The Mission-orientated Analysis Technique

INTRODUCTION

Chapter 13 of the book introduced the important topic of dealing with 'wish lists'. Much of the chapter dealt with an explanation of Mission-orientated Analysis (MOA), a technique for prioritising those items from the wish list that make the greatest contribution to achieving an overall strategic objective in a range of conceivable circumstances or, of course, identifying those that might do the least harm to strategic performance if they have to be dispensed with. It was pointed out that MOA could be applied at a simplified level, or as a full-scale analysis, though the latter would involve some simple arithmetic. The purpose of this additional text is to explain the full-scale use of MOA and to show the arithmetic by means of a worked example.

The text reproduces a slightly edited version of the original paper by the author 'A Mission-orientated Approach to Defense Planning', originally published in *Defense Analysis*, Vol. 5, No. 4, pp 353-367, 1989 and I am grateful to Dr Martin Edmonds, editor of that journal, and Taylor & Francis (http://www.tandf.co.uk)for permission to include it here.

Since that paper was written for a defence audience, the example is naturally from that domain, but please bear in mind that when the paper was written, the Cold War was still in being, hence the example used. However, we were at pains to point out in Chapter 13 that MOA can be applied to any domain, a point that was illustrated by an example drawn from health care.

Given the space limits of academic journals, the paper could have only a brief explanation of the principles of MOA. That appears in this text as, though it is something you will know from having read Chapter 13, it may reinforce your learning by giving a cross check on your understanding.

The rest of this text is the paper referred to (as written in the 1980s).

A MISSION-ORIENTATED APPROACH TO DEFENCE PLANNING

INTRODUCTION

At its most fundamental level, the problem of planning the acquisition of military forces in peacetime is a conflict between ends and means under the influence of constraints. The ends to be achieved are the ability to discharge a military mission, such as to defeat an enemy force if war should ever start. The means are the specific items of military equipment which are being considered for acquisition, and the constraints are those of money, manpower and other factors.

To take a specific illustration, the British forces in Germany have the overall mission, or strategic directive, of, if necessary, defending a particular sector of West Germany, defeating certain Soviet forces and contributing to the recovery of any territory which might be lost in the process. In order to be able to satisfy that strategic directive they require military equipment and consideration is currently being given to the acquisition of a new tank. The cost of the tank is likely to be very large and will, therefore, compete with other candidate equipments for the funds available to the army in the defence budget. That competition will extend to the requirements of the Royal Air Force and Royal Navy but for the purposes of this paper, attention will be restricted to hypothetical army problems.

In broad terms, the military planning problem is usually to evaluate which of equipments A or B will contribute more to the ability to accomplish a stated overall mission. This task might involve analysing the effect on operational capability of, for example, issuing a new tank to armoured regiments. That effect could be compared with the corresponding result for acquiring a new field gun for the artillery regiments so as to give a comparative indicator of the benefits of each. In practice, one would be much more concerned to create the package of requirements which does most for overall capability while still falling within financial, and other, constraints.

In some instances, the mission of the forces being planned for cannot easily be defined, or has very many possibilities, the US Light Divisions being, perhaps, examples. The methods described in this paper might help with that more difficult problem by being applied to at least some of the potential missions. If particular equipment options were shown to be robust across a range of cases, priorities might be more easily identified. This paper will, however, deal with the case where the strategic directive can be stated reasonably clearly.

There is, however, a deeper level still for analysis to tackle. This is the issue of risk. It may be assumed that it is impossible to provide all the army's requirements and that there will be a shortfall of operational capability below that which is ideally desired to discharge the overall mission. While the actual military capability may be sufficient for deterrence, which is a political judgement, there is a risk of military defeat if deterrence should ever fail, and that risk is a component of a deeper risk that deterrence will fail. A method of analysis should be able to display those risks so that higher-level decision makers can assess the situation.

The method proposed in this paper goes some way towards meeting these desiderata, though it is recognized that real-world problems are so complex that no single method can do more than shed light on them and provide a basis for further analysis. Since the method analyses the connection between military requirements and the overall mission it is called mission-orientated analysis (MOA). It should be made clear that similar names are used in the defence analysis community to describe a wide variety of approaches. It is claimed that the proposed method goes rather beyond those earlier techniques and creates a systematic framework supported by a numerical algorithm. In particular, MOA helps with the creation of packages of requirements and displays the attendant risks.

THE ESSENCE OF MOA

MOA is based on a number of simple ideas, the first of which is that of a hierarchy connecting the individual requirements to the overall mission. The hierarchy is needed because it is in practice very difficult to gauge the effects of a particular equipment option on overall capability in one mental or mathematical step. The hierarchy creates a ladder by which the effects of equipment at tactical level can be combined to show the resulting ability to satisfy the strategic directive.

The hierarchy starts with the strategic level. This describes the degree to which the overall mission is accomplished under a range of different circumstances or scenarios. The next level down acknowledges that, although the strategic level states the objective to be achieved, it is too broad for practical planning and it is therefore necessary to identify the essential elements of that overall mission. These are termed key mission components (KMCs). They correspond to major aspects of military operations, failure in any one of which would jeopardize the overall strategic mission. KMCs are still too broad for actual planning, so they are supported by a series of military functions, which represent the level in the military world at which equipments are issued and used.

The essence of MOA is very simple in terms of this hierarchy. An assessment is made of the extent to which, say, issuing a new type of tank would improve the ability to perform those functions involving tanks. That, in turn, would lead to an improved ability to perform those KMCs that are supported by tank functions. The enhanced ability to perform some of the KMCs will increase the ability to meet the overall strategic objective. By contrast, the new field gun would affect different functions, which would modify the performance of different KMCs and that, in turn, might affect the strategic capability in a different way. Conversely, to support a decision maker who wished to reduce particular risks at the strategic level, MOA would identify the KMC improvements needed, trace down to the corresponding functional improvements, and hence identify the requirements which would have the desired effects. These processes of upward and downward evaluation are implemented through a simple numerical algorithm which is described in the Appendix.

The key word in the preceding paragraph is “assessment”. Since the assessments can be made by military judgement, MOA is a structured judgement approach, though the judgements required also include the connections between functions and KMCs and from KMCs to the strategic level. (see the worked example in the Appendix for details). These different types of judgement come from different sources, the technical assessments of capability from technical experts and the judgements relating functions to KMCs and the latter to strategic capability from more senior officers. MOA thus ties together disparate sources of information but, since the sources of judgement are varied, it is more difficult for any one person to have too much influence on the outcome.

Where appropriate, military judgement can be supplemented or replaced by the use of operational analysis results, data from exercises or field trials, results from historical analysis or, indeed, any relevant source of information. In short, MOA has the attractive property that it can act as a framework for tying together disparate sources of information so as to make the best use of what is available. In the early stages of an analysis the assessments can be done very quickly using military judgement. As further analysis reveals sensitivities to data the military judgement can be reviewed and, if necessary, supplemented by any of the other sources of data.

FORMULATING AN MOA PROBLEM

The brief survey of the essence of the approach will now be amplified by considering an entirely hypothetical example, based on typical concepts of operations for the NATO Central Region. As Faringdon (1986) explains, some forces are assigned to the defence of the main axes of a Soviet advance, others are held available as mobile counterattack forces, while the remainder are used to preserve control over NATO's rear areas. The overall objective, or strategic directive, for any of the national forces is defined by the NATO strategy of forward defence as being to defeat the attacking forces and to recover any lost NATO territory. As far as military requirements are concerned we shall assume that, for an arbitrary nation's army, a list is available comprising a large number of different items varying from new weapon systems to increased stocks of ammunition. In a practical case there might be many hundreds of requirements including any facility, skill, or resource of any type, which has been identified as necessary to correct known operational deficiencies.

To keep the example simple, we shall assume that there are 32 items, labelled requirement 1, 2 etc. Each is a specific force improvement, the cost of which is known, such as to provide 1,000 rounds of ammunition for each soldier in six infantry battalions.

The first stage in analysing this problem is to devise a suitable hierarchy to relate the strategic level to the requirements. In practice this is usually the most difficult part of the problem and several iterations may be needed before an acceptable solution can be found.

The strategic level recognizes that the overall directive must be interpreted according to the circumstances in which it might have to be implemented, and that allowance must be made for partial achievement of the overall goal. For the purposes of this paper, there is little difficulty over the circumstances as there are several published scenarios for the Central Region. In particular, Hackett (1978) and Bidwell (1978) respectively, describe a war which commences with a Soviet build-up to which NATO responds, and a surprise attack. Close (1979) by contrast, considers a Soviet invasion which is led by massive penetrations by helicopter-borne forces. For each of these three scenarios, or "strategic elements", one formulates four operational definitions of levels of performance in the given case. For the Hackett case, the highest level of military capability, corresponding to complete accomplishment of the strategic directive, might be:

> Defeat attacking forces as far forward as possible and conduct mobile operations to recover any lost territory.

This restates the strategic objective in terms of the circumstances of a massive attack with long warning. This is the highest level of performance required but, in order to define a measuring scale, the lowest acceptable level must also be defined. This is a level of military capability below which the army in question could not realistically be said to exist as a military formation. A suitable definition might be:

> Protect command centres and nuclear weapons for the minimum time required for decision on escalation.

These two definitions provide the upper and lower bounds for a measuring scale for performance assessment. The scale is completed by two intermediate definitions:

> Defeat attacking forces as far forward as possible and conduct mobile operations to recover any lost territory.
>
> Halt enemy invasion but without recovering lost territory.
>
> Inflict substantial loss and delay on advancing enemy forces.
>
> Protect command centres and nuclear weapons for the minimum time required for decision on escalation.

Definitions are also required for the Bidwell and Close cases to reflect the same strategic directive but allow for the different operational circumstances. Putting the three sets of definitions into a matrix, with some simplifications for brevity, provides the strategic capability matrix shown in Figure 1.

Level	**Hackett**	**Bidwell**	**Close**
1	Defeat enemy forces as far forward as possible and recover any lost territory	Disrupt enemy offensive and seize the initiative	Maintain forward defence and prevent enemy incursions
2	Halt invasion with minimum loss of territory	Counterattack to restore a stable position	Destroy enemy mobile forces in rear areas and establish a stable position
3	Inflict severe loss and delay on enemy forces	Secure rear areas for mobilization and reinforcement	Restore control over rear areas
4	Delay for nuclear escalation	Delay for nuclear escalation	Rapid reaction to protect key installations

Figure 1 An Illustrative Strategic Matrix

The second level of the hierarchy is the KMCs. These represent major task areas, usually corresponding to a senior level of military command. They affect the overall mission to such a fundamental extent that inadequate performance of a KMC will cause serious deficiencies in overall performance and, in the extreme case, complete failure to perform a KMC would jeopardize the overall mission. For this example, three KMCs are required: defensive operations, offensive operations, and maintain security of communications zone, abbreviated to DefOps, OffOps and MainComm, respectively. All three KMCs involve combined arms operations and require a wide range of military equipment, but they are, nonetheless, different military tasks and play different roles in the concept of operations. Each KMC is defined in four bands as was done for the strategic elements. The definitions reflect the form and manner of military operations, so that, for example, the highest level in OffOps might be defined to be the ability to conduct major offensive moves to exploit opportunities or regain the initiative. The lowest level might be to conduct limited operations to restore battlefield cohesion for a few hours.

The next level in the MOA structure is the functions. These correspond to more detailed military tasks, which require the equipments being evaluated. The functions would usually be carried out by a single service or arm. An example might be denial of enemy mobility which requires equipment for the placement of anti-tank mines and demolitions, and is usually carried out by combat engineers.

For the NATO Central Region, a few suitable functions might be infantry operations, armoured operations, air defence, airmobile operations, fire support, and denial of enemy mobility. These correspond to the roles of the infantry, armour, army aviation, artillery and combat engineers. They also match with obvious candidates for the equipment programme, such as new antitank weapons, a new tank, mobile air defence weapons, advanced helicopters, more powerful field guns and improved anti-tank mine systems, examples of each of which are regularly described in the open journals.

Each of the functions is defined in four bands. As an illustration, the highest level for airmobile operations might be to employ airmobile forces in strength to seize or recover key positions, while the lowest level could be to use airmobile forces in small “packets” to hamper enemy movements.

Finally, the lowest level in the hierarchy is the requirements themselves, examples of which were given earlier. Those illustrations all related to “new” or “advanced” equipment but, in a practical case, requirements can be for “more” of an existing equipment, for additional stocks, for more personnel or, indeed, for anything which will correct operational shortcomings.

The requirements can be enumerated simply by considering what is already in the forward equipment programme. Alternatively, they can be deduced in a more systematic way by evaluating each function as it contributes to those KMCs which it supports. For each KMC-function combination, a careful assessment is made of the conceptual capabilities required to carry out the military operations in question, identifying any shortfalls in present or expected capabilities and hence identifying specific items which would be required to eliminate the shortfalls. This strategic framework method is to be preferred over less systematic approaches to deriving lists of requirements, but may be unnecessary when the list is given.

Having developed the hierarchy, one now proceeds to make capability assessments. Experience has shown that qualified assessors, who are usually Lieutenant Colonels, have no difficulty in making the required judgements and that there is little or no difference between their assessments. They are asked to rate how well a given function will be performed with and without a specific requirement.

MOA EVALUATIONS IN THE EXAMPLE

The analysis commences by using the arithmetical algorithm explained in the appendix to create a base case evaluation to show the current strategic capability when none of the requirements is implemented. The resulting strategic matrix is shown in Figure 2.

Level	Hackett	Bidwell	Close
1	R	R	R
2	R	R	R
3	R	R	R
4	Y/G	G	Y/G

Figure 2 The Base Case Assessment

Reference was made earlier to the importance of being able to measure risk in strategic analysis. The matrix indicates the risks by its pattern of red cells. In this case, there is a large amount of red in the matrix which indicates that the assessed military capability is far less than that required to support the political objectives of the state by military means, if ever called on to do so. One might imagine a fairly interesting discussion between political leaders and their senior military advisers in the face of a picture like this. The implications seem to be that the risks must be accepted, or that resources must be found to reduce them, or that the political stance must be changed to one requiring a more achievable level of military capability. The Canadian defence White Paper (1987) states explicitly that the risks implicit in Canada's low military capabilities are no longer acceptable, and resources will be found to correct the deficiencies. The recent Canadian budget makes it clear that economic pressures must now override military risk and many major military projects are to be cancelled or postponed (*Toronto Star*, 1989).

The foregoing capability matrix is a fairly bleak picture (deliberately so, as this is completely fictitious). The reasons for the poor performance and high risks are, however, easily calculated by reversing the colouring algorithm and are shown in Figure 3.

Figure 3 shows that the reason that green is not achieved in, for example, Close level 4, is that the KMC of DefOps fails to reach the required level by about a band of performance. Study of that figure reveals that a one-band improvement in DefOps should have the side effect of making Hackett and Bidwell level 3 into dark yellow since only two KMCs would then fail to reach their target level for those cells. This “diagnosis” can be translated into planning terms by referring to the definitions of performance for the KMC of DefOps. For brevity, the KMC definitions are not given in full in this paper but this example of improving DefOps by “one band” might correspond to improving the forces tasked with defence from the level at which they can impose a 12-hr delay on the enemy (band 4) to the point at which they can impose a 24-hr delay (band 3). In a practical case the definitions might be much more specific and relate to a defined enemy force in particular locations.

The required improvement in DefOps can be translated into corresponding enhancements in the functions which support that KMC and hence into the requirements which would have to be implemented to achieve those increases in functional performance.

Testing that improvement does, indeed, have the predicted effects as shown in Figure 4. The calculation picks out 14 of the overall total of 32 requirements as being those which would require implementation in order to achieve this degree of strategic performance.

Each requirement is a specific item, the cost of which is known. If it turns out that the cost of the 14 requirements exceeds the available funds, the MOA algorithm, and the supporting software, can easily be used to try the effects of subtracting, or replacing, specific requirements to see how much strategic effect would ensue from cutting some part of the equipment programme. In short, the output from an MOA analysis has to be seen as the starting point from which deeper consideration can be given, rather than a complete and comprehensive solution to a planning problem.

The 14 requirements are an improvement package which MOA has created from the 32 individual requirements. This ability of MOA to generate packages is one of its strongest features, and distinguishes this version of MOA from other approaches with similar names in which the analyst must create packages himself.

Level	**Hackett**	**Bidwell**	**Close**
1	DefOps (2.5) OffOps (2.5) MainComm (3.0)	DefOps (3.0) OffOps (3.0) MainComm (3.0)	DefOps (2.0) OffOps (2.0) MainComm (2.0)
2	DefOps (1.5) OffOps (1.5) MainComm (2.0)	OffOps (1.0) DefOps (2.0) MainComm (2.0)	DefOps (1.5) OffOps (1.5) MainComm (1.5)
3	DefOps (1.0) OffOps (1.0) MainComm (1.5)	DefOps (0.5) OffOps (0.5) MainComm (0.5)	OffOps (1.0) MainComm (1.0) DefOps (1.5)
4	MainComm (0.5)		DefOps (1.0)

Figure 3 The Base Case Diagnosis

Level	Hackett	Bidwell	Close
1	R	R	R
2	R	R	R
3	Y/R	Y/R	R
4	Y/G	G	G

Figure 4 Improvement To KMC Of Defensive Operations

It is interesting to contrast it with a case in which a comparable improvement is sought in OffOps. That turns out to involve 11 requirements, which we shall assume to be cheaper than the 14 requirements of the previous case, but produces the strategic matrix shown in Figure 5. What constitutes a "good" strategic matrix is, of course, a matter of opinion, but this matrix certainly does not seem to be attractive. Only one cell is green and, to a senior military eye, the large swathe of shades of yellow might suggest that there is considerable imbalance in investment leading to distorted military capability. On the other hand, a politician might see this matrix as representing a high degree of deterrence, since there is some military capability at most levels of performance. It is, perhaps, one of the attractive aspects of MOA that it can reveal such consequences to senior decision makers.

To illustrate yet another mode of MOA analysis, consider the matrix of strategic definitions in relation to the colour-coded base case performance assessment. Suppose that it was the judgement of a senior commander that the most critical strategic weakness was the inability to satisfy Bidwell level 3 by being able to secure the rear areas sufficiently to receive reinforcements in a surprise attack. Instructing the algorithm to attempt to change that cell from red to green leads to the strategic matrix of Figure 6.

The desired result has been achieved and to do so requires the implementation of 17 requirements, which overlap to some extent with the requirements found in the previous cases.

The three cases tested have identified 14, 11 and 17 specific requirements, respectively. There is a certain amount of overlap between these three sets and those particular requirements would, in a practical case, by of great interest. To achieve a robust defence stance, they might even be seen as the main priorities.

Level	Hackett	Bidwell	Close
1	R	R	R
2	Y/R	Y/R	Y/R
3	Y/R	Y/R	Y/R
4	Y/G	G	Y/G

Figure 5 Improvement to KMC Of Offensive Operations

Level	Hackett	Bidwell	Close
1	R	R	R
2	R	R	R
3	R	G	R
4	G	G	Y/G

Figure 6 Bidwell Level 3 Turned Into Green

COMMENTS ON THE EXAMPLE

For this hypothetical example, it is fairly easy to identify suitable components for each of the three levels in the MOA hierarchy. It is equally easy to postulate brief definitions of capabilities. In a practical problem, matters are by no means so simple. Experience has shown that formulating a good hierarchy and appropriate definitions requires at least two iterations, and is probably the most time-consuming part of the problem. It is difficult to be categorical about the effort required, but experience indicates that it might be in the region of 10-20 man days for a problem involving, say, five KMCs and 10 functions. Making the capability assessments usually presents little problem, providing the assessors have been well briefed. In fact, the military usually react to MOA with considerable enthusiasm.

THE SCOPE OF MOA

The example used in this paper relates to high-level military operations, and MOA was originally conceived to meet that planning need. At this high level, one could conduct complementary and consistent analyses for the missions which compete for the defence budget. In the British case, operations in Germany are only part of the national defence problem, others being the army tasks in NATO's Northern Region and Home Defence, the Royal Navy's responsibilities in, for example, the eastern Atlantic and the Channel and the RAF's widespread commitments, all of which have to be funded from the UK defence budget. MOA could address all these problems, either separately with the results being compared manually, or even as one very large problem so as to emphasize the synergisms.

MOA can, however, be used lower down the scale of military seniority. Green (1988) assessed the approach in the context of planning for the new Canadian division being formed for the Central Region. MOA has also been used in various student projects, including planning of the very specific requirements of an artillery regiment and a signals squadron. Millar and Coyle (1990) have tested the method as an approach to the planning of tactical operations.

MOA is by no means limited to military problems and could, for example, be applied to business planning. For such a case the overall objective might be expressed in terms of corporate growth or survival. The military scenarios might be replaced by scenarios for economic growth, balance of payments etc. The KMCs might be such areas as service existing demand, introduction of new products, and generate corporate finance. The functions could be expressed in terms of manufacturing, personnel, training, marketing and so on. Finally, the requirements could be specific research and development, or capital expenditure projects. Similarly, MOA might well be applicable to say, health care, and some preliminary work has been done in that area. In short, it seems that MOA has a very wide range of applicability.

CONCLUSION

This paper has described what is felt to be a novel approach to problems of military planning. It has been argued that MOA's ability to display capability and risk against a defined matrix of performance, the way in which it generates improvement packages from individual assessments, and the fact that the assessments can incorporate a wide variety of information sources are all valuable aspects of a planning methodology. The potential for using MOA to produce mutually consistent analyses across a range of military problems, or at successive levels of military responsibility should not be ignored. In addition, the fact that MOA can be used to analyse non-military problems is an interesting example of a type of technology transfer.

In summary, MOA seems to be both novel and powerful, yet too much should not be expected of a planning technique. The real ingredients in any planning problems are imagination and insight and MOA confers neither. Its real role lies in freeing the planner from some of the drudgery of evaluating alternatives. However, MOA's diagnostic and predictive properties may act as a stimulus to imagination by suggesting areas in which further thought might be beneficial.

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APPENDIX: A WORKED EXAMPLE OF MOA

The MOA algorithm is essentially very simple, but writing it in formal mathematics leads to such a profusion of subscripts that the result is tedious. This appendix therefore explains the algorithm by means of a simple worked example consisting of three KMCs and four functions. The method of arriving at capability assessments is shown, followed by the steps in the resultant calculation of the colours in the strategic matrix. The example concludes by showing the reverse process of identifying particular requirements to correct strategic deficiencies.

Consider a function such as infantry operations in support of the KMC of DefOps. Assume for simplicity that there are only two requirements: advanced antitank missiles and scatterable mines. A four-band definition of infantry operations is developed, and infantry experts are asked to rate the contribution each requirement would make to the two problems of defeating targets at long range and protecting defensive positions. The assessment is made using a rating proforma on which the assessor places arrows to represent his judgements of the capabilities without and with the requirement in question. In each case, he attempts to assess capability as far as that item is concerned.

Function capabilities	Destroy targets at long range (Anti-tank missiles)		Protect own Positions (Anti-tank Mines)	
	Without	With	Without	With
1 Defend positions for up to 48 hr				
2 Defend positions up to 24 hr				
3 Seriously delay enemy advances from ambushes				
4 Monitor and hamper enemy advance				

In this example, the judge, perhaps a battalion commander with recent experience, feels that the existing capability for destroying hard targets at long range is so poor that, as far as that component of infantry operations is concerned, his battalion would be able only to hamper an enemy advance which is why he has placed his arrow at the boundary between bands 4 and 3. With the new missile, his judgement is that, if destroying distant targets was the only factor, his command would have a good prospect of defending positions for 24 hr. He takes account of the capabilities of the new weapon, its proposed scale of issue, the number of reloads available for each launcher, and so on. Similarly, he has made assessments of the ability to protect positions with and without the new scatterable mine system. (The example is entirely hypothetical.) In this case, all the assessments have fallen on the boundaries between definition bands, but they can also occur in the middle of bands, to represent intermediate cases.

In all cases, the assessments could be based on the expert's own judgement, or they could be derived from models, exercises or any source of military information. It is one of the strengths of MOA that it can use information from a variety of different sources.

The assessments are first used to derive the base case capability for infantry operations in support of DefOps. This is the capability which would exist if *neither* of the requirements was implemented, which is the net effect of the two Without columns. This capacity is calculated from the assessments by converting the four bands into a five-point scale. If the top of band 1 is equated to the value 1, then the boundary between bands 1 and 2 receives the value 2, and so on to the bottom of band 4, which is rated at the value of 5. On this value scale, the two "without" assessments are rated at 4 and the base capability is taken to be the mean of the two values, which is also 4. If both requirements are implemented, the ratings would be 2 and 3, which gives an overall rating of 2.5. Similarly, implementing missiles but not mines gives ratings of 2 and 4, for a mean of 3, and the overall capability for mines but not missiles will be 3.5.

The justification for averaging the individual ratings is that it represents, roughly, the tactical commander being able to exploit the strengths of one capability to overcome, to some extent, deficiencies in another. This is a simple approach, but MOA is intended to be simple as its purpose is to allow the staff officer to obtain broad priorities from a very long list of requirements within a short space of time. MOA is not intended to be a detailed combat simulation simply because it is aimed at types of problems other than those for which detailed simulations are appropriate. This amounts to saying that defence analysis is a very complex area and that is it convenient to have different methods for different problems.

The process of assessment and calculation of function scores is repeated for each function in each KMC to which it applies, resulting in a table of functional ratings, as shown overleaf.

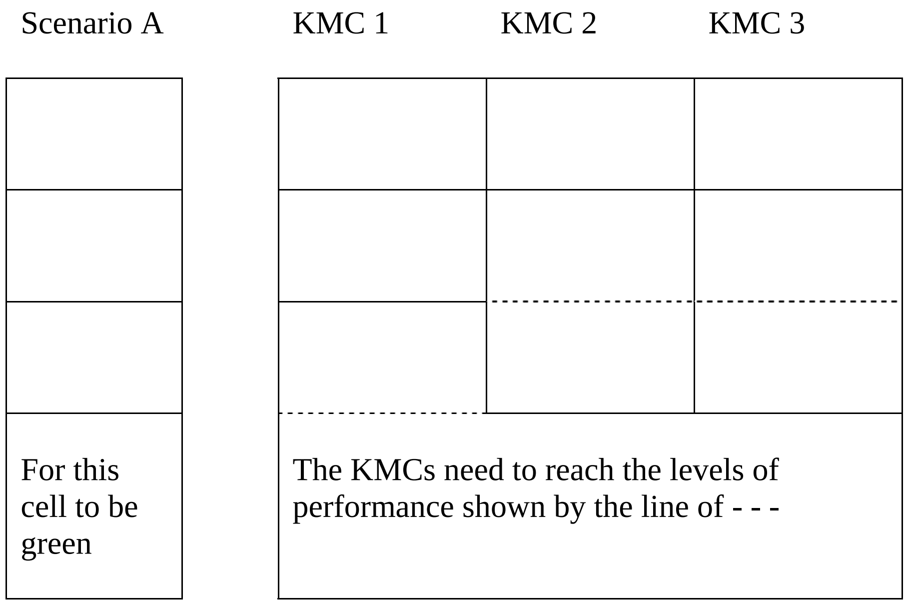
The next stage is to use the values in Table 1 to determine the overall KMC ratings. That is based on the principle that the worst function will dominate the KMC. For KMC 1, the worst function is 1 (the larger the numerical rating, the worse the performance). The justification for this simple approach is the KMCs correspond, approximately, to the responsibilities of formation commanders and it is harder for such a senior commander to trade off higher capabilities in one area against shortcomings in another. There are, for example, many instances of operations which would otherwise have been successful failing because of logistic deficiencies.

KMC-function ratings

	KMC 1	KMC 2	KMC 3
Function 1	4.0	n/a	3.0
Function 2	3.0	2.5	n/a
Function3	n/a	3.0	2.5
Function 4	2.5	n/a	4.0

The final stage in the base case assessment is the colouring of the strategic matrix. To accomplish that, the algorithm uses profiles reflecting the judgements of the overall commander on the degree of performance required from each KMC in order for a given strategic matrix cell to reach green.

Thus, the commander has judged that KMC 1 must reach a score of 4, and KMCs 2 and 3 must both achieve 3 in order for the lowest cell for scenario A to be green. He does this by considering the operational definitions for the scenario and the KMCs. To connect back to the example used in the main text, if he was assessing Close level 4, in which the requirement is rapid reaction to protect key installations, he would have to assess the levels of performance required in defensive operations (to limit further enemy penetrations), offensive operations (to regain any key points lost) and maintenance of the lines of communications (to permit the movement of his own forces).



The actual levels of performance for the three KMCs, as calculated from the function scores, are respectively, 4, 3 and 4. To decide the colour of the cell for the scenario A level 4, the actual KMC scores are compared with the required scores of 4, 3 and 3 given by the above profile. The first two KMCs reach the levels required for the cell to be green, but the third does not. The cell is, therefore, neither red nor green but, since it is nearer to green, it would be coloured Y/G. Furthermore, the calculation shows that it is KMC 3 which is source of the failure to achieve full green and that, if that KMC's score was improved by one point, it would reach the required level. This is the origin of the base case diagnosis presented in the main text.

If, in the judgement of the formation commander, it is required to achieve green in scenario A level 4, then it is necessary to improve the score of KMC 3 by one point. To achieve that, function 4 needs to be improved by one point. That can be done by implementing the requirement for new missiles, which would give the required result of 3. Implementing the scatterable mines would give a score of only 3.5, which is not sufficient, while implementing both requirements would give a score of 2.5, which is more than is required to turn that cell green. That would, in any case, be pointless, since the next constraint on KMC 3 is the rating of 3 for function 1.

As has been shown, the core of MOA is simple arithmetic so the calculations can be done by hand. For larger problems, that would be tedious and error-prone, so software has been developed to implement the method. The package allows the user to test the effects of implementing individual requirements, or those which apply to specified KMCs and/or functions. That might be termed bottom-up planning, but the package also supports top-down analysis in which one seeks to turn a given cell or cells green, based on higher direction or a detailed diagnosis of strategic failings. The software also supports data input, the display and amendment of definitions, the making and revision of user judgements, such as the requirement assessments or the judgement profiles. Future software enhancements will include optimization facilities to allow a given budget to be allocated so as to come closest to meeting strategic priorities, or do the least to diminish them when economies are to be made.