Centre for Technology Management working paper series
ISSN 2058-8887

No. 2

March 2018

Scoring methods for evaluating and selecting early stage technology and innovation projects

doi:10.17863/CAM.21297

Rick Mitchell (CTM, University of Cambridge) *
Rob Phaal (CTM, University of Cambridge)
Nicky Athanassopoulou(CTM, University of Cambridge)

* Please contact the corresponding author for feedback:
rfm26@cam.ac.uk

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Centre for Technology Management
Department of Engineering

Scoring methods for evaluating and selecting early stage technology and innovation projects

Rick Mitchell, Rob Phaal and Nicky Athanassopoulou

rfm26@cam.ac.uk, rp108@cam.ac.uk, naa14@cam.ac.uk
Institute for Manufacturing, Charles Babbage Road, Cambridge, CB3 0FS, United Kingdom

26 February 2018

Summary

In the early stages of technology or innovation projects it is often necessary to make decisions about which projects to pursue and which to shelve when only scant information is available. This practice-oriented working paper provides guidance on how to make the best use of the information that exists by assessing projects against a number of appropriate factors and allotting scores to each. We show how to design an appropriate scoring tool for any particular case, including: the importance of treating measures of Opportunity and Feasibility separately; how to choose the factors; how to ensure that the scoring is as logical and objective as possible; how to include the inevitable uncertainty; and how to manage the process, including the treatment of portfolio-level considerations such as 'balance'. It is important to manage the scoring process carefully to avoid cognitive biases. The results can be plotted in different ways to help the decision process.

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1. Introduction to multi-factor scoring

Based on several years of applied research and practice, this paper is about ways of evaluating and selecting innovation projects, with particular reference to technology-intensive research and development (Goffin & Mitchell, 2017). One would always prefer to do this by building a full business plan for each one, and then selecting those that would make the best contribution to the bottom line. But often, and especially for projects in their early stages, there may simply not be enough valid information to do this, and time and resources are limited. And yet decisions often have to be made, anyway.

In the face of this a common approach is just to rely on intuition, which after all is the way the human mind deals with everyday decisions involving incomplete information. Intuition can be wonderfully effective if it has been developed through confronting many examples of the problem in hand – as is the case for people like doctors and art historians. But in unfamiliar circumstances – and innovation projects must surely be so – our intuition can be surprisingly easily misled, as researchers such as Kahnemann (2011) have shown. So, it must be supplemented with as much logical structure as possible.

This has led companies to look for more robust approaches in which financial data may be augmented or replaced by information on the other factors known to be pointers to success (Cooper *et al.,* 2001). For example, when making a choice between two new product opportunities, knowing the size and growth of the market, the strength of competition, and how well the product is differentiated from others may together give a perfectly clear indication which is to be preferred. Using several factors rather than one allows all the major influences to be included. There is also an advantage in that the factors will be – at least to some extent – uncorrelated so errors will tend to cancel out.

Such multi-factor scoring tools are frequently advocated in the literature but users often have a vague feeling of unease about them. This is partly because it is painful to face the uncertainties involved, but it is made worse by the fact that it is not obvious how to go about designing the tool in a coherent way. We aim to show how this can be done in this paper.

Clearly there cannot be one set of factors suitable for all circumstances. For example, those for selecting early-stage technology projects are bound to be different from those for selecting minor modifications to an existing product. And there will be differences between companies and sectors. We consider how to choose these factors in a later section.

The factors, once chosen, can simply be used as a checklist to ensure that no important considerations are overlooked. There is great value in this, particularly if the list of projects is long and one needs to make a rough selection (triage) before making a more detailed analysis. However, a more complete and precise approach is possible, which can be tested and piloted quickly, with limited risk and cost, and then adapted and scaled up as value of the approach is demonstrated (Kerr *et al.,* 2013).

2. Application to technology and innovation projects

The movement of an innovative idea from conception to reality is often illustrated in the form of a funnel, an idea usually attributed to Wheelwright and Clark (1992). Figure 1 shows such an ‘innovation funnel’ in which projects progress from an early research phase through (potentially) several stages of investigation until a firm decision can be made to move to full implementation. Decisions will be made at various points (review or decision 'gates') whether to continue in the light of what has been learned so far; and the funnel shape indicates that many projects may be rejected along the way, as uncertainty is reduced and confidence increases.

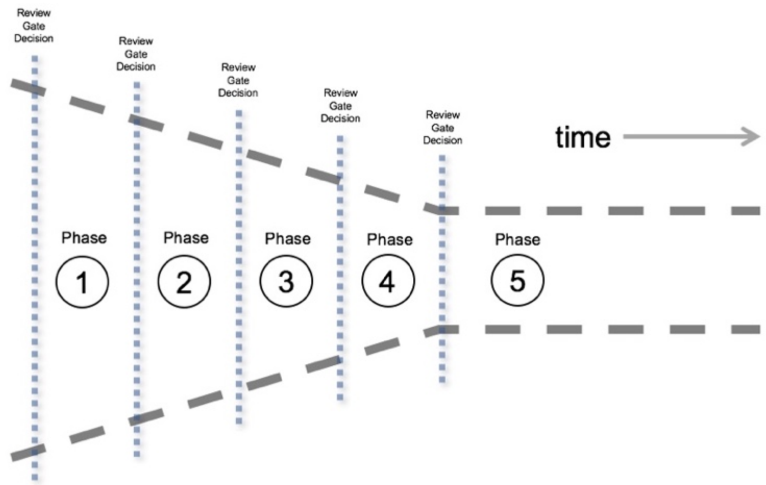

Fig. 1 – The innovation funnel, adapted from Wheelwright & Clark (1992), with illustrative 'stages' and 'gates' to differentiate between product and technology development (Cooper, 2006), moderated by technology readiness levels (TRLs)

In the early *pre-commercial* phases (shown as 1 and 2 in Fig. 1) projects must be judged not in direct commercial terms but by their ability to deliver against one or more strategic aims which cannot yet be readily quantified financially. Examples might be fuel efficiency, weight reduction or opening a new product application. Here multi-factor scoring is an appropriate, perhaps the only, selection tool. The criteria for success will depend very much on what those aims are and so will tend to be very different from company to company

Later on (the *application-focussed* stages, 3 and 4) an eventual application will be in view and projects can be judged in relation to their likely commercial success. Scoring is also useful here because there is still considerable uncertainty, so a financial analysis alone cannot be relied on. By the time a project reaches stage 5 (*Implementation*) there should be enough information to prepare a business plan or similar financial justification so scoring is not appropriate. Scoring tools will generally need to be modified as projects go through the various decision stages.

3. Designing a scoring tool

Table 1 shows an example of a scoring tool based on one used by DuPont in the past for prioritising new product introduction (NPI) projects. Here scores are allocated against each of seven factors, using the scaling statements in the boxes as guidance, and the results are added to give an overall score for the project. DuPont's approach was to start with the conventional financial measures such as NPV and augment them with broader considerations.

The principle is that, other things being equal, the highest-scoring projects will be the ones chosen for implementation.

Table 1 – Project scoring tool based on that used by DuPont (Cooper et al., *2001)*

Rating scale	*10*	*3*	*1*	***Score***
Factor				
Strategic alignment	Close fit to Strategy	Supports Strategy	Not fully in line with strategy	
Value differentiation	Significant differentiation	Moderate	Slight	
Competitive advantage	Strong	Moderate	Low	
Market attractiveness	Highly profitable	Moderately profitable	Low profitability	
Fit to supply existing chain	Fits current channels	Some change, not significant	Significant change required	
Technical uncertainty	High	Medium	Low	
NPV	>$50m	$10-50m	<$10m	
			Average:	

This example prompts a number of questions that must be faced when designing a scoring tool:

1. *Structure:* is a single list appropriate, and should the factor scores be added rather than multiplied?

2. *Factors:* how many factors are needed and how should they be chosen?

3. *Scaling statements:* how many are appropriate, and how should they be designed?

4. *Weightings:* should the factors all count the same or is there a case for giving a higher emphasis to some – for example by applying a weighting to some factors compared to others. If so, how should the weightings be chosen? The DuPont tool also uses a non-linear scale. What is the justification for this and how non-linear should it be?

5. *Risk and uncertainty:* is it possible – or worthwhile – to accommodate risk and uncertainty in the process?

6. *Portfolio considerations:* how should dependencies, synergies and trade-offs between projects be dealt with, to 'optimise' the set of projects been pursued, and how can the portfolio be dynamically re-balanced over time?

We consider each of these issues in the following sections.

3.1 Structure of the tool

Adding the scores from different factors implies that a high level of one can compensate for a low level of another. Clearly this may not always be so. For example, a fundamentally uninteresting opportunity is not improved by being easy to do; and the size of the opportunity is irrelevant if it requires competences that the organisation does not have. So, factors that describe the size of the opportunity presented by the project need separate consideration from those that describe the competence of the organisation to address it.

Examination of a set of approximately 40 portfolio project selection 2x2 matrices revealed that about 60% of them were of the general form of Opportunity x Feasibility (Phaal & Mitchell, 2009; and Mitchell *et al.,* 2014). Other descriptions can of course be used, such as Impact or Value instead of Opportunity. Thus, there are two roughly (we emphasise this) separate considerations and a separate set of factors is required for each:

- *Opportunity:* The magnitude of opportunity plausibly available to this organisation.
- *Feasibility:* How well-prepared the organisation is to grasp the opportunity.

In fact, the distinction between Opportunity and Feasibility is implicit in many appraisal tools such as McKinsey's market-attractiveness x business-strength matrix, A.D. Little's risk x reward matrix, and the familiar SWOT analysis (opportunities-threats and strengths-weaknesses). In all of these the two dimensions are estimated and displayed separately.

Opportunity is a rough measure of the value that may result from the project, while the Feasibility indicates the investment that may be required to bring it to fruition. They can be combined into a single figure of merit as we show in section 5.3.

3.2 Choosing the factors

Clearly the factors in the tool should cover all the important considerations and should be independent, not measuring the same thing in different ways. They should also be as precise and objective as possible and it is advisable to take some care to define them clearly. The scaling statements help with this as we show below. Ideally one should aim for a relatively large number of factors in total so that the uncertainties tend to cancel out. However, experience shows that the more there are, the less attention will actually be given to each one during the scoring process. Five to seven for each list seems about right.

In the *Application-Focussed* stages (see Fig. 1) there is one overriding aim, namely the eventual commercial success and so the approach and criteria may well be similar for many different companies and applications. Tables 2 and 3 list frequently-used factors, taken from the literature and our own consulting experience. These serve as a good starting point for managers designing their own tool but we emphasise the need to select a restricted number and be ready to add to and modify those proposed. Whatever their origin the factors chosen should, of course, be as far as possible independent measures, not ones that overlap or express the same thing in different ways.

If different scoring tools are to be used at several stages down the funnel (Fig. 1) it is important, to give some thought to how the factors should change as the project proceeds and more information becomes available. In particular the factors should be regarded as approximate estimators of the measures to be used in the business plan that will be required at the implementation stage. So, for example, if the key financial measures are Sales Volume, and Gross margin, plus a consideration of Future Growth opportunities and Intangibles, then it should be possible to link any of the scoring factors though to one of these. We use the term Dimensions for these in the examples below.

We defer consideration of pre-commercial projects (Fig. 1) until Section 4, after discussing scaling statements.

Table 2 – Suggested Opportunity factors for application-focussed project

Dimension	Factor	Explanation
Volume	Market size	Size of potential market, or number of potential adoptions, reasonably available to us
	Our sales potential in a given time	Sales volume or number of adoptions anticipated in a defined time (say, 5 years)
	Synergy opportunities	Possible additional benefits to other projects or activities; or the possibility of new opportunities in combination
	Customer benefit	Identifiable benefit to customers (internal or external) or potential adopters
	Competitive intensity in market	Number or significance of the competition
Margin	Increased margin, or benefit per unit	Improvement in product margin (e.g. by cost reduction or price premium) compared to existing products; or benefit to us per adoptions
	Business cost reduction or simplification	Contributes towards cost reduction or simplification of business process
	Industry / market readiness	How easy will it be for customers or adopters to take up the product; do they have to change their behaviour or processes?
Platform for future growth	Market growth	Anticipated growth rate of market
	Future potential	Product is a platform for future products or could open new markets beyond the project timeframe
Intangibles	Learning potential	Will improve the knowledge or competence of the business
	Brand image	Will improve the image of the company with investors, customers or other stakeholders
	Customer relations	Project is important for retaining key customers

Table 3 – Suggested Feasibility factors for application-focussed project

Characteristics of the product	Product differentiation	How well the product is differentiated from those of major competitors
	Sustainability of competitive advantage	Our ability to sustain our competitive position (e.g. IPR, brand strength)
	Technical challenge	How confident are we that the proposed product is technically feasible at all?
Skills and knowledge	Market knowledge	Our understanding of size and requirements of the market
	Technical capability	Do we have the required technical competences to complete the project?
Business processes	Fit to sales and/or distribution	Fit to our sales competences and/or distribution chain
	Fit to manufacturing and/or supply chain	Ability to manufacture or supply the product
	Finance	Availability of finance for the project
Organisational backing	Strategic fit	How well does the project fit our company strategy?
	Organisational backing	Level of staff or management backing at an appropriate level

3.3. Scaling Statements

The factors in the tool should be scored against a scale, say 0-8 or 0-10. Scaling statements are used, as in the Tables in the Appendix, to give some clarity to what a particular score might mean in practice. They not only ensure consistency when several people collaborate in the scoring, but also help to define what the factors actually mean.

Scaling statements are in fact the key to an effective scoring tool. Defining them adequately is likely to take a good deal of effort, but it is very well worth it. In fact, we would go so far as to say that without coherent scaling statements the value of any scoring tool is questionable.

Scaling statements should ideally be quantitative, but in any case, should be made as concrete as possible. This means avoiding vague terms such as 'large', 'significant' and 'important' and instead using statements that could, at least in principle, be observed, checked or demonstrated. If it is very difficult to express the scaling statements for a factor in concrete terms you may need to reconsider whether that factor is appropriate at all. Can it really be useful if you can't define it in a way that is, at least in principle, observable?

Do not make the outer scaling statements too extreme because this will mean that the scores for most projects will group in the middle of the scale and so will not be well differentiated. Choose statements that might quite probably be met in practice, not ones that represent the outer extremes of what is possible. A particularly good (or poor) project can always be scored outside the range for some factors. Why not?

Three scaling statements is a minimum; five can give more precision. More than that probably implies more precision than this tool can provide. We do, however, find that people often want to choose a value midway between the scaling statements. A scale of 0 to 8 allows them to do this while keeping to integer values.

It is crucial that the scaling statements for the various factors should be aligned with each other so that as far as possible a score of, say, 5 on one factor is an equally good pointer to the likely success of the project as a score of 5 on another. This may not be an easy task but it is vital. Indeed, it is worth emphasising that <u>any</u> attempt at comparing projects (formal or informal) involves considering them from various points of view and making some judgement as to how one consideration compares with another. Usually this is done intuitively; here we are attempting to make it as objective as possible. The process is not perfect but the fact that it is difficult just re-emphasises how inadequate purely intuitive approaches often are.

Scale alignment is easiest if the statements can be expressed numerically. For example, for an improvement to a product line, the cash generated by an increase in sales may be directly compared with that from a cost reduction. Things are not so straightforward with non-numerical statements, however. We find that the best approach is as follows:

1. Start by choosing one factor, the *base* factor, which clearly has significant impact and for which fairly clear and objective scaling statements can be designed.

2. Choose the midpoint, or *pivot* statement for this factor. This should indicate an unexceptional or 'middle of the road' case such that if this were the only measure available to judge a project it would be difficult to decide whether to accept or reject it.

3. Choose scaling statements for the other levels of the base factor, remembering not to make the outer ones too extreme.

4. Choose the pivot statements for the other factors in the same way as in Step 1.

5. Select each factor in turn and, for each level, choose a scaling statement that is equivalent to that of the base factor. One way to think about this is to imagine two projects, one in

which the only information available is the scaling statement for the base factor and one where only that for the second factor is available. Then for each scaling statement of the Base factor, choose one for the second factor that is equivalent: that is to say, such that it would make the projects of equivalent value.

This should be possible for most of the statements but at the higher levels it may turn out that for some factors one cannot find a level which has as great an impact as the Base factor. For these the upper scaling statement(s) should just be left blank. Of course, if too much of the scale is blank this is an indication that the factor is of relatively small importance and it might be better to choose something else. A special case is where a factor is important but does not have a range of possible values, just 'Present' or 'Absent'. Patent cover might be an example. In this case there would only be one scaling statement.

The Appendix contains examples of scaling statements for Opportunity and Feasibility factors for new product introduction (NPI) projects. These may be helpful for reference although we emphasise that in practice scaling statements must always be customised for the particular circumstances.

3.4 Weightings

Many authors propose that the factors in a scoring tool should be allocated different weightings to reflect their relative importance. However, if a factor is assessed on a continuous scale, it would make sense only in relation to some assumed scale for each factor, so why not align the scales as described above? Separate weightings are then unnecessary. The exception is perhaps when financial factors are included, such as 'time to break even' and NPV in the DuPont tool (Table 1). These are summary measures and it is arguable that they should be accorded steadily greater (and eventually, unique) weighting as projects mature.

It is also sometimes proposed that a non-linear weighting should be applied to all scores, giving extra emphasis to high levels (as in the DuPont example). It is not clear how such weightings should be chosen and why the same non-linearity should apply to all factors. Again, aligning the scaling statements is more logical and makes this complication unnecessary.

3.5 Risk and Uncertainty

People often use the term 'risky' to describe projects whose outcome is not known precisely. And this is often taken as a criticism. In fact, uncertainty cuts both ways because it includes the possibility of upside as well as downside outcomes. Innovative projects are by definition uncertain so the important thing is to try and understand, as far as possible, what the range of possible outcomes is before taking a decision. The upside opportunity may outweigh the downside and anyway the information points to where actions can be taken to improve the prospects.

The best approach is simply to ask participants in the scoring process to select upper and lower extreme scores for each factor: the *plausibly* best and worst-case values, or confidence limits, rather than a single point value. Where several people collaborate to score projects, they should then compare their values and use them agree on their overall confidence limits for Opportunity and Feasibility. This retains very important information that would otherwise be lost, and forcing groups to agree on single (fallacious) values has been observed to generate unnecessary conflict. And we have found that people often find it easier to agree on confidence limits than on a single value.

The range of uncertainty is very likely to change as a project progresses – indeed reducing uncertainty is the core activity for most research and pre-development projects. Therefore, the outcome of the decision-making process should be not only the selection decisions with statements of the key assumptions, but also a list of issues to be addressed by the next decision point.

3.6 Threshold criteria

As we mentioned in the introduction one of the useful characteristics of a multi-factor tool is that estimating errors in the factors are likely to be uncorrelated so that the sum of several is a more accurate estimate than one alone. However, this cuts both ways because it leads to a tendency for the sum or average of the factor scores to group around the central value. For example, projects will seldom score zero on Feasibility, even if one or more of the factors is highly pessimistic. So, it may be that projects should be rejected regardless of other considerations if they do not meet certain threshold levels on certain factors: for example, if the market growth is too low or the technical challenge too high. Such 'show stopper' thresholds should be noted in the tool. Equally, certain categories of projects may be given overriding importance and so might bypass the decision process altogether. Projects to deal with legal, health & safety or acute competitive issues might be examples.

4. Factors and scaling for pre-commercial projects

Pre-commercial projects aim to develop new capabilities that will be of value to the organisation in addressing longer-term challenges or opportunities. At this stage, any estimates of commercial outcomes will be sketchy, at best, but we do assume that projects will be intended to deliver some clear benefit to the company. This is the domain of advanced development or targeted research, rather than academic research aimed purely at generating new knowledge.

Three main differences are noted between these and application-focussed projects:

1. It seems unlikely that a useful set of generic factors and scaling statements can be offered for Opportunity. Instead, specific measures will be needed for the contribution to particular aims of the organisation's technology policy.

2. Ultimate feasibility may be very difficult to assess at this stage – indeed feasibility is likely to be the main focus of the work of any proposed project. However, it cannot be discounted entirely. Research plans will address feasibility issues.

3. Technology projects may include *enabling technologies* that are relevant to more than one policy aim.

The first step in project selection must be to identify and articulate what key strategic opportunities and challenges they might address. We call these strategic Aims and they will be the main content of the technology strategy, if the company has one.

Once this is done, the simplest approach to project selection is to use the 'strategic buckets' concept (Cooper & Kleinschmidt, 2001) and to assign separate budgets to each Aim. Scoring and selection is then done independently for each aim.

This approach is straightforward except for the case of projects that may contribute to more than one aim. Any such enabling technology or capability may not score highly enough for inclusion against any one of the aims but might still be valuable in terms of its score against several. If such occasions are rare it may be possible to make an ad hoc adjustment to the budgets to include it. However, if they occur frequently one may have to consider all projects together, selecting those with the potential to make the greatest overall contribution to the company. To do this one must align the tools for the separate aims. The easiest way is to reinstate the idea of weighting by comparing the anchoring statements for the base factors. So, if for example, it is judged that the statement for a score of 3 on one Aim is of equivalent worth to the company as the statement for a score of 9 on another then the first aim is clearly 3 times as important as the other. One can then retain the separate tools but apply a weighting to account for this.

Once the weightings have been agreed any project can be scored against any of the aims and the overall total will be a valid measure because all the scores are of equivalent worth. The results can be displayed in a cross-impact matrix such as the one given in Table 4, summarising the contributions to the various aims, as well as the scores for individual project.

Table 4 – Cross-impact matrix relating projects to strategic aims

	Policy aim 1	*Policy aim 2*	*Policy aim 3*	*Policy aim 4*	*Policy aim 5*	***Project total***
Project 1	2-6	3	0	5-7	0	10-16
Project 2	5-8	0	0	0	0	5-8
Project 3	0	4-8	0	0	0	4-8
Project 4	0	1-2	0	0	0	1-2
Project 5	2-3	3-5	0	2-3	0	7-11
Project 6	0	0	0	0	4-8	4-8
Project 7	0	0	0	0	2-8	2-8
Aim total	9-17	11-18	0	7-10	6-16	

4.1 Selecting the factors for Feasibility

It is tempting to say that for early-stage projects the ultimate feasibility should be given little or no significance because if the Opportunity is sufficiently large, ways may be found round the difficulties. This may be so but clearly Feasibility cannot be discounted entirely - if that were so, anti-gravity would always be the preferred way of reducing weight! A practical measure of feasibility for this stage is the time or effort required to bring the project to the next decision point such as the next stage gate or technology readiness level (TRL). In selecting projects, one would therefore be aiming to find the best use of the immediate research budget (or the advanced development budget or whatever) in relation to the possible benefits of the projects.

4.2 *Selecting the factors for Opportunity*

A comprehensive set of generic factors certainly cannot be offered for Opportunity for early-stage projects. For each case, one must choose those factors which will contribute to performance in the specific strategic aim.

5. *Managing the scoring process*

The overall project scoring process is summarised in Fig. 2, with key considerations elaborated below.

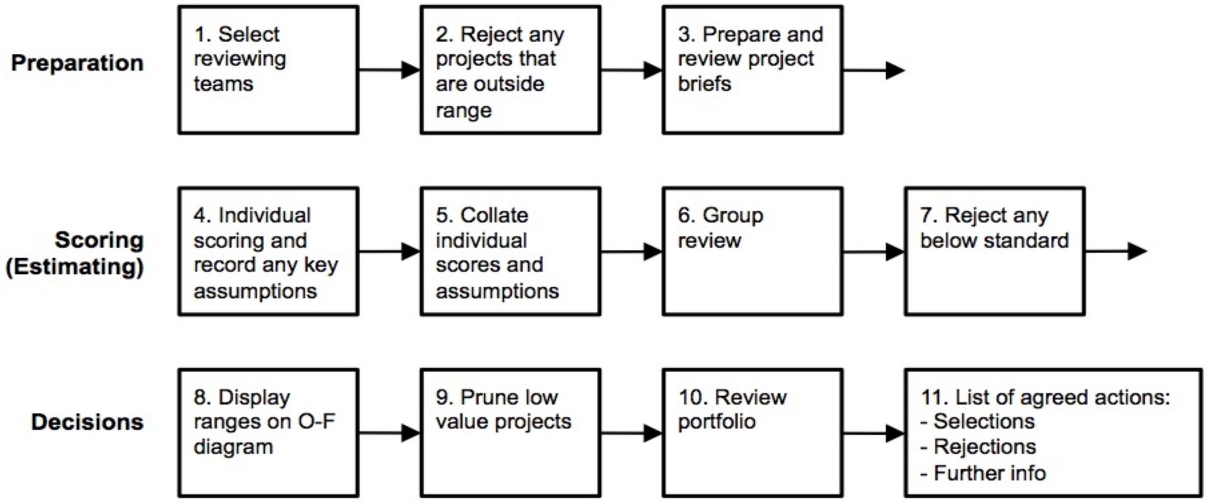

Fig. 2 – Summary of the scoring process

5.1 *Preparation*

Project briefs

Multi-factor scoring is designed for situations of imperfect information so it is all the more important to make use of all the knowledge that is available. The first step is to assemble as complete a description as possible of each project including all the relevant factual information. These descriptions should be as objective as possible so it is a good idea for each one to be reviewed by at least one additional person. The whole process is only as good as the information on which it is based.

Review projects for compatibility

Remove any projects that do not fall within the definition adopted for the scoring tool. Also reject any that are regarded as essential for whatever reason and so outside the decision process.

Choose the scoring team

In using a scoring system there is great value in tapping into the different experiences and intuitions of several people so that as large a range of relevant knowledge and experience as possible is brought to bear. Certainly, there are pitfalls in relying too heavily on a small number of experts particularly if some are already committed to certain projects. Of course, all those chosen must know enough about the topic to make a valid input.

5.2 Doing the scoring

If there is a large number of projects on the table a quick assessment can be made by using the factors as a checklist, and rejecting any obviously poor candidates. However, it is worthwhile to hold on to some of the 'least bad' candidates for re-consideration later in case too many projects are rejected by the full process, and to enable portfolio-level adjustments.

Individual scoring

This is a very important activity and participants must be able and willing to allocate time and care to it. Each participant should be given the briefing papers and time to study them. It is important that individual team members should first form their own opinions and record their ratings for each factor before holding a group discussion. There are two reasons for this. The first is simply to give people time to think and if necessary look up relevant facts. The second is that any group may readily be biased by assertive or talkative individuals or even (an uncomfortable but well-attested fact) simply by the first to speak. So, it is best if everyone has time to formulate their thoughts beforehand.

For each project team members should choose upper and lower scores for each factor, using non-integer values if they wish, and calculate the average values for the project as a whole. If the tool has been well defined all scores will lie between 0 and 8. However scores above 8 or below zero may be used if it seems right. Truth is better than conformity. Any key assumptions should also be recorded.

Group discussion

The participants should then meet in a small group or workshop to discuss and review their scores and assumptions, factor by factor so as to arrive at agreed upper and lower values for each factor and for the project as a whole.

There can be up to three outputs per project from this process:
1. Agreed plausible best case and worst-case scores for Opportunity and Feasibility.
2. A note of any project that is likely to violate one of the threshold conditions and so to be a candidate for immediate rejection.
3. A note of any factors for which either the range of scores is particularly wide indicating that more information should be gathered.

5.3 Selection

Each project is now defined by four scores: the best and worst-case Opportunity and the best and worst-case Feasibility. These may be displayed on a grid as shown in Fig. 3 and 4. In principle, each project should be represented by a rectangle as shown in Fig, 3. However, the rectangles tend to obscure each other making the diagram difficult to interpret. The key information is retained by plotting only the best and worst-case points, as shown in Fig. 4.

The dotted curve shown in Fig. 4 is one of many one could plot showing where the product of Opportunity x Feasibility is a constant. The one illustrated passes through the midpoint of the diagram where (O=4 and F=4, if the scores for O and F go from 0 to 8). If the scaling statements have been well chosen this curve separates the diagram into two regions representing, roughly, projects whose estimated return on investment is acceptable or unacceptable.

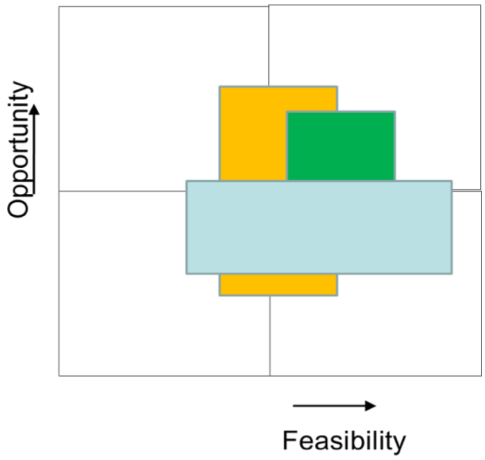

Fig. 3 – Opportunity-Feasibility scoring ranges visualised

This display presents the core scoring and uncertainty information about each project in a clear way, allowing comparisons between projects, and in particular emphasising which dimension, Feasibility or Opportunity, needs more attention.

To make a simpler comparison between projects we recall that Opportunity is a rough measure of the value that may result from the project, while the Feasibility indicates the investment that may be required to bring it to fruition. It is therefore possible to combine them into a single overall figure of merit because the product of the two scores, Opportunity x Feasibility, is in fact a rough indication of the potential Return on Investment, ROI, for the project:

Opportunity x Feasibility ≈ Opportunity / Difficulty ≈ Value / Investment ≈ ROI

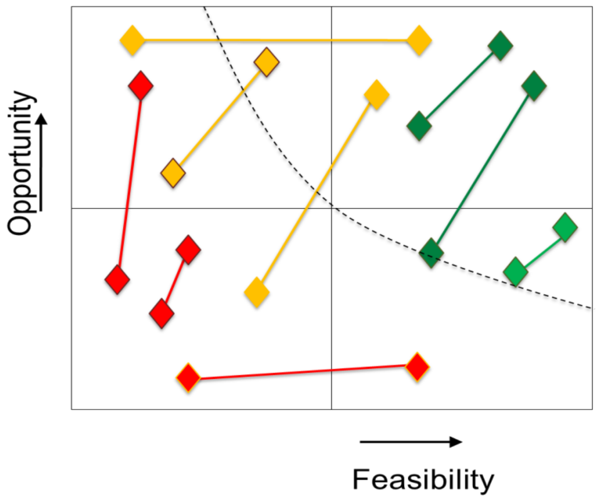

Fig. 4 – Opportunity-Feasibility scoring ranges (min-min, max-max) visualised

It is valuable to retain information about the Opportunity (O) and Feasibility (F) scores - and indeed, about the individual factors – but the product is a convenient and effective way of making overall comparisons between projects. Figure 5 shows such a comparison, showing the product O x F for the projects as vertical bars.

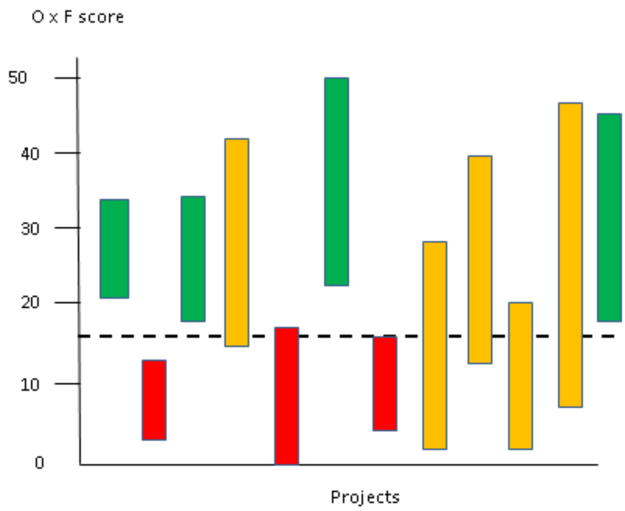

Fig. 5 – Alternative Opportunity-Feasibility visualisation[1]

If the scoring scales go from 0 to 8, the dividing line between broadly acceptable and broadly unacceptable projects comes at an O x F score of 16 (dashed line). Those falling entirely below the line (shown red in the diagram) will generally be rejected and those entirely above the line (green) will probably be accepted. The projects that span the line (shown in orange) may need further investigation to reduce their range of uncertainty before firmer decisions can be made. The details of the scoring will show where the key uncertainties lie. It is important to remember that the plot shows the confidence limits for each project, which means in practice it is equally likely that the result will be anywhere between those limits for early stage projects.

5.4 Choosing a portfolio of projects

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The simplest way to make the final selection of projects is to take the midpoint of each O x F bar as a median estimate of the value of the project and then select them in order of this value until the available budget is used up. But an aggressive or a conservative selection can also be made by giving more attention to the upper or lower limits, depending on risk tolerance. This can be done formally, by taking a weighted average of the two extremes, or informally just by eye.

The information generated by the scoring can also be helpful in determining a portfolio of projects. Organisations will often wish to have a range of projects covering different aspects of the business, such as different strategic aims, market segments, core competences and risk profiles. The easiest way to ensure an appropriate balance of effort between these aspects is simply to earmark separate budgets or *Strategic Buckets* for each and operate a separate selection system for each one.

[1] This representation was developed in collaboration with Duncan Hurlstone

However, it may sometimes be necessary to further adjust, the selection within a bucket. For example, it may be found that specialist resources would be over-committed; or that the selection is too much biased towards short term, or long-term, projects when a judicious mix would be preferable. Correcting this requires adjusting the selection, which on the face of it involves choosing some potentially less valuable projects. Strictly speaking it would be a compromise, rather than a balance, Balancing a portfolio is a dynamic process, making trade-offs and adjustments to ensure that the portfolio is never too much out of balance.

However, when we accept that the expected value of each project is not a single figure but a range, the problem becomes tractable, as illustrated in Fig. 6.

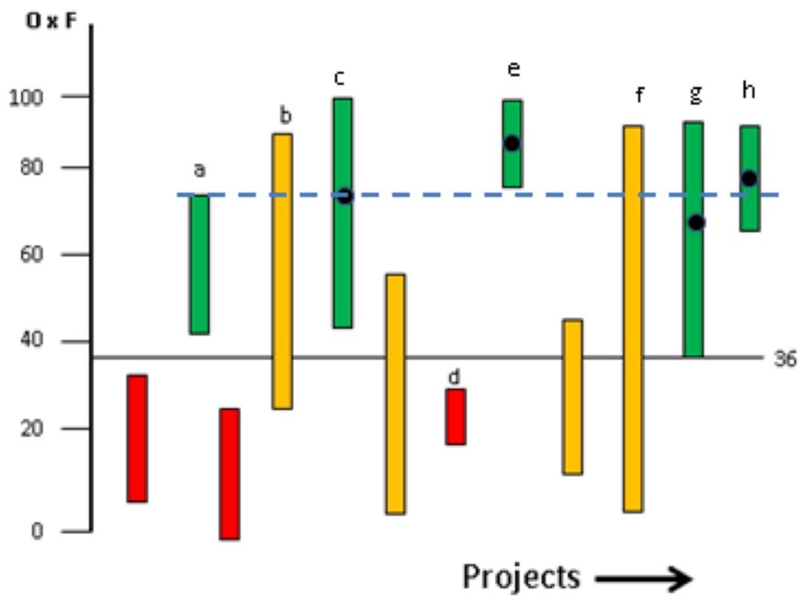

Fig. 6 – Adjusting the portfolio

In this figure four projects, c, e, g and h, have been selected on the basis of optimum values of O x F. Their midpoints are indicated by the dots. The dotted line is the mean of these. If the resulting portfolio were considered to be unbalanced in some way it is clear that any of the projects b, f, and possibly a, could be included to improve the balance because their range overlaps the median line. Since the actual outcome of a project is equally likely to be anywhere within the bar the new selection would not necessarily jeopardise the value of the portfolio, given the assumed state of knowledge at this early stage.

5.5 Outputs

The first review of a group of projects is unlikely to result in completely clear-cut choices. Some firm decisions may be made but there may still be a need for further work to clarify uncertainties. Even for those projects where confidence is high, an acceptance is likely only to mean permission to proceed to the next stage of investigation. Therefore, apart from clear rejections or acceptances, the key outputs of the scoring process will often be lists of actions to be taken to address risks and further reduce uncertainty in each project.

The methods described in this paper are often used in conjunction with other methods to improve the quality of information and decision making. For example, project and portfolio selection methods are often used in conjunction with roadmapping methods, which help to identify innovation opportunities, provide context, and also to elaborate the details of particular options to aid their evaluation (Phaal *et al.,* 2011).

6. Endnote

Multi-factor techniques such as scoring are a valuable way to bring clarity to the decision-making process when choices have to be made on the basis of relatively sparse information. A check list of important factors can by itself be very valuable in stimulating discussion and ensuring that significant issues are not overlooked. This is suitable for occasional use or as a triage tool when an initial selection must be made among many projects of varied quality.

A fully-developed scoring process, such as that described here adds further precision and clarity but it takes time and effort and so is most suitable for repeated use as part of a regular process. But it must be emphasised that the results are inherently imprecise so they should never be applied blindly. In any case they should give way to more financial analysis as soon as enough information is available.

The project selection framework approach set out in this working paper is generalizable, and can with adaptation apply in virtually any selection decision-making subject to uncertainty, with selection criteria, scaling statements and process adapted appropriately. Multiple variants of the O x F method have been observed in firms, applied to different portfolios, in different parts of the business, including areas not primarily concerned with technological innovation.

7. Acknowledgements

Contributions from colleagues are gratefully acknowledged, to conceptual discussions, together with development and testing of methods: Dr Michèle Routley, Dr Clive Kerr, Duncan Hurlstone and Christian Rasmussen.

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Appendix

Factor Score	Scaling statements				
	0	2	4	6	8
Market size	< 5,000 units	25,000 units	50,000 units	100,000 units	200,000 units
Our sales potential In a given time	> 1,000 units in 5 years (gross margin £300k)	3000 units in 5 years (Gross margin £1M)	10,000 units in 5 years (Gross margin £3M)	20,000 units in 5 years (Gross margin £6M)	50,000 units in 5 years (Gross margin £15M)
Synergy opportunities	None	Little	Will help to complete product portfolio	Important	A key part of a major initiative
Customer benefit	No obvious benefit to customers.	Some benefit to some customers	Clear customer benefits within existing norms; work visiting existing customers to promote	A significant advance in more than one key feature of interest to customers	Eye-catching new benefits; a talking point at shows; entry to competitor accounts
Competitive intensity in market	4 or more strong competitors	2 strong competitors	Usual competition; or 1 strong competitor	We will be alone in the market	
Increased margin, or benefit per unit	Benefit worth <£300k	Benefit worth £1M	Benefit worth £3M	Benefit worth £6M	Benefit worth £15M
Business cost reduction or simplification	<£300k	£1M	£3M	£6M	£15M
Industry / market readiness	No expressed demand OR requires major change of customer behaviour	Some customers have asked for this but requires some change in customer behaviour	Definitely attractive to most customers; no change to customer behaviour required	There is pent up demand for this	
Market growth	Stagnant market	<5% per year	5-10% per year	20% per year	>50% per year
Future potential	Update of an existing product	May lead to further variants of applications	Will definitely lead to further product variants or applications	Could lead to a new product line or several applications	This is the beginning of a major new business OR many further applications are foreseen
Learning potential	None	Useful learning	Corrects one or more core competences where we are currently weak	Class leading learning in competences vital for 50% of future business	
Brand Image	No impact	Little impact	Will help retain the image of our company	Would expect favourable press comment; special feature in annual report	
Customer relations	Existing customers may be worried about this	No impact	This will help retain key customers	Failure to do this could endanger business from an important customer	Project is vital to retaining customers for 25% of the business

Examples of Opportunity Scaling Statements for Application-Focussed Projects (for illustration only)

Factor Score	Scaling statements				
	0	2	4	6	8
Product differentiation	No features that are better than competition	At least one feature is better than offered by the competition	We have some minor features that are better than the competition	At least one important feature is significantly better than the competition	Several important features are s much better than competition
Sustainability of competitive advantage	Key differentiating features will be easy to copy. Or serious concerns about IP against us	We are 6-12 months ahead of the competition. No serious IPR concerns.	Competitive advantage can be maintained with continuous effort	We are at least 2 years ahead of the competition	Key features are protected by IPR or unique capabilities that are not easy to copy
Technical challenge	Key features not yet demonstrated by us or others. Or >3x change in an important parameter	Step change in at least 1 important parameter. Or some key features not demonstrated but we're confident they can be	Key features have been demonstrated in prototype, but others remain	All features have been demonstrated in prototype	
Market knowledge	Market size not supported by data and requirements not yet checked with customers	Market estimated within a factor of 2 or 3 with some data support	Enough data to size the market to +/-50% and requirements are supported by discussions with sales force	Market size known to +/-20% and customer view established by formal survey	
Technical capability	We will have to buy in new major capabilities, OR recruit a new technical team, OR rely on a partner.	We lack some important capabilities and a plan is needed to acquire them.	Existing staff can acquire capabilities in 3 months or less, or by recruiting one or two new people.	Some new skills required but they can be acquired in time.	Well within our capability. No new skills or knowledge required
Fit to sales and/or distribution	Entirely new distribution channel required. OR requires new sales skills that at least half the sales force will struggle with.	Changes to sales or distribution will need special attention	>75% of sales force could sell it with training or >75% of existing distribution applicable	Some changes to sales or distribution but within our capabilities in the time	Well within competence of existing sales and distribution
Fit to manufacturing/ supply chain	New production technology required or major change of supply chain	Adaptation of manufacturing process or change to supply chain that will require special attention	Changes required but within our capability in the time	Minor changes to manufacturing or supply chain well within usual expectations	
Finance	Extra funding will be required and possible source not yet identified	Outside budget but justifiable	Within budget	Well within budget or some external funding available	External funding available for the entire project
Strategic fit	Project is clearly outside our strategic intent and fits no product vision	Some doubt about how this fits into existing strategies	Fits strategic intent and a specific product vision	Fits strategic intent at a high level of ambition and meets more than one specific product vision	
Organisational backing	There is opposition from several stakeholders.	We have some persuading to do.	We do not anticipate trouble gaining support for this	Strong support from all important stakeholders	

Examples of Feasibility Scaling Statements for Application-Focussed Projects (for illustration only)