

**Report to the National
Measurement System
Policy Unit, Department
of Trade & Industry**

**TESTING SPREADSHEETS AND
OTHER PACKAGES USED IN
METROLOGY**

**REPORT ON DISCUSSIONS WITH
OTHER NATIONAL MEASUREMENT
INSTITUTES (1999/2000)**

**BY
M G COX and P M HARRIS**

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Testing Spreadsheets and Other Packages Used in Metrology: Report on Discussions with other National Measurement Institutes (1999/2000)

M G Cox and P M Harris

Centre for Mathematics and Scientific Computing

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ABSTRACT

The NMS Software Support for Metrology Programme (April 1998 to March 2001) is a UK government-supported programme designed to tackle a wide range of generic issues arising from the use of mathematics and software in measurement science. Project 2.1 of this programme is concerned with the *numerical correctness* of software used in metrology. An activity within the project is to enable discussion with other National Measurement Institutes concerning the project results, and to account for work undertaken by other National Measurement Institutes in this area. The purpose of this report is to inform those interested in the NMS Software Support for Metrology programme about such discussions and interactions. Three such reports are to be produced, one at the end of each year of the programme, and this report is the second of these covering the year 1999/2000.

This report constitutes part of the deliverable of Project 2.1 “Testing Spreadsheets and Other Packages Used in Metrology” within the UK Department of Industry’s National Measurement System *Software Support for Metrology* Programme 1998–2001.

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Authorised by Dr Dave Rayner,
Head of the Centre for Mathematics and Scientific Computing

National Physical Laboratory, Queens Road, Teddington, Middlesex, TW11 0LW

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1. Introduction

The NMS Software Support for Metrology Programme (April 1998 to March 2001) is a UK government-supported programme designed to tackle a wide range of generic issues arising from the use of software in measurement science. One of the issues addressed in the programme is the numerical correctness of software used in metrology: it is recognised that a poor software implementation can lead to inaccuracy that could have been avoided, and as a consequence the accuracy of measurement results is compromised. Spreadsheets are widely used in the day-to-day operation of many measurement and calibration laboratories, and yet the facilities they provide are usually taken on trust without any testing or validation.

Project 2.1 of the Software Support for Metrology (SSfM) programme is concerned with the use of spreadsheets and other software packages in metrology. The main project aims are to

- a) develop a methodology for qualifying metrology software using, for example, reference data sets and corresponding results,
- b) apply that methodology to the testing of functions provided by proprietary software packages identified as being widely used within metrology, and
- c) produce a best-practice guide on developing and testing spreadsheet applications.

An activity within the project is to enable discussion with other National Measurement Institutes (NMIs) concerning these project aims, and to account for work undertaken by other NMIs in this area. The purpose of this report is to inform those interested in the NMS SSfM programme about such discussions and interactions. Three such reports are to be produced, one at the end of each year of the programme, and this report is the second of these covering the year 1999/2000.

In the first year of the project (1998/1999) activity concentrated on establishing appropriate contacts at a number of (key) NMIs, understanding the extent to which spreadsheets and other software packages are used by NMIs in metrology, and identifying existing work undertaken by NMIs in the area of testing spreadsheets and other software packages used in metrology. These objectives were achieved through the survey reports [1, 2], and the results of these surveys are given in the first year report [3].

In the second year (1999/2000) activity has concentrated on making the outputs and deliverables from the project available to NMIs, and more widely to International Associate members of the SSfM Club, and to seek their feedback: this activity is described in Section 2 of this report. In addition, an updated version [4] of the survey report [2] was produced during the year, and the conclusions of this report relating to the testing and validation theme of the SSfM programme are summarised in Section 2. Section 3 indicates planned activity for the final year of the project.

2. Activity for the Year 1999/2000

2.1 *Visit to National Institute of Standards and Technology (NIST)*

The paper [5] was presented at the Workshop on Software-Embedded Systems Testing (WSEST) held at NIST, 8-9 November 1999. The paper describes NPL's work within the SSfM programme in the areas of validation and testing of software in measurement systems, including validation of embedded software in scientific instruments, guidance on measurement system validation and testing of software packages such as spreadsheets.

Some valuable contacts were made with staff at NIST, notably with those involved in providing reference data sets with certified computational results that enable the objective evaluation of

- a) statistical software (NIST's StRD project), and
- b) software used in dimensional metrology.

In addition, NIST staff provided information about related work in the area of software testing, notably that described in [6, 7, 8] and contact with the author B.M. McCullough from the Federal Communications Commission (FCC) of this work has since been established.

It will be important to continue interactions with NIST in this area because although there are some differences in the approaches to software testing taken by NPL and NIST, there is also substantial synergy in the work undertaken by the two organisations. Furthermore, NIST would appear to be the only major NMI, apart from NPL, that is active in the area of software testing (see Section 2.4).

2.2 *Contacts with International Associate Members of SSfM Club*

During the second year of the project a number of deliverables have been completed describing

- a) a methodology for testing software used in metrology [9], including the design of reference data sets and corresponding reference results,
- b) a case study showing the application of the methodology to testing software used in metrology [10], and
- c) the results of applying the methodology to testing functions taken from the Microsoft Excel spreadsheet package [11].

These have been provided to International Associate Members of the SSfM Club at the organisations listed below, and their feedback concerning the deliverables requested:

- Instituto Nacional de Tecnología Industrial (INTI), Argentina
- Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
- EGP, Brazil
- Danish Institute of Fundamental Metrology (DFM), Denmark
- Bureau International des Poids et Mesures (BIPM), France
- Bureau National de Métrologie – Institut National de Métrologie (BNM-INM), France
- Physikalisch-Technische Bundesanstalt (PTB), Germany
- Hellenic Institute of Metrology (EIM), Greece
- National Metrology Laboratory (NML), Irish Republic
- National Standards Authority of Ireland, Irish Republic
- Istituto di Metrologia "G. Colonnetti" (IMGC), Italy
- National Research Laboratory of Metrology (NRLM), Japan
- Nederlands Meetinstituut (NMI) Van Swinden Laboratory, Netherlands
- National Physical and Standards Laboratory, Pakistan
- Instituto Portugues da Qualidade, Portugal
- State Research Centre of Russia, Russia
- CSIR Elektropribor, USSR
- Singapore Product and Standards Board, Singapore

- Standards and Metrology Institute of Slovenia (SMIS), Slovenia
- National Metrology Laboratory, South Africa
- South African Bureau of Standards (SABS), South Africa
- Centro Espanol de Metrologia (CEM), Spain
- Laboratorio de Metrologia, Spain
- CERN, Switzerland
- OFMET, Switzerland
- Industrial Technology Research Institute (ITRI), Taiwan
- National Institute of Standards and Technology (NIST), USA
- Federal Communications Commission (FCC), USA

Thus far, the only response received has been from Centro Espanol de Metrologia (CEM), Spain that conveys support for the work and asks whether the work is to be extended to versions of the Microsoft Excel spreadsheet other than the version tested in [11]. Feedback from other NMIs and International Associates of the SSfM Club will be encouraged during the final year of the project.

2.3 *Miscellaneous international contacts*

The following organisations have requested copies of the deliverables [9, 10, 11]:

- Advanced and Applied Research Lab of the Inkjet Business Unit of Hewlett Packard
- National Park Service, USA

These contacts are to be followed-up during the final year of the project.

2.4 *Software Status Report*

The purpose of the status report [4] was to describe the status of SSfM related activity world-wide, and to survey international concerns in SSfM related issues. It covers all the themes and projects addressed by the SSfM programme: we are concerned here with the conclusions of the report relating to the testing and validation theme of the programme, and these are reproduced below:

1. There is surprisingly little emphasis outside the UK on testing for numerical correctness the software that metrologists use on a day-to-day basis. Exceptionally, NIST provides reference data sets for testing some of the software used by metrologists (see section 2.1). The effort does not yet appear to be strongly integrated with metrologists' needs and with fitness for purpose. NML Australia is starting to review software usage within metrology. There will be greater pressures in the future for such activity as organisations strive for certification to ISO 9001.
2. There is an awareness that some of the software packages used by NMIs are deficient and therefore require care in their use (superficially-simple functions such as standard deviation and the inverse t -distribution are highlighted).
3. Advice is generally lacking from software suppliers on the quality of their products. This fact raises difficulties in the context of quality systems used at the NMIs.

3. Future Activity

The paper [12] has been accepted for presentation at the Euroconference on Advanced Mathematical and Computational Tools in Metrology to be held at the Instituto Portugues da Qualidade (IPQ), Portugal, 10–13 May 2000. This is expected to have a good attendance from representatives of European NMIs (NPL, PTB, IMGC, IPQ, VNIIM) as well as other European organisations, and will complement the visit to NIST undertaken during the second year of the project.

In addition, further deliverables from the project will be completed, including

- a) the results of testing functions from software packages other than the Microsoft Excel spreadsheet,
- b) a best-practice guide on developing and testing spreadsheet applications, and
- c) guidelines to help users select software for their application domains.

These will be provided to NMIs, and more widely to the International Associates of the SSfM club, for their comment.

Although to date feedback from NMIs to the deliverables produced by the project has been disappointing, we expect in the near future a greater awareness across the NMIs of the need for testing for numerical accuracy of software in the context of “fitness for purpose”. In the area of uncertainty evaluation, covered by Project 1.2 of the SSfM programme, the publication of the Mutual Recognition Arrangement [13] has encouraged substantial debate among NMIs concerning sound statistical approaches to analysing the data from key comparisons and, in particular, lead to EUROMET INTMET project 504 “Statistical Analysis of Interlaboratory Comparisons”. As yet there has been no comparable “trigger” in the area of software testing, although quality standards such as ISO 9001 can be expected to make their presence increasingly felt. When this occurs NPL, through its SSfM programmes, and NIST will be in a strong position to influence the response of NMIs to this trigger and will benefit accordingly.

4. Acknowledgements

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