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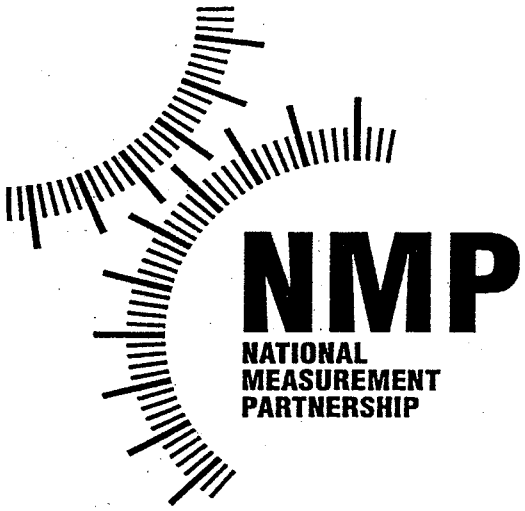


# CONFERENCE DIGEST

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# Mapping Measurement Impact Model

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## Abstract

This paper outlines the Mapping Measurement Impact Model used by the Department of Trade and Industry to economically assess the benefit to industry of different research projects to be funded as part of the National Measurement System and as a means to inter-compare their programmes.

### Introduction

The aim of this model is to project the additional benefit in terms of increased turnover that UK industry can expect to gain as a result of the funding of projects within National Measurement System (NMS) programmes.

The NMS programmes are formulated every three years. Contractors are appointed to solicit views of industry, academia, trade associations and scientists on what work is required in the coming programme. A list of projects approximately 15% above the level of budget is put forward to a Department of Trade and Industry (DTI) Measurement Advisory Committee Working Group (MACWG) who have the task of considering each project and making decisions about what will be funded. In making this decision they take many aspects of the project into account and its economic impact is one of these factors.

The model delivers an *economic benefit measure* (EBM) which estimates for each project the net present value (NPV) of the extra benefit which it will deliver to UK industry. The EBM is divided by project costs to produce a single *cost benefit ratio* for each project which is used by the DTI's MACWG.

## Background

The model is based upon the method developed during earlier studies undertaken by Scientific Generics (SG) into DTI sponsored programmes [Klein et al, 96]. A key aspect of the earlier SG work highlighted the types of interactions that organisations have with the NMS and the perceived benefit that the organisations felt they had gained as a result of the interaction. The type of interaction between the NMS projects and UK organisations can vary widely from direct consultancy to the much more intangible and indirect effect of UK influence on international standards. The study initially highlighted five groups of interaction mechanisms. An additional two mechanisms .were added through improvements to the model undertaken by NPL and SG for DTI reported in May 1998.

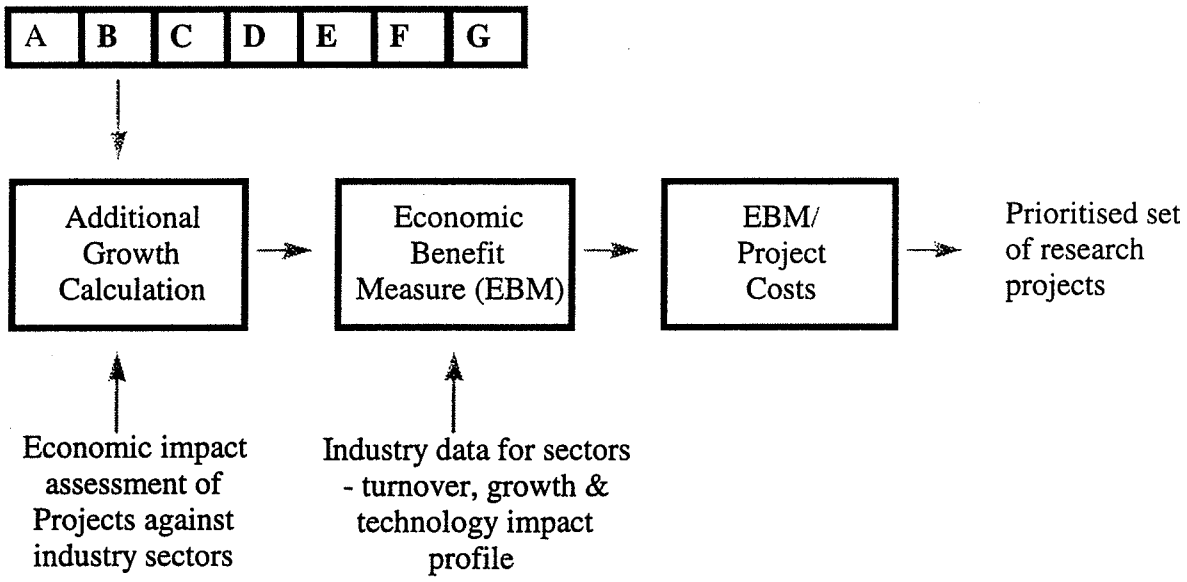
The Model benefit mechanisms are:

A: Providing traceability to primary international standards
B: Generating exploitable new measurement technologies
C: Using leading-edge metrology (usually measurement services) to support advanced products
D: Providing an expert service to industry (usually as consultancy) to diagnose and solve measurement-related problems
E: Providing leadership and dissemination in frontier technology areas through technology transfer
F: Representing UK interests on international bodies
G : Facilitating the compliance of existing regulation or legislation

Recent developments to the model have been undertaken by NPL and PA Consulting Ltd with input from the London Business School to bring the economic calculations inline with current best practice. These were reported to the DTI in August 1999.

**The model**

Scores by industry experts against benefit mechanisms that industry identified as the most useful.




The three main data inputs to the model are:

1. Specific scores (see A-G above) for individual proposed projects reflecting expert judgements of the strength of the interaction mechanisms in relation to each project.
2. Data to represent an assessment of impact on sectors by the projects within an NMS programme.
3. Financial data about those sectors which the NMS programme will impact upon.

The following subsections describe the process of building the model in more detail.

## Scores for individual proposed projects

Each of the proposed projects is given a score 1 - 7 against each of the benefit mechanisms based upon the likely outcome of the project taking into account activities within the life of the project or as a result of the project.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| The work will NOT provide benefits though this mechanism | | | The work will provide an AVERAGE level of benefits through this mechanisms in comparison to other NMS projects | | | The work will proved SIGNIFICANT and SUBSTANTIAL benefits through this mechanism |

The scorer of the projects is asked to make a self assessment of their knowledge of the area of the project. The scores are weighted based upon this assessment. There are three categories for assessment:

| | |
|---|---|
| Expert | Someone who has or has had direct experience of current industry measurement problems and the associated research solutions |
| Knowledgeable | Someone who has or has had a practical industry knowledge of current measurement problems |
| Aware | Someone with an awareness of the current industry requirements |

## Impact assessment

The nature of the impact by each project in an NMS programme on each sector is classified as underpinning, direct, or both (*U/D/B rating*). These are defined below.

U Underpinning - Projects which support industries in this sector by underpinning the business through traceability or conformance to regulation/legislation requirements. This will probably take place through a third party such as a NAMAS accredited laboratory. There will be limited contact with organisations within the sector.

D Direct - Projects which enable direct contact with organisations in the sector through calibration services, consultancy or club membership. This weighting applies to sectors with high measurement or research needs.

B Both - Projects which provide both underpinning activities to the industry and services direct to organisations.

| **Length Programme Industry Impact Assessment** | Trapped ion optical frequency standards 1.1 | Absolute optical frequency metrology 1.2 | Optical frequency reference grid 1.3 | Gas - cell based frequency standards 1.4 | High stability Fabry-Perot cavity techniques for wavelength metrology 1.5 | Laser wavelength and interferometer calibration services 1.6 | National standard co-ordinate measuring machine 2.1 | Two-dimensional standards 2.2 | Large Scale Metrology 2.3 | Standard specifications 2.4 |
|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle manufacture | U | U | U | U | U | B | B | D | B | U |
| Vehicle Components Manufacture | U | U | U | U | U | B | B | D | B | U |
| Electricity, Gas & Water supply | | | | | | U | B | D | B | U |
| Engineering & architectural services | | | U | U | | U | D | D | B | U |

Example of industry impact assessment for Length programme projects

In this process it is important not to 'double count' for the effect of a project. If, for example, a calibration service impacts the manufacture of an instrument, the effect of the use of that instrument within other industry sectors can not also be counted unless the user sectors themselves have other interactions with the NMS programme directly either through traceability or technology transfer.

The timing of the impact is also collected. Some projects will have an immediate effect on industry, typically those with a high technology transfer content, and other will have to wait for the results of a research project before industry can benefit and this may be several years. This timing is used in the model to delay the start of the NPV calculation.

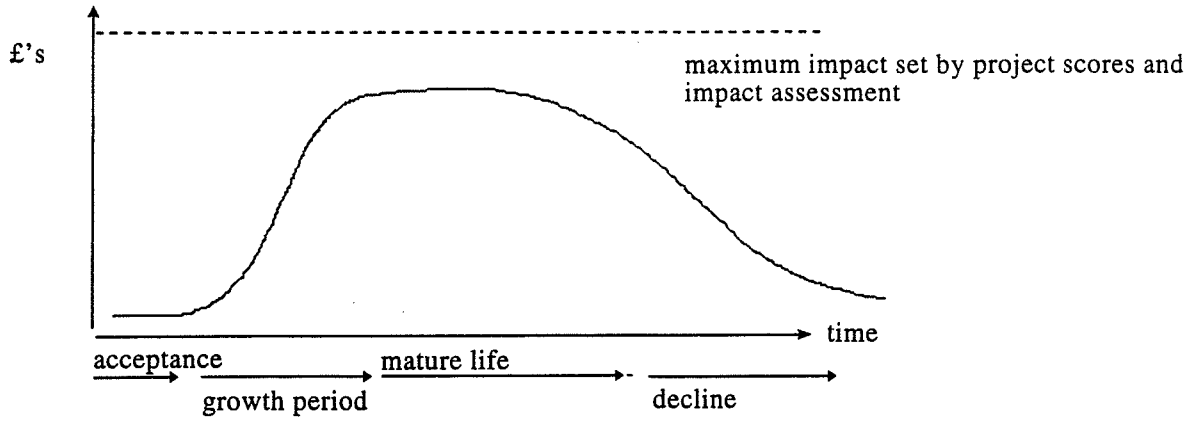
The majority of the analysis described above is conducted in close collaboration between the NMS programme contractors and programme formulators, overseen by a priority consultant to ensure uniformity of approach by all projects.

**Industry Data**

The priority setting model determines the NPV of the benefit associated with each of the project's activities upon different sectors. A standard list of measurement dependant sectors has been developed for this based on Standard Industrial Classifications but aligned more closely with the source economic data.

This NPV depends upon the following information about each industry:

- The total turnover size of the industry in the UK. This information is usually collected from the National Statistics Office (NSO) but in the case of some services additional sources of information are used.
- Projected growth figures for each industry over the next ten years. Forecasts and analysis based on full scale macroeconomic models are bought from Oxford Economic Forecasting (see OEF (1998)) which profile the sectors in incorporating normal economic fluctuations and even recessions.
- Impact profiles were generated to model competitive behaviour and product life cycles within sectors. These profiles reflect well-understood behaviours of products (going through phases of acceptance, growth, maturity and decline).



## Model Hypothesis

The model makes some assumptions of the interaction between the benefit gained from each mechanisms and the type of interaction that the NMS provider has with that sector. It is felt that projects that have direct impact upon sectors will give their benefit through mechanisms requiring direct interactions such as D and E. However the model assumes that benefits through mechanisms A, F & G will be best for sectors which projects have an underpinning impact upon. This relationship is modelled below:

| | Providing traceability to primary international standards<br>A | Generating exploitable new measurement technologies<br>B | Using leading-edge metrology to support advanced products<br>C | Providing an expert service to industry to diagnose and solve measurement-related problems<br>D | Providing leadership and dissemination through technology transfer<br>E | Representing UK interests on international bodies<br>F | Facilitating the compliance of existing regulation or legislation<br>G |
|---|---|---|---|---|---|---|---|
| Underpinning | ✓ | ½ | ½ | ✗ | ½ | ✓ | ✓ |
| Direct | ✗ | ½ | ✓ | ✓ | ✓ | ✗ | ✗ |
| Both | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Weight | 12% | 2% | 8% | 37% | 19% | 12% | 10% |

The scores for each mechanism are weighted within the model according to industry surveys.

Also it is considered that mechanisms A & B have an impact upon an industry regardless of whether the industry is in growth or decline. Therefore in the model the economic impact calculation from scores A and B is independent of the industry growth projection figures. Mechanisms C, D & E, however, are considered to accelerate industry growth and so the calculation of the benefit from these scores includes the projected growth figures.

## Modelling the NPV

The model uses the economic benefit associated with each project, the relative importance of the mechanisms dictated by the impact assessment and project scores to calculate the additional growth that each project can give. This additional growth factor is then projected onto the sector, taking into account delays in project impact, using the sector growth and turnover figures and taking into account the sector impact profile. The NPV of this growth is calculated.

To take into account the non-trivial differences in discounting across sectors and variations in innovation life cycles the model calculates an individual discount rate using the following non-linear equation for calculating the discounting process:

$$\delta^i = 1 - \left[ (50 / A^i) / 100 \right]^{1/(A^i - 0.5)}$$

This is a constant proportion or reducing balance discounting process. For each sector, i, a discount rate, $\delta^i$, is chosen to reduce the original impact to some small proportion of its value at a point half a year before the end of its assumed time frame, $A^i$. In the version of the equation used here this value is set to equal $50/A^i$ per cent at that point so that depreciation is as defined in equation above.

This formulation has the advantage that it can be adjusted by sector and/or programme and so can be customised by the user.

## Conclusion

The model has been used in various forms for the last three years helping the formulation process of over 16 programmes. The model has undergone a programme of continuous improvements and it is envisaged that work stemming from the NMS 10 year review will enable the benefit mechanisms and their calculations to be reviewed as these are now based upon research undertaken over 5 years ago.

As well as programme formulation, the model has also recently been used to review the portfolio of NMS programmes providing one axis of a risk vs benefit vs cost assessment.

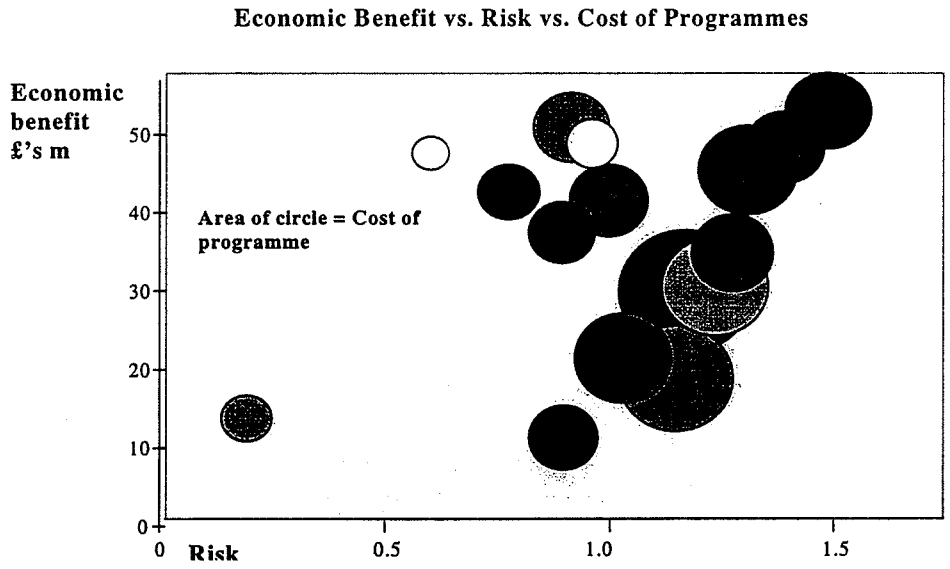



Figure 1:Anonymous example of NMS portfolio diagram

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