probability of making the best decisions, but it also prioritizes work to those items that matter either for value or decision path. While most of the decision tools referenced are well documented in the literature, placing them into the context of the Four Question Approach allows teams and management to focus more closely on efficiently mitigating issues, shortening workflow, and creating significantly higher decision confidence. This novel approach works well in all phases of project planning through project management implementation.

Introduction

As more companies, governments, and teams within those entities implement decision-centric methods[1] and management it becomes more important to have a consistent approach to working decision options and sequencing. Decision-centric approaches help companies and teams improve value, shorten time to completion, and create more stable, robust solutions to complex problems.

We will outline an approach to the allocation of resource and effort within a project that centers on the objectives that need to be fulfilled and the decisions that need to be made. We shall borrow heavily from the field of Decision Science.

When we are involved with project planning, execution, and risk management we can be confronted with innumerable tasks, objectives, decisions, and threats. It is important for teams to rapidly assess the importance of and prioritize action on these elements. We shall use “element” or “element of concern” to portray a task, threat, issue, benefit, decision, or uncertainty; the aspect of the project that may be troubling. These are the typical categories that crop up for attainment, avoidance, and management, but not everything is worth the time and effort of teams. To be worthy of money/effort/time, three aspects must be true: elements must be material to the project, there must be at least a chance that efforts to affect them would be successful, and that it makes economic sense to attempt to affect them. Then we turn around with Question 4 and look at what happens if our assumptions or decisions are wrong. The discussion of Question 4 will include a case study of an asymmetric risk assessment of well spacing decisions. This case study is presented in detail as the method has not been published before now.

An objective of this paper is to provide a go-to set of questions that when answered will provide a way to prioritize the application of effort and scarce resource[2] within a project. It is a resilient set of questions that applies across many contexts and industries. We will concentrate on two contexts: project planning and development, and project execution. Discussion of each question will provide context and initial direction to deal with project issues. Where possible, appropriate decision support tools will be mentioned, referenced, or used as examples.

For each Question we will look at identification options, context, and tools, then provide tools and logical approaches for what might be done. There will be references to decision support tools and decision intelligence methods. The reader is encouraged to follow up on process and tools. An annotated bibliography is provided for that purpose.

The Four Questions

Materiality

Question 1: Does the issue/threat/opportunity make a material difference to the project?

[1] A Decision-Centric approach utilizes a structured approach to projects with uncertainty and ambiguity. It prioritizes work to strategic vs tactical decisions and objectives. It allows project planning and execution to be efficient and targeted to optimal, well-communicated pathways.

[2] A Scarce Resource is anything of limited availability that it used to carry out or complete the project. Typically, and from a manager’s perspective this means capital, human resource, and time. It may also include tangible items such as fuel, steel, and rig availability.

To answer this question, we need to be clear on what we mean by "Materiality". To be considered worthy of management time, an issue or decision must have at a minimum, threat of substantive impact to the outcome. The impact may be to decision pathways (the sequence of decisions made in a project) chosen, to the extent project objectives are fulfilled, or to financial risk/benefit. There are several dimensions of materiality within a project and identifying what matters, what makes a difference to a project and managing those elements without wasting resource/time on non-material items is critical to attaining the best overall outcome.

Materiality is more than size. An element, even if small in magnitude, is material if it affects the use of scarce resources or impacts schedule in a way that might cause a decision maker to select a different path. The expenditure of scarce resource to mitigate or control the downside risk that prevents or impedes the achievement of important project objectives should be considered material.

As with the derivation of value due to new information (which will be covered in Question 3), elements should be considered material if their occurrence, outcome, or threat could cause you to change your preferred decision path, or if they substantively impact the minimum fulfillment requirements of an Objective.[3] Merely reducing uncertainty without affecting a decision has no value. Impactful changes in outcome magnitude may change the value of a project. The quest for precision is not material unless a decision is affected. For example, a project team has a need of 60 MMcf/d egress from an area. Available capacity is between 200 and 300 MMcf/d. Even though the uncertainty of the egress availability is significant, it is far from the need and unlikely to affect the development decision. The uncertainty is immaterial to the project and narrowing it would be a waste of time.

As such, it is important for the project manager to distinguish between managing to improve precision in the predicted outcome and managing to create the best decision path. Just because an element is large, that, in and of itself, does not require the devotion of effort and resources to its management.

All things being equal, the closer a predicted outcome is to a decision threshold (the position along the continuum of possible results a different option would be preferrable)[4], the more material an issue is. That said, the decision itself must be a material decision and the change in choice must offer a meaningful difference over what is planned. Recognize that this difference may be a combination of expected value, downside risk exposure, or external competitive threat. Using our egress example, if the capacity is estimated to be between 50 MMcf/d and 70 MMcf/d, bracketing the required 60 MMcf/d, egress would certaintly be a material concern. Depending on the company's reisk tolerance, an egress uncertainty of 65 MMcf/d to100MMcf/d may or may not be material.

Expect that an element may change in materiality through the life of the project. One must ask not only if an element is material, but also "Is it material now?". Do we lose competitive advantage or eliminate future options if we elect to ignore something that will become material? A good rule of

[3] Every project carried out and every decision is made within a context of desired objectives. Commonly objectives are expressed in a two-word statement such as "maximize margin" or may be multiple words long as in "minimize time to first production", but always have a clearly defined desired outcome. Often these objectives may conflict, e.g., maximize throughput and minimize cost, where complete fulfillment of one objective prevents fulfillment of the other. Characteristically, each objective will have a minimum acceptable fulfillment. Options are deemed infeasible or unacceptable if this minimum acceptable threshold is violated.

[4] A Decision Threshold is the point at which a decision-maker is indifferent to two decision paths. It is the point at which the preferred decision solution changes.

thumb is that future materiality indicates present materiality, whereas past materiality may have decreased. Future materiality means the element should be considered within the decision context but may not mean it needs to be actively managed. Optionality has value.

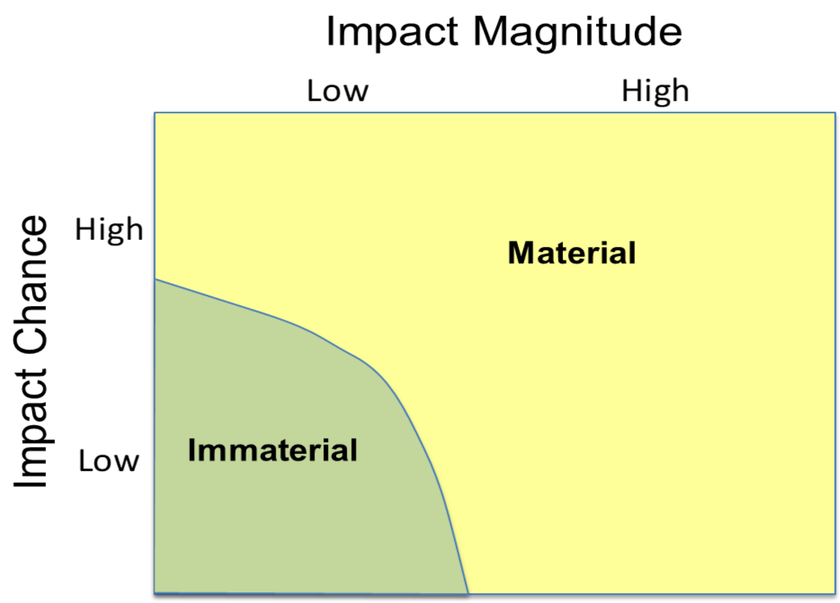

Figure 1: Materiality is a combination of Chance and Magnitude at affect decisions and actions in the project. Rare, low-impact elements are usually accepted as immaterial.

Materiality is linked to competitive advantage as well as project management and execution so there are two categories of materiality to be concerned about: Internal and External.

Internal materiality examines how an element affects project value, its cost/schedule, its decision sequence, and solution options. Does the element that you are concerned about play a substantive role in the project itself?

External Materiality deals with how a project relates to its environment, principally in the context of competition for scarce resources within the company and its portfolio or in a competitive control context amongst the company's competitors.

External materiality comprises nuanced concepts such as competitive advantage, leverage, sway (decision influence) and what can be called "sitting at the grown-ups' table." Does the issue at hand affect competitive advantage (either offensive or defensive advantage)[5]? Does it change what you need to do or what you need to protect? If the answer is yes, then the element is material.

An important element of external materiality is your firm's working interest (WI) in an opportunity. WI must be sized to assure the ability to get things done and be a significant influence in the area. Is the size of your investment big enough to earn you accommodations from suppliers?

[5] Offensive advantage is an aspect, asset, procedure, or control that allows the company to exceed the capabilities of the competition. Defensive advantage is an aspect, asset, procedure, or control that impedes the actions and influence of the competition.

What size positions does the local competition have, and will they hold more sway over infrastructure development and timing? If eventual sale is a goal, does it have the scale to appeal to more than the neighboring producers and thus command a higher value in the market?

Material control

Two indicators of material control within a project may be identified as choke points or enabling elements. These are usually desired items to control. Another indication of a control point is where a resource or supply item is limited. Feedstock availability, rig availability, and access to markets via a transportation network are all examples of potentially controllable items that may change the decisions in the project. These examples are all tangible elements, but control may also be economic or financial. If you do not control choke points and enablers within a project, plan for a significant amount of your profit to go to those who do.

When we examine Objectives Hierarchies (Figure 2), we often see objectives that can be accomplished only when several other objectives are fulfilled. These Objectives are "pinch-points". When achieving at least minimum fulfillment in a particular Objective enables several other objectives to be fulfilled, they are called "enablers". While all Objectives are important to one degree or another, the most material Objectives, the ones that demand special attention are the pinch-points and the enablers. These should be the first material objectives selected when evaluating the decision sequence within any project.

In Objectives Hierarchies the lower level "Means" objectives enable higher level objectives. For example, Obtaining Feedstock Agreement, enables the objective to Minimize Cost, which enables the objective to Maximize Operating Margin, which ultimately enables the ultimate objective of Maximize Project Value.

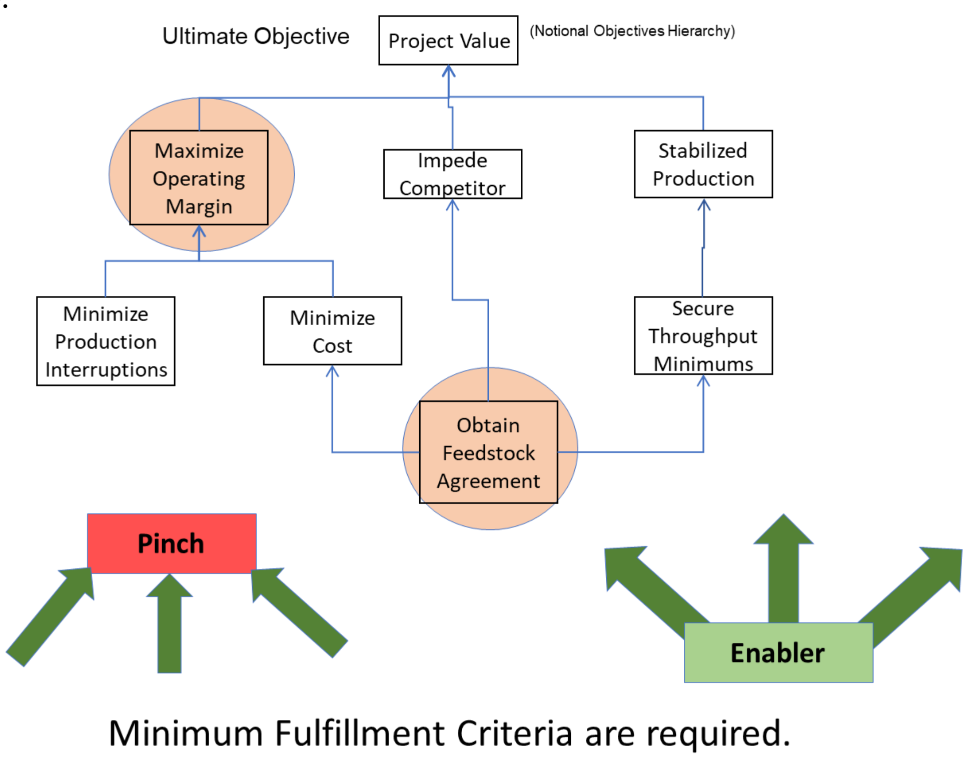

Figure 2: A notional Objectives Hierarchy showing a pinch-point and an enabling objective (red ovals). Obtaining a feedstock agreement is an enabler as it helps accomplish three other Objectives. Maximize Operating Margin is a pinch-point (albeit a simple one in this example) as it requires multiple objectives to be at least minimally fulfilled.

As a control point analogy, picture a crowded, windowless room with a single door. For people to exit they must use the choke point, the door. The person who controls the doorway effectively controls the room notwithstanding their ownership of the room itself. Companies have recognized the importance of control by building and operating all-weather access roads into sensitive or difficult areas, controlling the LNG facilities governing the exit of natural resource from a country, pre-booking scarce resources such as field-support vessels/helicopters beyond their needs, and positioning their acreage between infrastructure and developing fields. Having control of pinch-points or enablers whether they be tangible or Objective-based, can provide material advantage in negotiations.

Confidence and Materiality Indifference

Confidence is a key component of decision making. The confidence that what you have is at least as great as what you need to have is a key threshold, especially in go/no go situations. What you "need to have" may be to achieve a minimum Objective threshold, or it may be a threshold for a decision solution (e.g., transition between facility sizes). For for any given level of confidence there is a threshold, based on risk tolerance, at which the decision-maker is indifferent between two or more options. This indifference point is the decision threshold; the point at which the anticipated best choice changes. Alternatively, the same approach can be used in infrastructure planning where the team is indifferent between two infrastructure capacities. The process to identify the decision threshold is called an "indifference assessment." It is often more important to know where your decision changes than it is to have a precise prediction of the project outcome. "Sensitivity to probability" analysis is another type of indifference assessment.

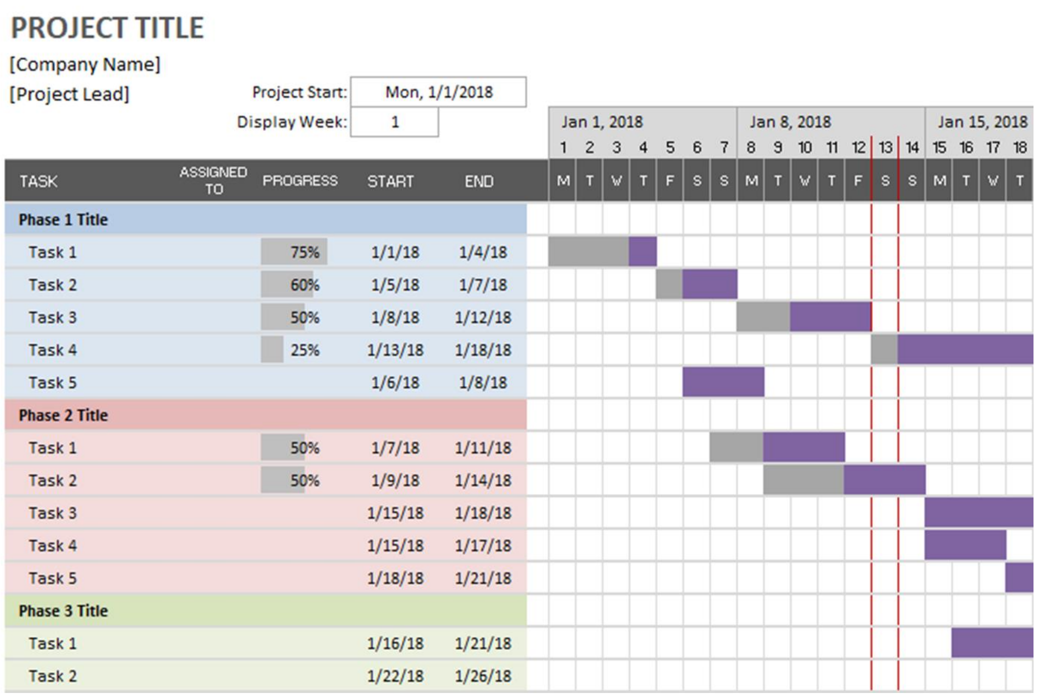

Figure 3: An example of a generic Gantt chart. Note that of the five tasks which were to be completed by the listed date, one had not been started and four were only partially completed. Unfortunately, this is typical. It is best to use stochastic uncertainty modeling techniques to provide realistic and reliable forecasts of cost and schedule. This is best accomplished using a PERT format tool.

We have discussed materiality from a project choice perspective. Let us examine aspects of materiality in project execution and project risk management. A Gantt chart, invented by the Engineer and Management Consultant Henry Gantt in the 1910's, shows a project's tasks (Figure 3). Project managers typically start off with high-level material project components and sub-divide as necessary. The PERT chart (Project Evaluation and Review Technique) was first developed by the US Navy to aid their nuclear submarine development program. It places the tasks in sequence with precursors connected to dependent tasks. The workflow can be followed through the chart. It aids in the management of projects by identifying those elements that may be carried out in parallel and those elements in the project that are chokepoints or enablers (the "pinch-point" of Objectives Hierarchies is now a choke point in process flow). This allows the allocation of effort to be prioritized to the material events. But which of these tasks are material? Do they all deserve the same attention and effort? Instead of a decision solution approach as we have discussed for project planning and development, Materiality in project execution is more often associated with threats to cost and schedule. The same Four-Question approach is applicable for the allocation of money/effort/time.

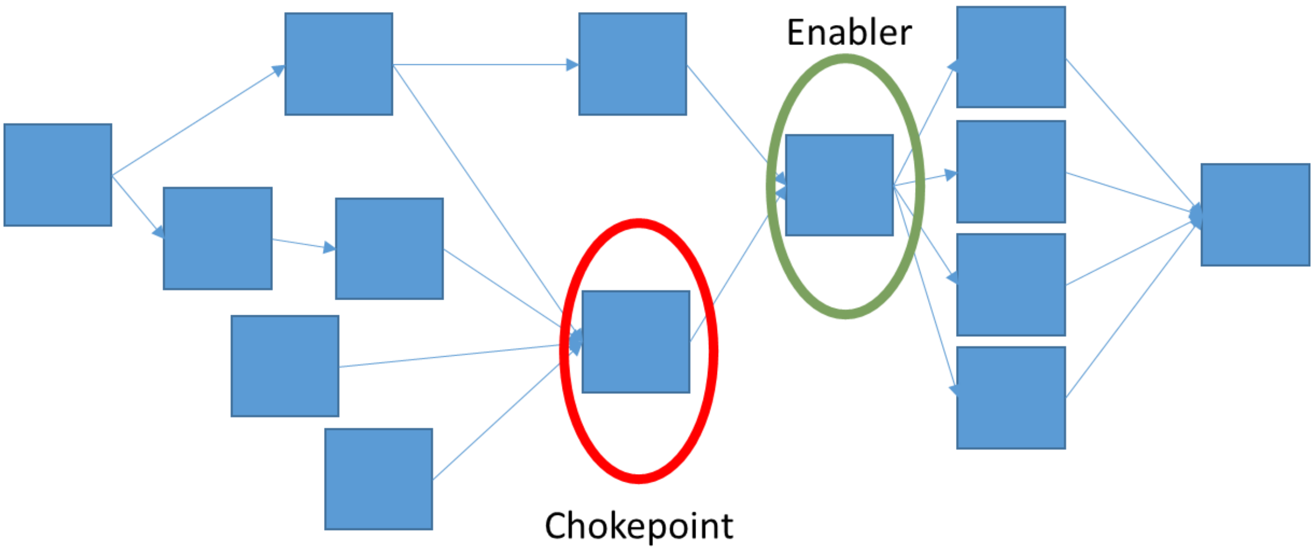

Figure 4: Notional PERT chart showing task sequencing and two critical management points.

PERT charts aid Critical Path Management (CPM). The Critical Path of a project is the sequence of events that takes the longest to get to the final targeted outcome. Figure 5 shows a project with 16 tasks. Deterministically, the Critical Path has been identified as the series of green boxes bearing the "CP" designation. It should be the objective of task managers to keep their task off the Critical Path. This effort, if successful, shortens the duration and achieves the final objective as earliest.

While a PERT chart does not usually show a time frame, it can. However, when a project manager considers the uncertainty in cost and schedule for each task, it becomes obvious that there is no truly fixed schedule as the project is carried out. Each item is enabled by the completion of the earlier item. A delay anywhere along the paths will delay the start of subsequent tasks.

It is not our plans and expectations that cause delays and overruns, it is the surprises. We can see that any task on the Critical Path has a direct effect on the total execution time. What we do not see without the inclusion of uncertainty are the likelihood that non-Critical Path items

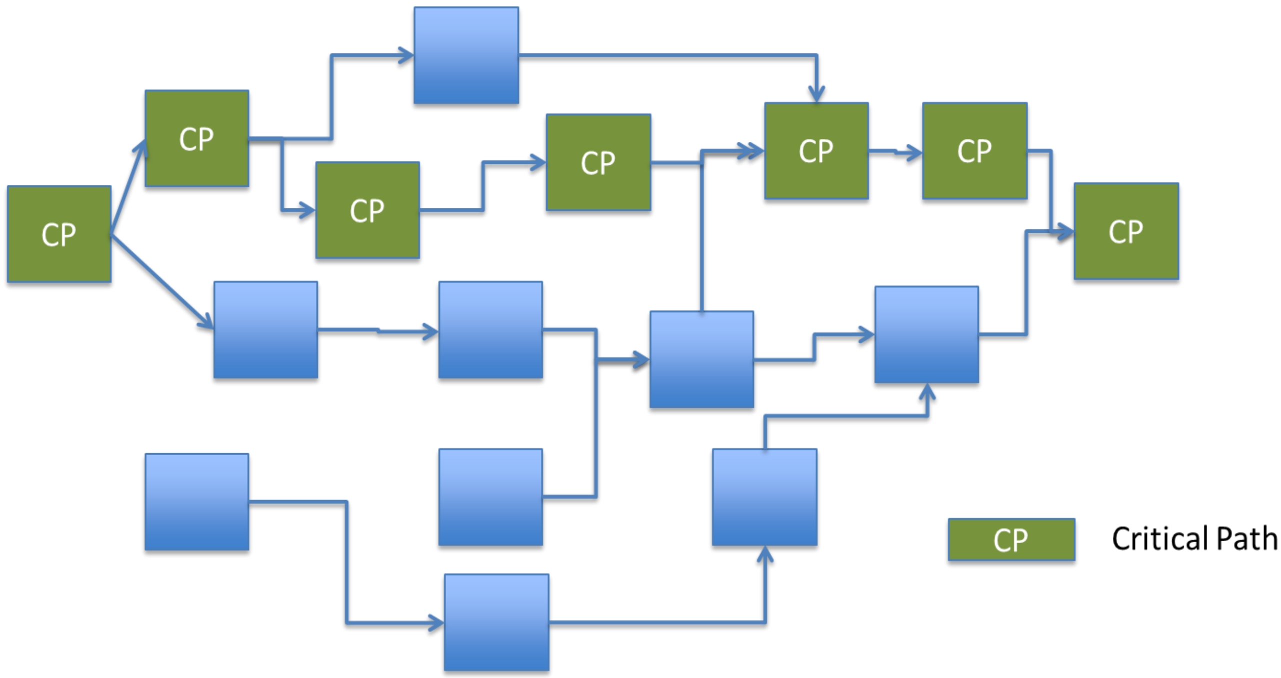

Figure 5: A notional PERT chart for a project with an indicated high-probability Critical Path. All Critical Path items should be considered material unless proven otherwise.

Figure 6 shows the PERT chart with the addition of the “Dangerous” tasks. The danger is not to personal safety but rather to the Critical Path (cost and schedule). They are, due to the uncertainty of all tasks, the tasks that are most likely to be surprise variants of the Critical Path.

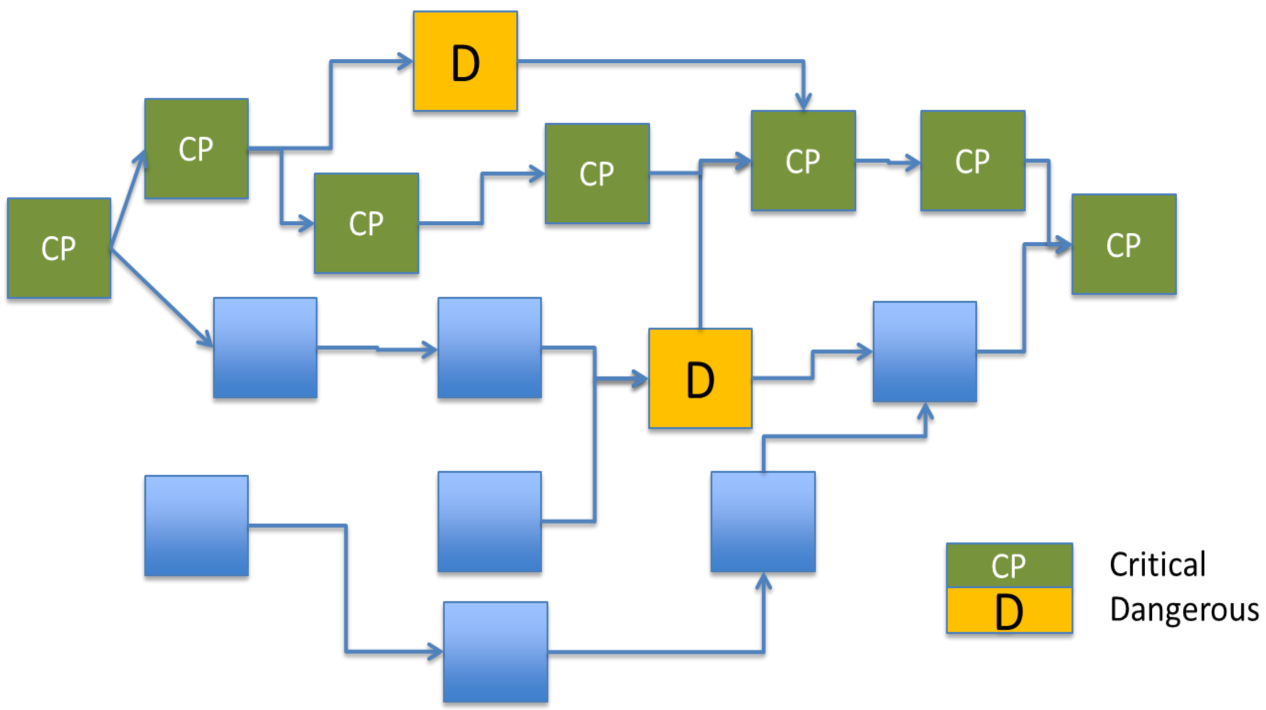

Figure 6: The notional PERT chart shown in Figure 5 ammended to show items that have a high probability of jumping to the Critical Path. Dangerous items should be considered material if their probability of jumping to the path is greater than management’s risk tolerance.

Material tasks are those that are on the Critical Path and those that are likely to join the Critical Path.

We favor the PERT chart for its true sequencing ability and suitability for stochastic modeling of cost and schedule uncertainty. Figure 7 shows the percentage of the time that a particular task is on the Critical Path for an example small structure construction project. The items always on the Critical Path and those likely to be on it should be considered material within the project. Additional items that should make the material designation are high risk activities that could expose the company to inordinate risk. Figure 7 identifies material items in execution, but what about cost? Total cost for any individual task is a combination of fixed and variable rates. Cost and schedule are linked via variable or stand-by rates so while Critical Path elements should be deemed material do not be blind to high uncertainty in non-Critical Path items. What constitutes a material cost item will be dependent upon the project and the risk tolerance of the company.

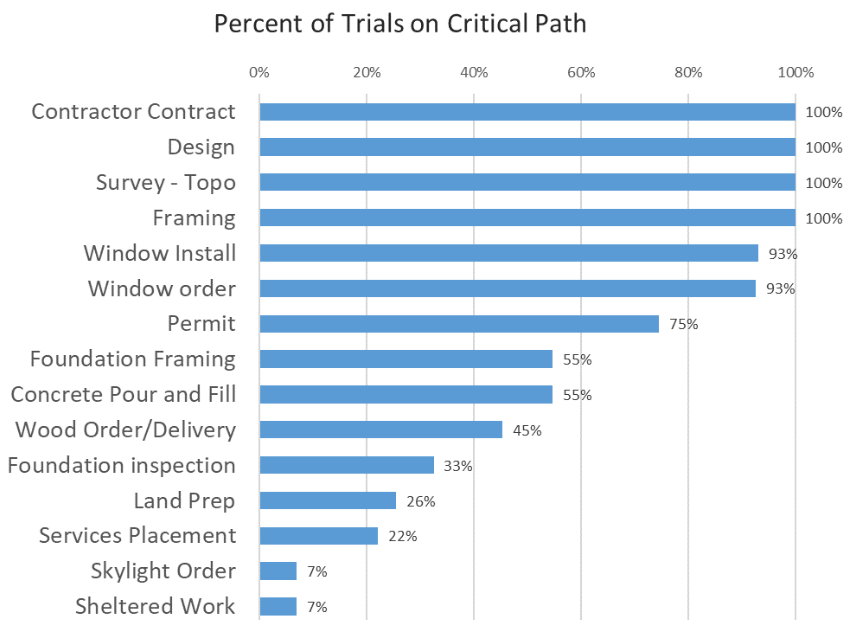

Figure 7: An example of elements of a construction project ranked by their probability of being on the Critical Path

Influence

Question 2: Can anything be done to affect the outcome?

So, it has been determined that an element is material, what is next? If an element is material, one must be able to do something about it to justify the resource expenditure to affect it. To use the literary, avoid tilting at windmills.

An example of a material event that you cannot do anything about is a tropical system. A historical frequency may show a probability of x number of storms per year, but we have not learned how to avoid them or manage their intensity for a particular location. Tropical systems are material events. If we cannot alter their frequency or intensity, we must find other ways to handle the risk. While financial risk may be transferred to others (insurance), damage mitigation and recovery planning becomes a material concern.

Typically, the effort in this phase would be aimed at reducing the downside risk to the project or company of a material element. While the same principles may be used to capture upside potential, our discussion will involve downside threat handling. Risk management provides options to deal with downside exposure. Downside risk may be accepted, transferred, avoided, or mitigated.

Haskett (2008) describes a Pain and Regret Assessment where Regret is the chance that an unfortunate event will occur, and Pain is the penalty inflicted given that the event occurs. We reaffirm here for the sake of Decision Professionals that a well-made decision itself is not "regrettable" but that it is the undesired outcome that we reference as a regrettable occurrence. To affect either the Regret and/or Pain of an element of concern, we have choices. The answer to Question 2 should provide decision makers with options. Those options fall into one of four categories as shown in Figure 8.

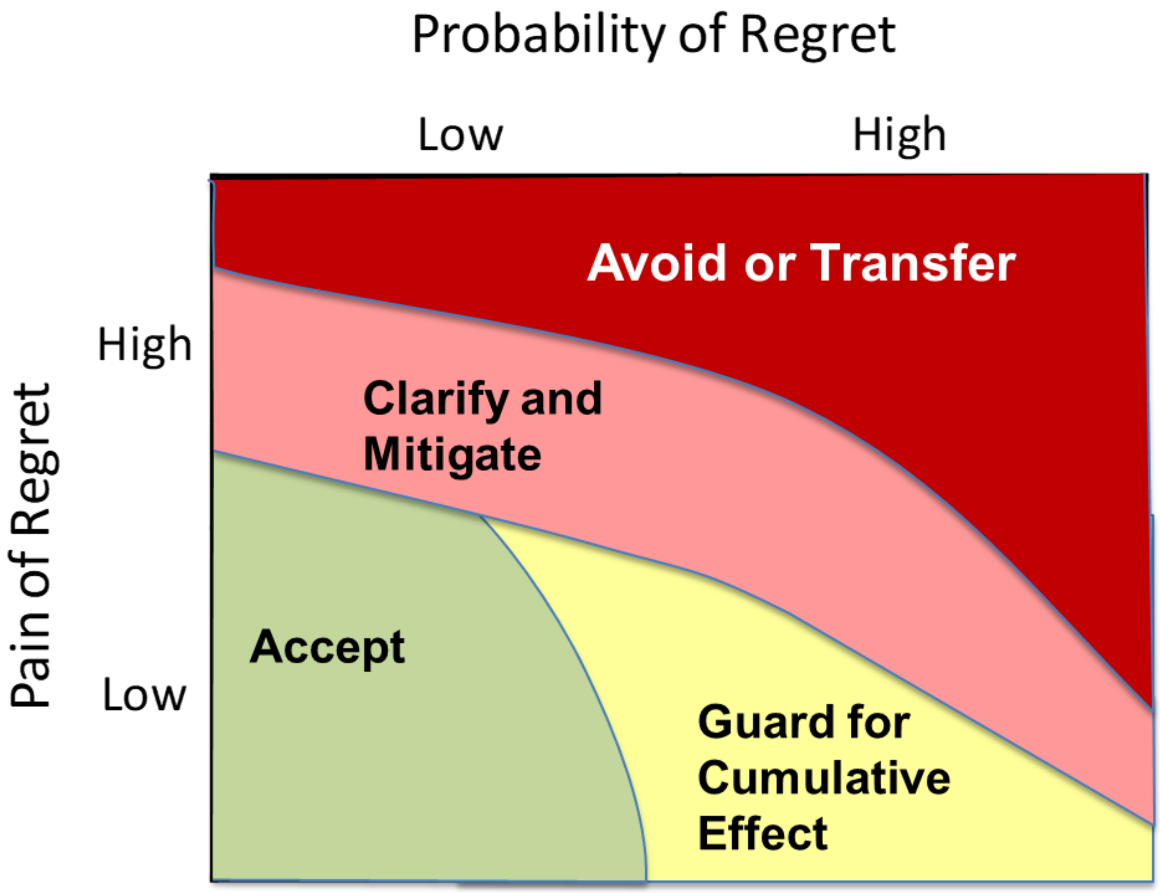

Figure 8: Pain and Regret Matrix as adapted from Haskett (2008)

Even in low probability (frequency) events there comes a point at which the risk is intolerable. Avoidance becomes the sensible option. For example, choosing to walk across a busy, multi-lane, high-speed highway. That said, there is always the cost component to take into consideration. Figure 8 assumes there will be a cost to do something about Pain and Regret. It assumes that if there is no cost or loss of upside potential that the element of concern the solution is trivial. The decision to avoid would be a given.

Acceptance – elements with a low probability of Regret and a low degree of Pain may be accepted. This path is typical of upside capture situations where materiality was based on a magnitude increase in "goodness". As a risk element, something scoring low-low would be unlikely to have survived the materiality challenge.

Avoid or Transfer – elements where downside outcomes are intolerable that threaten the survivability of the project or company should be avoided or risk transferred. Emphasis in the risk management process shifts to mediation in recovery (if possible) as opposed to mitigation of the event itself.

Guard for Cumulative Effect – Go for a walk in virtually any remote northern wilderness and you will meet a tiny nemesis, the blackfly. On its own, a single blackfly is a nuisance but is easily dealt with. It has a high Regret in that it is highly likely to be present but a low Pain. Add a few thousand of its relations swarming around your face and invading every open gap in your clothing and the cumulative effect becomes material. The same principle applies to high frequency events that cause low pain for a project. It is important to identify those elements that have a repeated chance of occurrence and safeguard the project for their combined effect.

Clarify and Mitigation takes the most time and effort which is why this space has been carved out for final examination. It is in this step that we examine the downside potential, identify the causes of the downside, and formulate mitigation plans. To figure out if something can be done to eliminate or mitigate an undesired outcome, you first must figure out what might cause it. That search is not always straight-forward.

There are several decision tools that can help us. We will concentrate on two of them. The first step is to qualitatively identify the range of possible outcomes from an uncertainty, the business and project context variables that provide or prevent value, and the scarce resource limitation or control deficiencies that can endanger the project or the company in totality.

Imagine you are five or ten years in the future, after the project was completed. Notice the shift to past tense. That is an important aspect of the tool we are about to use. There is no doubt. The project failed.

Looking back on the project and your involvement in it, you classify the effort as one of the biggest failures in your career, not only from a company perspective but also from your personal perspective. It is a project in which you wish you had never been involved. Now create a story as to why you feel this way. What happened in the project? What caused the failure? What do you wish was done to have avoided or at least mitigated the failure?

Originally published by Klein (2007), this technique is called performing a Premortem. His method has been adapted for decision support. The most difficult aspect of this is to keep the realization that the project is over and that it was a failure. It did not achieve one or more of its critical objectives. People may start to say things such as "It could have failed because of…" This defeats the purpose of creating a story of how it did indeed fail.

Once the "proximate causes"[6] have been identified, use a presumptive root cause assessment[7] to

[6] Proximate Causes – The events, errors, omissions that directly led to the failure.
[7] Root Cause Assessment – the process of tracing back an error or context that resulted in failure.

wind your way back through "contributory causes"[8]. Keep going until you find a cause that is both material and potentially mitigatable, transferable, or avoidable. Describe what needs to be done to avoid that eventual failure.

Figure 9 has been provided to assist in carrying out a pre-mortem. Remember to keep them thinking in past tense. It really does affect the results of the exercise.

Depending on how threatening the downside outcome is, decision makers may wish to pay a risk premium to have it covered. This is the principle that makes insurance companies profitable. Given a completely unpalatable outcome, especially one that may endanger company survival or destroy competitive advantage or positioning, the mandate that cost must be less than penalty does not hold.

[8] Contributory Causes – The precursor events, errors, or omissions which casa=caded through to create the Proximate Causes

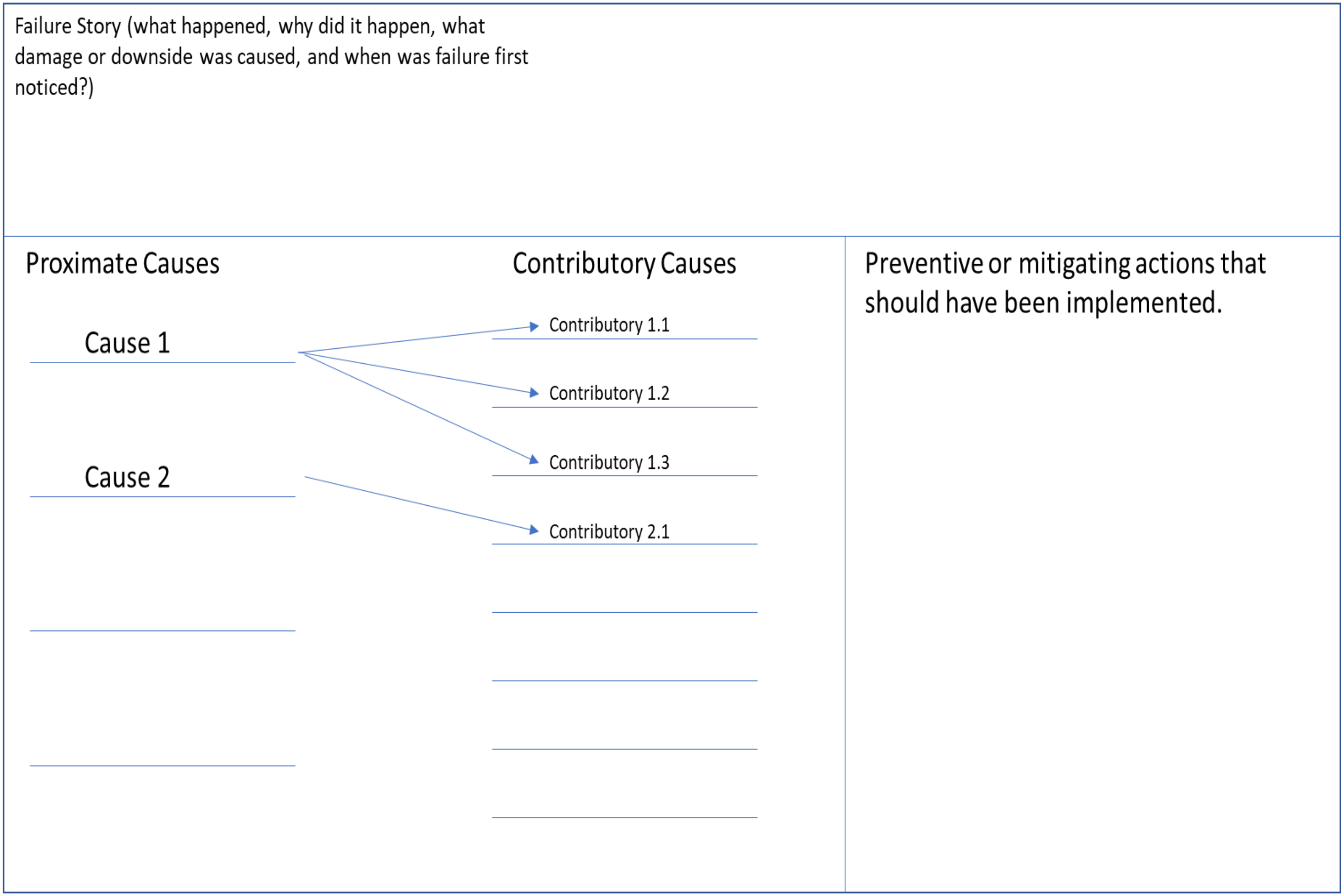

Figure 9: An example of a data capture page for a premortem

Value

Question 3: Can you afford to do anything about it?

There is an element that has been determined to be material to the project or company. It has been assessed that there is something that can be done to reduce the probability of its occurrence, mitigate its anticipated Pain, or aid the recovery from its occurrence. The next question to ask is "Is it worth doing anything?" or if it is an uncertainty, "Is it worth getting new information to make a more confident decision?"

It should be immediately evident that the cost of mitigation or if you are lucky, elimination of a downside potential must be less than the penalty suffered if the downside event were to occur.

To put in a slightly different context the value of the project with the mitigation must be more than the value of the project without the mitigation. This will be a common theme across all efforts.

The art of Decision Support relies on the appropriate application of the appropriate tool at the appropriate time. This can be said about many endeavors, but when we deal with large scale infrastructure decisions or new country, product, or business entry there are Decision tools and approaches that can help us.

You have determined that the element of concern is material and that you *may* be able to do something about it. However, doing something about it will cost the project something. It may be a time delay as the project sits waiting for an uncertainty to resolve. There may be a way to buy certainty or to buy your way out of a potential downside outcome. There may be a cost to transfer risk to somebody else such as an insurance company or Joint Venture partner. There may be a cost for information that informs you of your preferred decision. There may even be a reduction in project upside as that potential is negotiated away to prevent downside loss. It may cost the project human resource as you commit staff to assess and implement a solution. In some way, obtaining a more certain future or avoiding a negative potential will have a cost.

This cost must be less than the value gained by your action. More than that, given that not all actions will be successful and not all new information is perfect, the Expected Value gained must be greater than the expected cost of what you do in this step. To put it in the standard Value of Information format, the value of the project with the mitigating action or information must be greater than the value of the project without it.

$$Expected\ NPV\ Benefit > Cost$$

Frequently, we are unable to eliminate the element of concern. We may only be able to reduce its probability of occurring. We pay for mitigation, but the untoward event may still happen. We anticipate that its mitigation will lead it to occur in a combination of lower probability and lower impact. Vaccinations are an example of imperfect actions that partially mitigate an undesirable event. As with all invasive procedures there is a risk balance assessment that is done, and risk assessments must be carried out with as little bias as possible.

Sometimes we can do something or buy information that can give us an indication of the result. If the information is completely reliable; the indications are 100% indicative of the outcome, we are dealing with Perfect Information. This is an important construct, because if the cost-benefit analysis of perfect actions/information is not positive, we can stop. There is no point in doing the valuation of imperfect actions/information because less reliable indications are most assuredly worth less than the perfect actions/information. This is a fundamental principle of a tool called Value of Information (VoI).

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Unfortunately, most of our efforts only give us imperfect information. We have a change in the probability of the undesired event occurring. Our information may tell us a condition exists when it does not (false positive), tell us it does not exist when it does (false negative), or it can be truthful (true positive and true negative). The value of any information hangs on its reliability.

Much has been written about VoI over the past decades including Leach (2014), Coopersmith (2002), and Begg (2008). A good summary paper of VoI methods and applications is Bickel (2007). Leach *et al* (2010) provides an example of VoI in the context of unconventional resource exploitation.

VoI deals with the value of actions that may provide indications of an outcome. Seismic programs give us indications of what we are likely to discover but in no way does shooting seismic alter what is in the ground, which is why the value of seismic is a VoI assessment. The tool that covers the ability to affect the outcome is Value of Control (VoC). Control is the ability to reliably define an outcome. It is typically focused on an uncertainty but can also be applied to the elimination of a chance event. Once again, the value gained by controlling an outcome is equal to the value of the project with the chance or certainty event fixed minus the original project value. It should be obvious that if the ability to fix an uncertainty is present, then the uncertainty should be fixed at the outcome most advantageous to the project, but this may not be possible, and any value calculation needs to take this into account.

We return to the concept that the cost of control must be less than the value of control for it to be worthwhile. VoC attributed by fixing an uncertainty increases with the asymmetry of the penalty of being incorrect. We will discuss asymmetric risk in detail with Question 4.

Partial or imperfect control is termed “influence”. Examples of influence include advertising, lobbying, elimination of part of the range of uncertainty, and risk transference. The value of imperfect control will be less than the value of absolute control.

Value of Learning (VoL) is a relatively new tool in the decision support collection. Unlike many statistical methods it assumes that teams have some degree of intelligence and strive for continuous improvement. Teams will, eventually, create an efficient process. VoL is the value gained by speeding that process. It is focused on population learning as opposed to discrete event learning (VoI is discrete event learning). VoL is most appropriate for those situations where teams, by hit-or-miss, will eventually reach the most efficient solution and asks the question, what would the value be if we were to be efficient from the start as opposed to having to learn as we go? That context means VoL is most appropriate for activities that are repeated (e.g., hydraulic stimulation), or where they contribute as a population to a whole (e.g., efficient well spacing). It is production or project management efficiency gain related. How much is it worth to learn about the process or exploitation plan?

First do the assessment of project value without the learning. Then, recognizing that the time or number of attempts to peak efficiency is an uncertainty range, run the assessment again using instant learning. Assume all anticipated efficiency gains are seen immediately upon paying a fee. Subtract from that the value of the project with the slower efficiency gain. The non-VoL assessment must include the subtraction of all product, resource, and competitive advantage irrevocably lost due to early inefficiency if it had not already been included. If the cost of this Perfect Learning is greater than the derived value, do not spend the time and resource to do early learning, but do have a learning plan.

VoL may not occur at once from your expenditure or learning plan implementation. What is paid and the methods used may only accelerate learning. The value of slower learning will be less than the value of immediate learning.

If the opportunity arises to use OPM (other people's money) to affect your outcome, apply the funds to prove the materiality of the riskier (potentially more regrettable/painful) elements in your project. This advice applies to concern elimination, VoI, VoC, and VoL.

Confidence

Question 4: What if you are wrong?

Asking what happens when, or what it means if you are wrong is likely the single most important question you can ask when deciding or dealing with a project element.

You have determined that the element is material, that you can do something to improve it or mitigate its effects. You have determined that the improvement is worth the allocated people/time/money or have found a positive value to information and uncertainty control. But you have not been able to eliminate all uncertainty from the project vis-à-vis your element of concern. It may still endanger the project or possibly the company, or it may simply be a matter of efficiency. Either way, you must decide to implement the project in a certain way, and you could be wrong. How might you be wrong and what penalty do you open the company to? What can you do about it?

We are biased. It is very difficult to escape that bias. As a result, we often construct plans that are the result of biased assumptions and cumulative approximations. Teams often build to a solution without investigating options. This may be because of Group Think, constructive bias, or only paying attention to the data/information that fits pre-conceived solutions. There are many biases that we apply with and without intent (Welsh 2018 and Benson 2016). Even corporations have biases. This can lead to the creation of analyses that seem defensible and internally consistent, but that mislead when reality bites.

We covered pre-mortems in the Question 2 discussion, but that was with respect to individual issues. Here we need to broaden that perspective to consider the dangers for the project as a whole and the possibly the risk the company is acquiring given the assumptions made in the project.

We plan to create infrastructure or carry out projects in a way that maximizes our value or fulfills other objectives. Alas, sometimes we are wrong in our decision and looking back on it we would rather have done things a bit differently. The difference between what we were planning to achieve and the degraded result that we did achieve is the pain of being wrong. That pain is seldom symmetrical around what we intended to achieve. Being wrong in one direction is typically much more painful than being wrong in the other.

Risk, the financial or objective (non-fulfillment) pain of being wrong, whether it be the potential for an ill-fit infrastructure, poor timing, damage to your company reputation, or leaving value on the table during a negotiation, is asymmetrical.

Figure 10 shows a value curve for development timing after initial indications from an exploratory discovery. NPV is assessed across the time from immediate development, development during appraisal, development after appraisal and development well after efficient appraisal has finished (or delayed due to unnecessary "confidence building" appraisal wells drilled without connection to an infrastructure sizing decision).

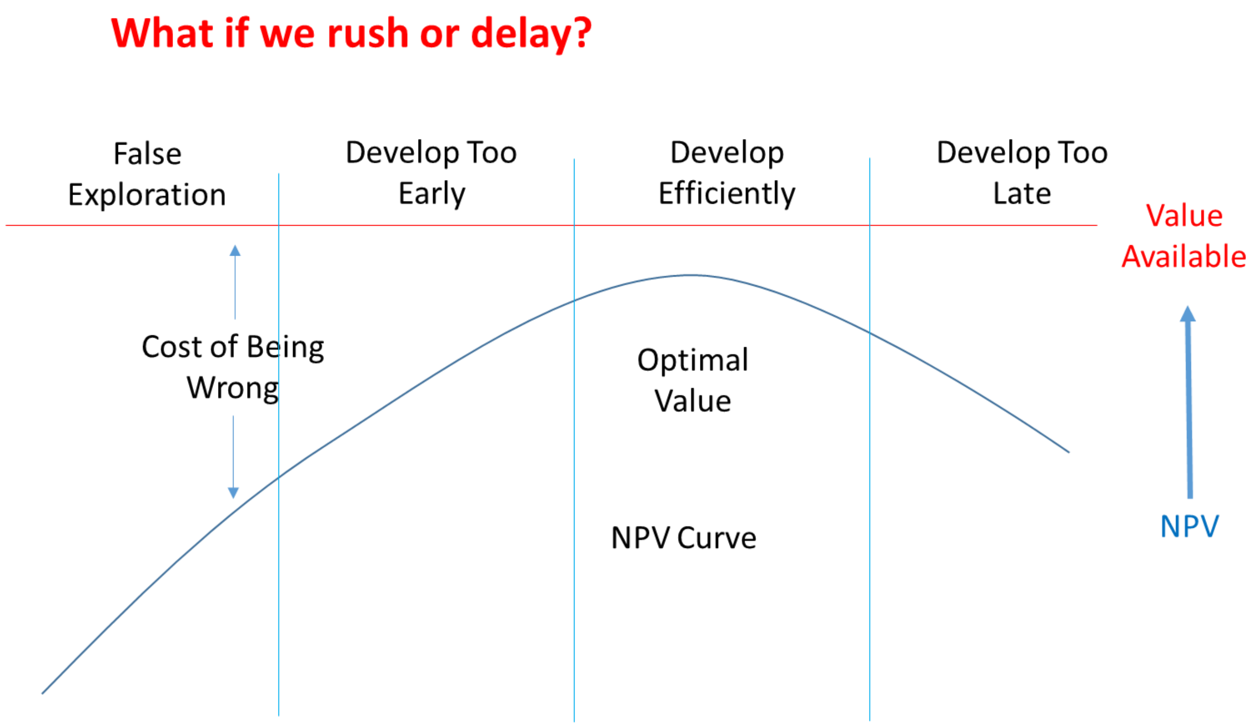

Figure 10: Risk asymmetry as seen in a development timing assessment.

The danger early on is that the exploration result has given a false impression of the size and extent of the resource. Conventional exploration wells are usually drilled at what Explorationists define as the best location for discovery. This is usually at the top of an accumulation and infrastructure planned based on that result may be over-sized resulting in immediate degradation of value.

By mid to late efficient appraisal, the size of the reservoir is reasonably well defined but uncertainty still exists in processing and egress. The likelihood of inefficiency is still considerable. The best value is created when the appropriate development and infrastructure plans have been informed by decision-centric methods.

Further delay results in a degradation of value based on the time value of money. This can be for many reasons but a common one is delay due to immaterial information gathering and uncertainty reduction. This is the drilling of additional wells or further scientific study that would not affect any decision. It is the quest for unreasonable precision and attempting to answer, "what is there?" as opposed to "is what is there at least as much as we need to be for us to make a decision?" *Precision does not matter if it does not affect a decision!*

We shall take this concept a bit further by applying it to a project execution decision and follow it up with an example. Figure 11 shows a similar dimensionless value curve but differs from Figure 10 in that it deals with a tangible aspect of a project. We have defined a predicted state (what we are going to build based on) within the range of an uncertainty (represented by the x-axis). Based on that predicted state we have constructed an intent. In other words, we have made decisions based on that uncertainty outcome expectation being correct. The value curve is created based on the value we achieve given the outcome of the uncertainty. Naturally, we expect that the outcome will be our predicted state and therefore we have designed our intent to maximize the value at that point, but we may be wrong. The penalty of being wrong is dependent on how poorly our decided intent fits with the actual uncertainty outcome. In this example, we suffer more if the actual outcome is to the right of our intent. We suffer if it is to the left, but not to the same degree.

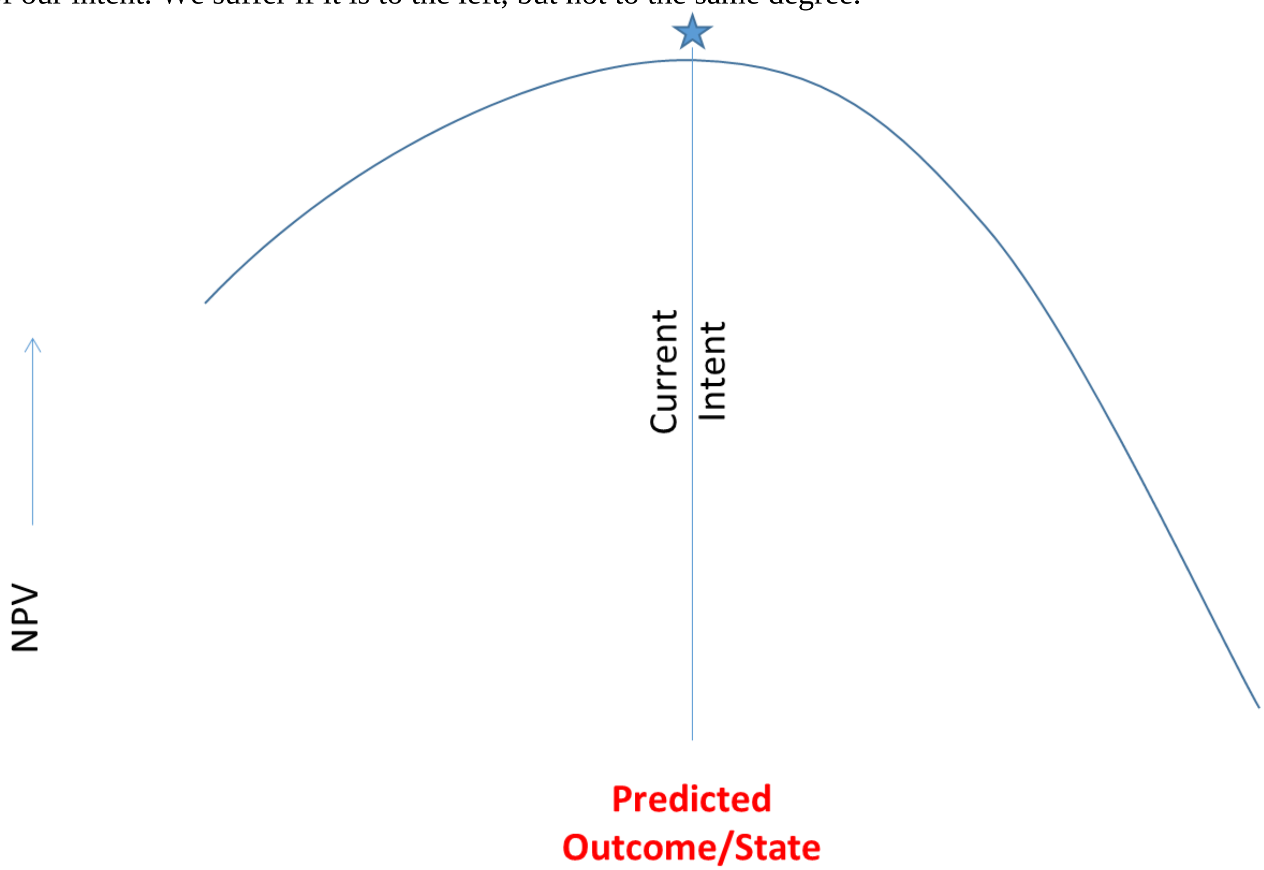

Figure 11: Dimensionless asymmetric value curve for the outcome of a decided plan with respect to an uncertainty. The range of the uncertainty is the x-axis. The current intent is what is planned for the project.

This is risk asymmetry and if we see it ahead of our decision, we may be able to modify our decision to take it into account. There may be an opportunity to better risk-balance our intent decision.

We shall take this further with a practical example (Figure 12), a company is developing an unconventional play. This is an actual well-spacing decision case that has been redacted for publishing. While there were several factors that governed the efficient well-spacing, we shall concentrate on just the drainage efficiency. The efficient well-spacing is unknown but in-house subject matter experts expect that the efficient drainage radius is has a range of 600’ to 1200’. They have described the 80% confidence interval as 650’ to 1050’. They expect an efficient spacing of 850’.

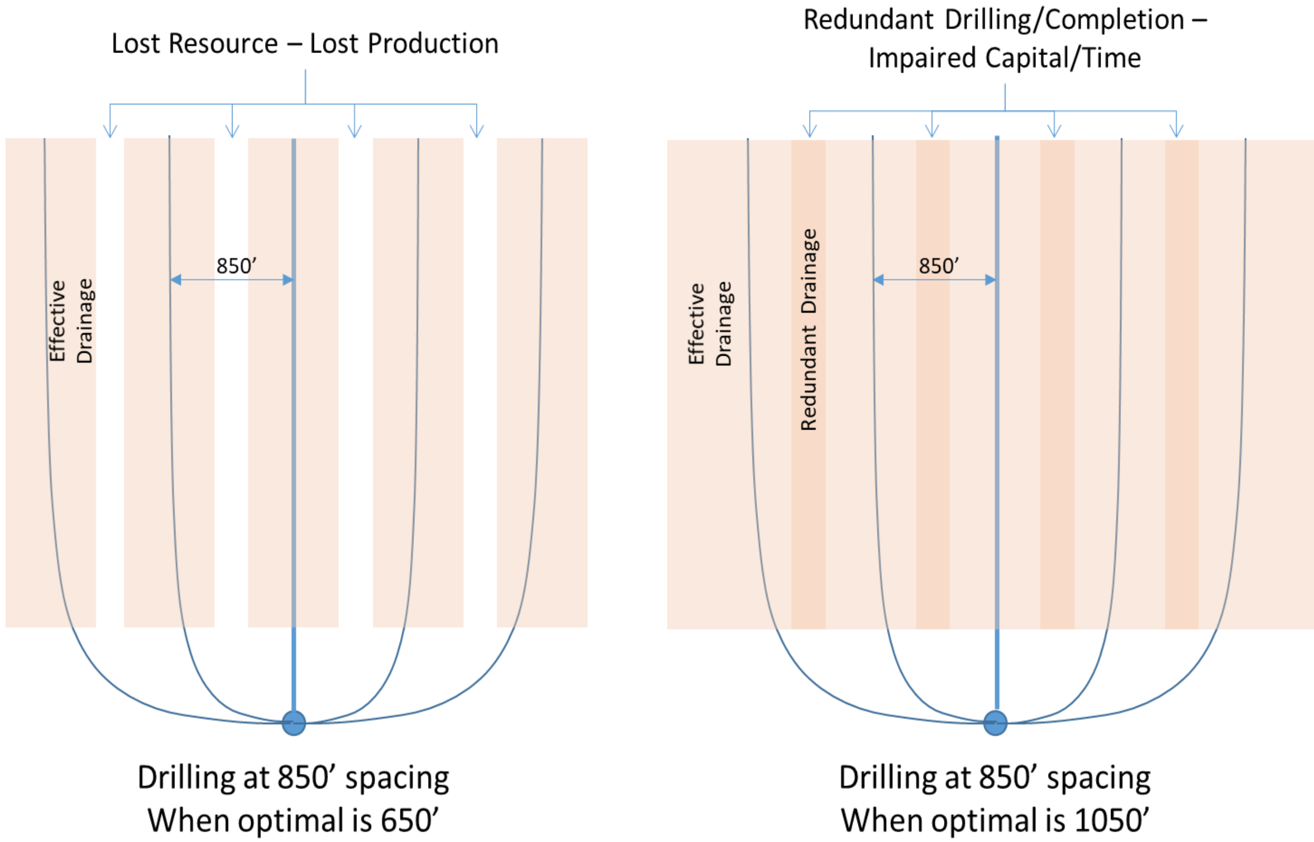

Figure 12: End-member (80% confidence) outcomes for drainage given a drilled well-spacing of 850' but actual efficient drainage of 650' and 1050'.

In the 650' drainage case drilled at 850' spacing, there is untouched resource left behind. In the 1050' drainage radius case drilled at 850' spacing, there is considerable overlap of drainage area and capital has been wasted. Over capitalization is typically more value destructive than lost resource. Over-capitalization affects the project now. Lost resource is typically many years away.

Figure 13 shows the well-spacing example as a value curve. Value is calculated on the intent to drill for efficient drainage radius of 850'. The x-axis represents the actual efficient drainage of the reservoir when combined with the hydraulic stimulation method applied.

The risk asymmetry shows over-capitalization being far more detrimental to value than the loss of resource. This bilateral inefficiency considers the learning anticipated within the play as described by VoL in the Question 3 section. The production engineers will, some day, with much angst, recognize the efficient drainage spacing is different than what they predicted. Ideally, they will have recognized from the beginning that they could be wrong and had instituted a prioritized learning plan that would confirm or correct their assessment as early as possible. The eroded value only extends to the point in time where the drilling plan would be altered.

Altering the intent will cost money, time, and resource. The value gained by changing the plan must be greater than the cost to change it. There will be a range around the current intent in which the rescued value is less than the cost to change the plan. This is named the "Zone of Immateriality". Its vertical height is equivalent to the after-tax cost of changing the plan.

During the planning for the initial drilling, an offsetting rights owner approached the company with a request to create a joint venture. They were willing to commit money to drill wells within their existing land. The negotiations settled on them drilling a series of wells to test the larger downside risk.

The intersection of the value curve and the Zone of Immateriality denotes an indifference point. An indifference point is a location along an uncertainty range at which a decision-maker is indifferent to either choice (in this case the choices are staying with the existing though somewhat inefficient plan or paying the cost and changing the decision away from the initial intent). It is the point at which the value of the project unimproved equals the value of the project with improvement. Understanding how far away the expected result is from the indifference point is an important decision support tool. It is called an "Indifference Assessment".

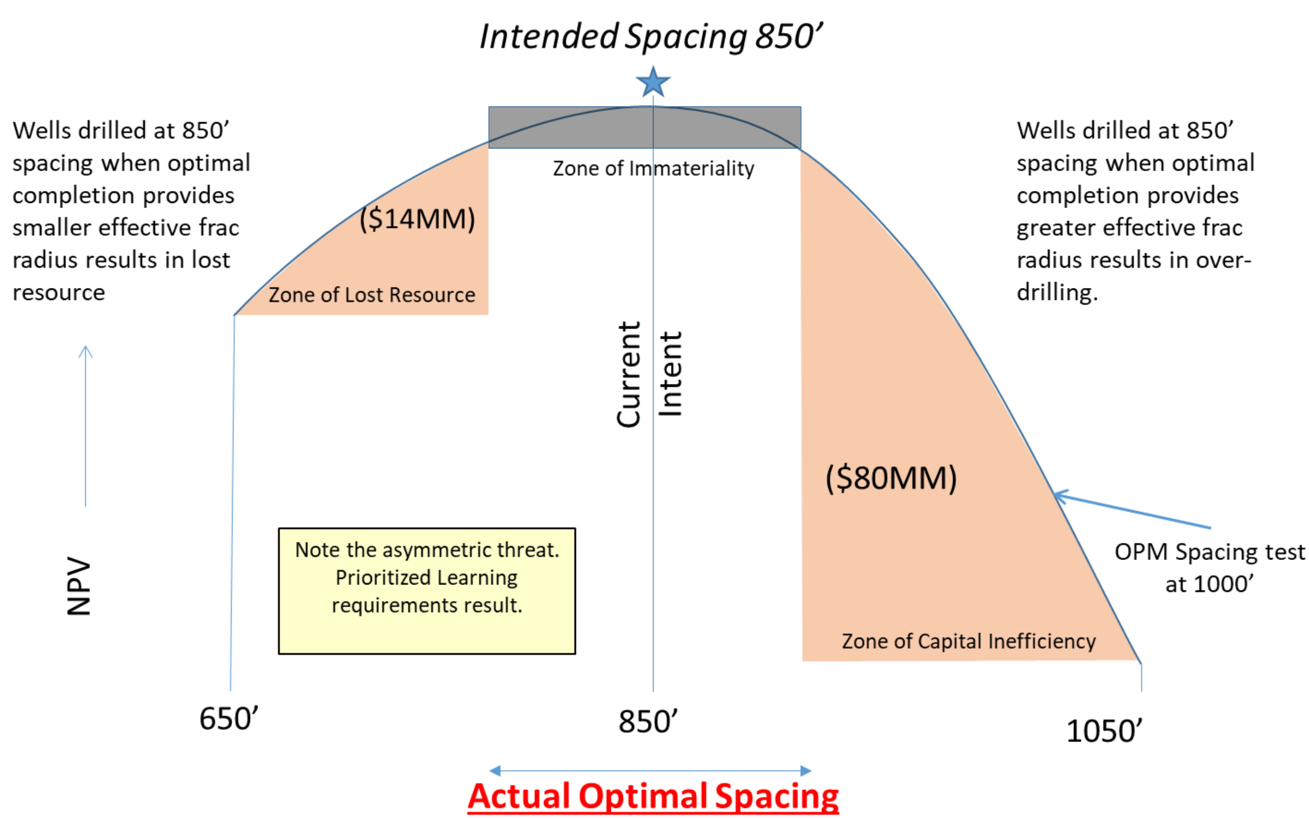

Figure 13: Well-spacing value curve example showing risk asymmetry and zone of immateriality. Note the OPM (other People's Money) test of the greater downside potential.

So, what can we do? Figure 14 shows a point into the program where it has been determined that the efficient drainage radius was found to be approximately 700'.

Dropping the well-spacing to 700' is outside the Zone of Immateriality so it has value. The value comes from the recovery of lost resource. If the spacing was dropped further, as in an in-fill program, it becomes a balance between production acceleration and over-capitalization. A new value curve should be constructed using the new intent to describe the risk asymmetry more reliably.

While the asymmetric risk assessment what-if-you-are-wrong approach was shown here in a progressive learning situation, it is appropriate for discrete learning and negotiation-based decision support equally as well.

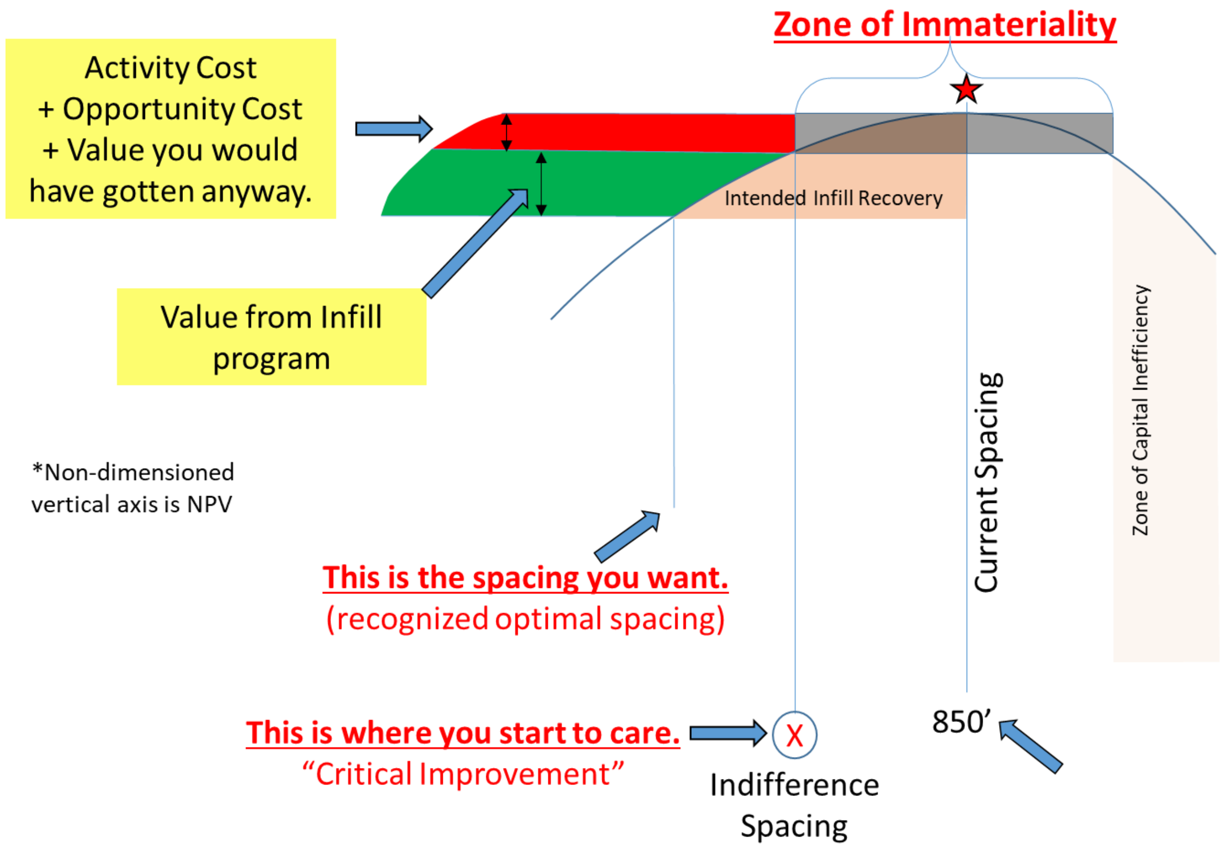

Figure 14: Making material decisions based on outcome correction.

Summary

Taking a consistent decision-centric approach to issues, uncertainties, threats, and opportunities in projects and project management can provide substantial value addition and time savings. There are innumerable tools in decision science that can be applied to projects and project management processes. We have covered only a handful of important ones here in the four-question context. Following the four-question approach will avoid the pitfalls of working "in the weeds", striving for over precision, recognizing the potential value of information, control, and learning. It will allow you to prioritize project activities and keep Critical Path surprises to a minimum.

One must always determine if the concern is material to the project. Does it make a difference to the outcome or to an important decision, and if it is material, is it material now? If it does then move on to the next question to determine if anything can be done about it. Only if there is a potential to affect change in the element of concern is the next step, determining the affordability of affecting it, appropriate. Then for all situations, assess what happens if you are wrong. Is that threat material? Is there a way to tell you are wrong early? What are the signs of impending failure? Reiterate the process seen in Figure 15 until concerns have been handled to the required level of confidence.

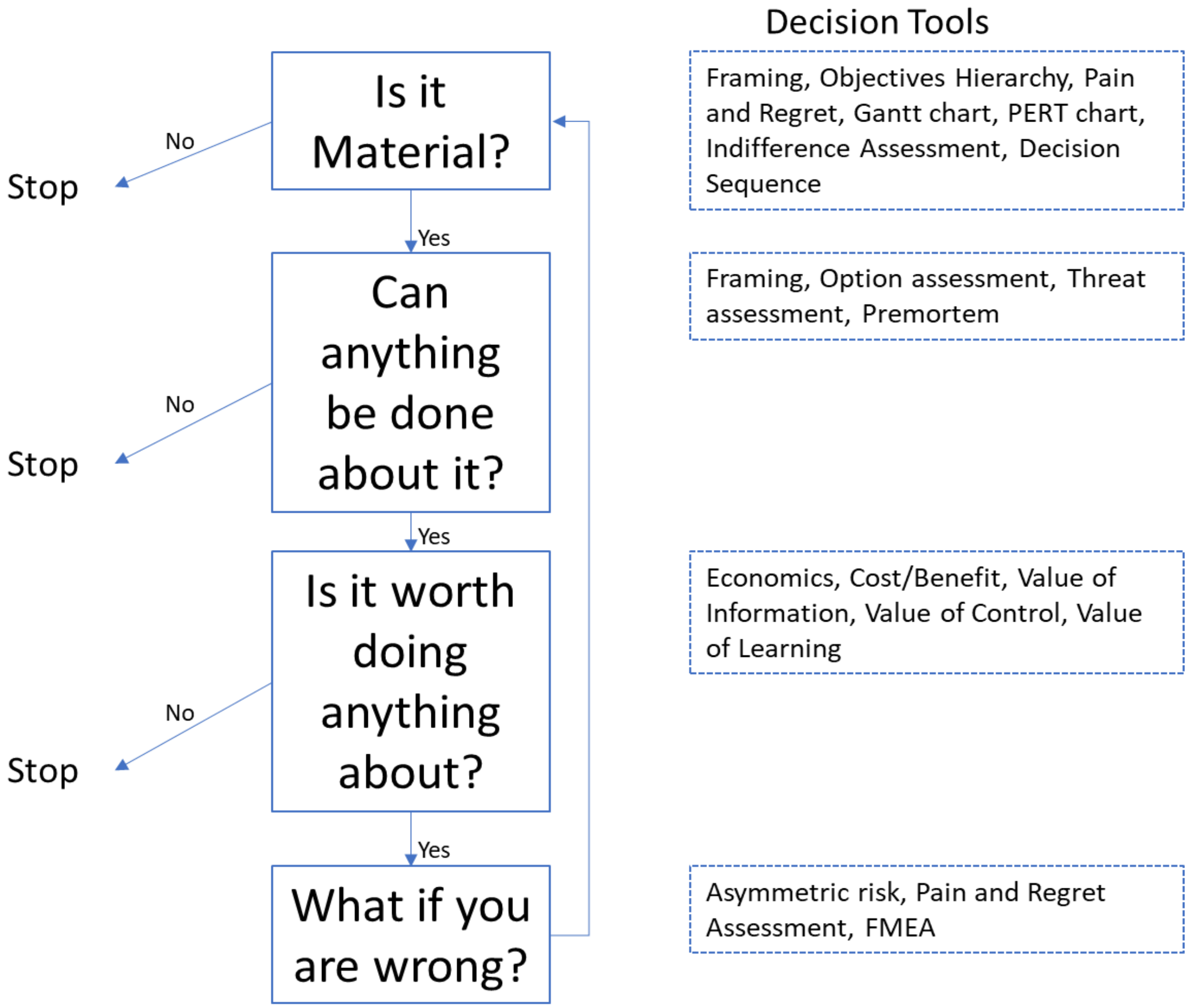

Figure 15: Four Question flowchart with linked Decision Support tools.

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Annotated References

- Begg and Cunningham 2008, "Using the value of information to determine optimal well order in a sequential drilling program", AAPG Bull. of Pet. Geol. V. 92, No. 10

  Steve Begg won the SPE International Award for Management and Information partly based on this paper.

- Benson, B, "Cognitive Bias Cheat Sheet," Better Humans, Medium, September 1, 2016

  Benson takes the view that we use bias in order to help us make decisions faster. He looks at why we use bias as opposed to the typical approach of saying why bias is bad. If we understand why bias originates, we can understand when they are helpful and when they are not. He categorizes around 160 biases into four source conditions:

  Too much information,
  Not enough meaning,
  The need to act quickly and,
  What should we remember?

  This, combined with the practical work of Matthew Welsh, provides a good foundation for exploring bias.

- Bratvold, R. B., Bickel, J. E., and Lohne H. P., 2007, "Value of Information in the Oil and Gas Industry: Past, Present, and Future", SPE 110378, SPE Reservoir Evaluation & Engineering, August 2009.

  If there was only one paper to read on Value of Information, this would be it. The authors describe VoI and run through the history of the method, applications, and issues, and provide an excellent summary of papers that purport to use Value of Information. They cite real-world applications, the assessment of reliability, and include an entire section on VoI misconceptions.
  Important observations (pearls of wisdom) include:
  "Information that does not hold the possibility of changing a decision is worthless."
  "…Increasing uncertainty regarding geologic success [many would say "chance" as opposed to "uncertainty"] does not necessarily lead to greater information value." It should not as information and learning may be associated with either chance or uncertainty (population vs discrete learning).
  "The lowest possible reliability is 0.5 [50%]".
  This paper is an excellent review and reference for analysis and decision makers alike.

- Coopersmith and Cunningham 2002, "A practical Approach to Evaluating the Value of Information and Real Option Decisions in the Upstream Petroleum Industry", SPE 77582

  Read this paper after Bratvold et al 2009.

- Haskett, W.J., 2008, "Pain and Regret", SPE 116773, SPE ATCE, Denver

A paper authored after several projects where the management decision-style prioritized the identification and mitigation of downside threat.

- Haskett, W.J., 2005, "Exploitation and Management of Risk and Uncertainty", Drilling, Hart Energy Publishing, March 2005, p.5-7.

  Featured article in the monthly magazine of the American Association of Drilling Engineers describing a stochastic decision approach to drilling to identify and mitigate potential downside hazards. While useful as a reference for the FMEA elements mentioned here, most of the content may be found elsewhere in greater depth.

- Klien, G., 2007, "Performing a Project Premortem", Harvard Business Review, September 2007
  A short, succinct explanation and guide for carrying out a project premortem.

- Leach, P.E., 2014, "Why Can't You Just Give Me the Number?", 2nd edition, Probabilistic Publishing, pp. 148-164.

  This is subtitled "An Executive's Guide to Using Probabilistic Thinking to Manage Risk and Make Better Decisions". It is a good book, written at a reasonably high enough level to keep the reader out of the weeds but still provide enough practical information to allow a sound understanding of process and principles.

- Leach, P. E., Brown, P. J., and Haskett, W. J., 2007, "Value of Information Applications in Unconventional Resource Plays", SPE 108175.

  This short paper provides a straightforward tree-based application of VoI with associations to Cost of Failure and Reliability. While the examples cited are unconventional, the process and calculations are consistent with any VoI application. This paper has been included here to provide a clean, rapid VoI example. Clean examples are not found in most papers.

- Welsh, M., 2018 "Bias in Science and Communication: A Field Guide", IOP Publishing, ISBN 9780750313124

  Welsh in a noted expert in decision bias. This, his first book, discusses bias as a natural cognitive process with implications for both science and project management.