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WP1 - Systematic exchange of information and best practices

T1.4 - Study of Metrology Knowledge Transfer in the European Research Area

Deliverable D1.4 National KT activities workshop
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SP (SE) as task leader and NPL (GB), plus input from all partners

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Short description of work:

T 1.4 Knowledge transfer (KT) activities (SP Sweden, NPL + input from all partners)

Recognising the importance of knowledge transfer activities, a task group in iMERA has advised on KT aspects relevant to the project. A wide variety of knowledge transfer mechanisms have evolved to different degrees in participating countries such as direct research collaboration with industry, collaborations with regulatory agencies, universities etc, "metrology clubs" - interest groups around specific topics, best practice guides, scientific publications and participation in documentary standards activities. The various national approaches to transferring the knowledge generated by the metrological R&D activities have been surveyed. A workshop has identified opportunities for the practitioners to improve national KT activities. Recommendations on KT as an essential component in the European Metrology Research Programme are given.

REPORT STATUS : PU (Public)



Structuring the European Research Area

SUPPORT FOR THE COORDINATION OF ACTIVITIES

The partners wish to acknowledge and thank the European Commission for supporting this project as an ERA-NET Coordinating Action under “Coordination of Research Activities” of the 6th Framework Specific Programme “Integrating and Strengthening the European Research Area”.

Explanation of Report status (one of the following):

PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

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EXECUTIVE SUMMARY

Measurement knowledge transfer is a key factor in metrology's impact on modern society since better measurement is an essential component in promoting innovation, growth and welfare. KT is considered an essential element in a European Metrology Research Programme since new measurement knowledge, created in research, needs to be transferred to be useful. Recognising the importance of metrology knowledge transfer (KT) activities, a European task group lead by SP, assisted by NPL (UK) and other iMERA partners, is part of the EU ERA-NET project iMERA – Implementing a Metrology Research Area <http://www.euromet.org/projects/imer/>, and has been advising on KT aspects relevant to the project.

Metrology KT is a two-way information exchange between national metrology institutes (NMIs) and metrology stakeholders (universities, practitioners, industry, regulators). A wide variety of knowledge transfer mechanisms have evolved to different degrees in participating countries such as direct research collaboration with industry, collaborations with regulatory agencies, universities etc, “metrology clubs” - interest groups around specific topics, best practice guides, scientific publications and participation in documentary standards activities.

A European survey conducted during 2005 in iMERA of the various national approaches to transferring the knowledge generated by metrological R&D activities gave some indication of the expectations and experiences of metrology KT of European stakeholders, particularly, which are the best ways of learning about measurement and which measurement subject is most interesting. In the iMERA KT survey of 2005, no great differences overall were found amongst the various metrology knowledge transfer **mechanisms** in the benefit as perceived by stakeholders. Nevertheless, university training in metrology is ranked lower than say NMI research collaboration in terms of benefit of these mechanisms of metrology KT. Similarly, there are no great differences overall amongst the various **subjects** of metrology in the need as perceived by stakeholders. Nevertheless, metrology training in the emerging technologies (such as bio, nano, etc) and in societal needs are ranked lower than say training in measurement uncertainty and quality assurance. The overall low ranking of an emerging technology is to be expected and is in line with investigations of the overall awareness of European citizens in emerging technologies such as nanotechnology, which are also typically more of a research issue than an industrial concern at the early stages of development. The survey also investigated the rating of the various metrology KT mechanisms and subjects by stakeholders compared with NMIs. In most cases, stakeholders appeared to give higher ratings than NMIs, that is, NMIs have a tendency to underestimate the value of metrology KT.

At a one-day workshop, held in Berlin on 1st December 2005, coordinated by the iMERA T1.4 KT team, presentations were made not only of the survey results but also four case studies – two NMIs and two stakeholder organisations – of metrology KT. In workshop break-out discussions, the nature of and suggested plans for metrology KT as part of the projected European Metrology Research Programme were formulated.

For the future, the aim is to improve the effectiveness of metrology KT as a means of improving knowledge level of metrology in the European Union and elsewhere. Metrology KT covers a wide range of measurement needs/subjects as well a broad spectrum of KT mechanisms. This calls for a **specific, proactive coordinated action** of metrology KT in Europe, over and above the usual knowledge transfer attached to any project. A number of recommended actions to this end are given in the conclusion.

1 Introduction

Reliable measurement results are important in almost every aspect of our daily life, ranging from fundamental science, through health and safety to global trade.

It is therefore not surprising that one of the more essential ingredients in improving trade, innovation, growth and well-being is efficient **transfer of measurement knowledge**. This is in line with the more general observation made by the European Commission in its so-called ‘Lisbon’ strategy, which emphasises the role not only of research but also education (and innovation) in encouraging growth and employment [figure 1].

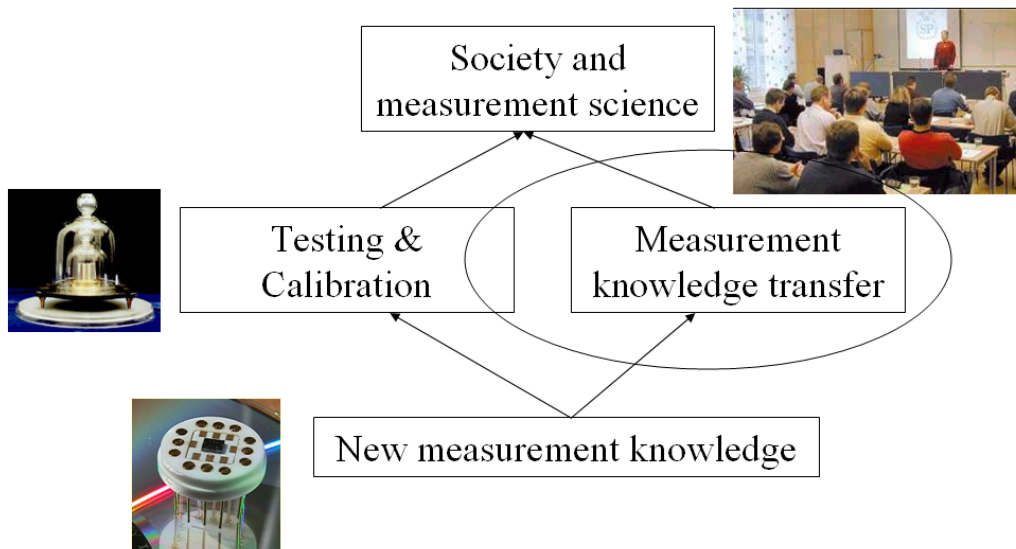


Figure 1 The European Commission 'Lisbon' Strategy emphasising the role of education*

The ERA-NET iMERA project has several tasks addressing stakeholder interaction and knowledge transfer (KT). This gives some opportunity of spreading awareness and obtaining feedback, and encouraging active participation, from various societal groups not immediately in the measurement research sphere. The task has included two surveys and a European workshop during 2005 which identified opportunities for practitioners to improve national KT activities [iMERA T1.4].

* <http://europa.eu.int/growthandjobs/>

Critical success factors for innovation & trade:



Pendrill & Schmidt 2005

Figure 2 Critical success factors for innovation & trade performance

Alongside improving testing and calibration methods, new measurement knowledge created in metrological research can also be exchanged with stakeholders as a key action in enhancing measurement-related trade and innovation are shown in [figure 2](#). Such critical success factors as new knowledge creation and good knowledge transfer are internationally recognised as essential in enhancing trade and innovation [[DTI 2003](#)].

What are the best mechanisms of transferring and what aspects of metrological knowledge are most needed? What would a European metrology KT programme achieve which has significant added value to a mere collection of national programmes? How should metrology KT be part of the future European Metrology Research Programme? Answers to these questions, as studied in surveys and workshops of the present iMERA T1.4 KT task, are given in the following chapters.

2 Survey of Metrology Knowledge Transfer in the European Research Area

Various *national approaches* to transferring the knowledge generated by metrological R&D activities have been surveyed in the European Research Area.

2.1 Survey structure

The basic structure of the survey was established through two principal dimensions of any pedagogical activity: *how* to transfer knowledge and *which* knowledge is to be transferred. The aim of the survey is thus to find the preferred way of transferring the most sought-after knowledge.

There are many different **ways** of transferring knowledge including: direct research collaboration with national metrology institute (NMI); 'Metrology clubs'; measurement guides/books; measurement training provided by national metrology institute (NMI); measurement training provided by university/institute; measurement training by commercial course provider; measurement conferences/workshops/summer schools etc.

Other metrology KT mechanisms considered by survey respondents to be beneficial were:

- Interlaboratory comparisons (ILC, KC, PT,...)
- Customer contacts
- Standardisation
- On job experience
- Spin-off companies

Measurement is a wide discipline and national metrology institutes are active in knowledge transfer over a considerable range of **subjects**, such as:

- MEASUREMENT QUALITY, including Measurement & quality assurance; Measurement & societal needs; Legal and regulatory metrology; Decision-making and conformity assessment
- MEASUREMENT OF QUANTITIES, including How to measure a specific quantity (mass, length, electricity etc); Measurement uncertainty; Measurement traceability
- MEASUREMENT BY APPLICATION, including Measurement in Emerging Technologies (e.g. nano, bio etc); Measurement in research & science; Measurement & testing; How to measure for a specific application (process control, industrial production, energy, pharmaceuticals, etc)
- MEASUREMENT SYSTEMS, including Measurement & software/IT; Instruments and sensors

§2 How?

§3 What?

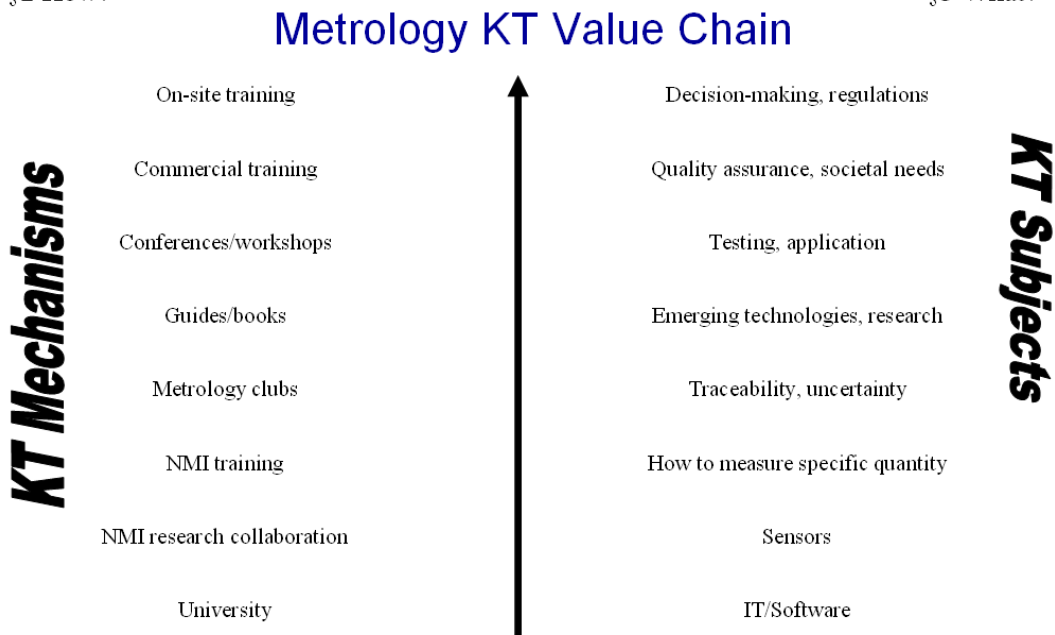


Figure 3 Value chain for metrology knowledge transfer

Both the different mechanisms and the various measurement subjects can be ordered in a value chain, where one direction [figure 3] of knowledge transfer can be from enabling science & technology – such as the development of advanced sensors at universities – towards application of measurement knowledge on-site at a factory when making decisions about product conformity for instance. From the point of view of the receiver of measurement knowledge – in this example, on the workshop floor or in society – the value of metrology knowledge transfer increases, the ‘closer’ the new knowledge is transferred to him. Of course, KT is normally a two-way process.

2.2 Stakeholder survey

2.2.1 Respondents

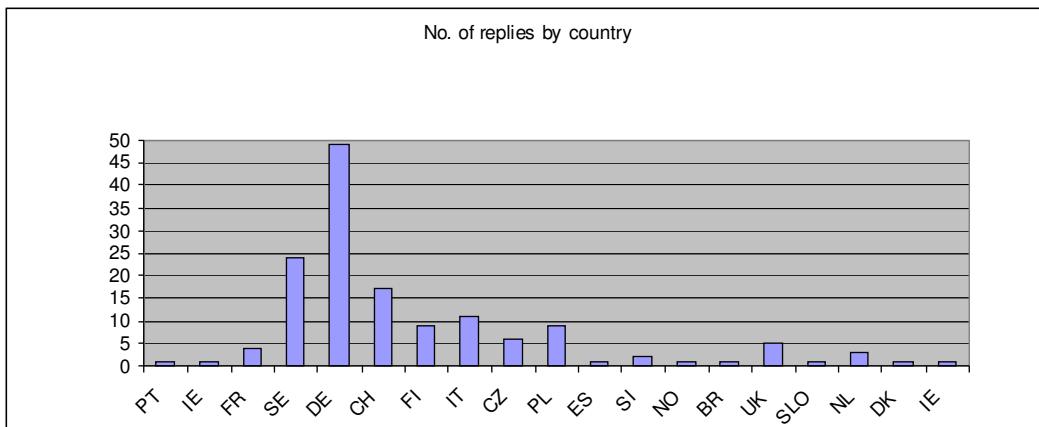


Figure 4 Responses (absolute number of replies, $n = 155$ in total) to survey by country

Principally the partner countries of the ERA-NET project iMERA were targeted in these surveys. It was left up to the national metrology institute (NMI) of each country to itself decide how best and to whom to distribute the survey. As a result, the response frequency varied appreciably amongst the different countries, as evident from [figure 4](#).

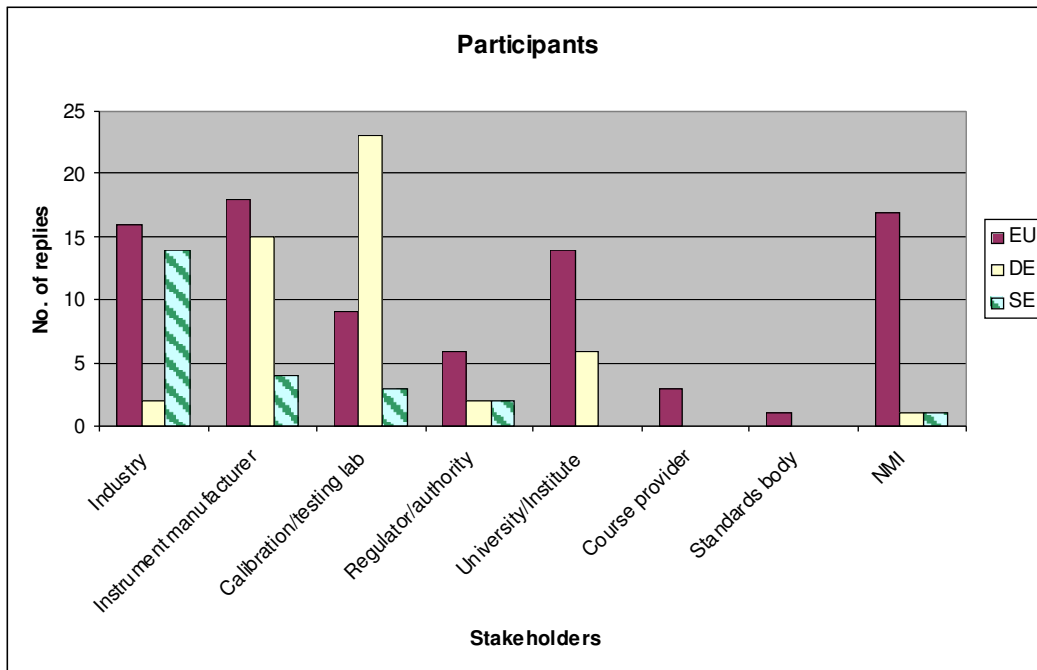


Figure 5 Responses (absolute number of replies) to survey by **stakeholder**[†]

Even the response frequency from different categories of stakeholder [figure 5] varied from country to country, again in part depending on each NMI's individual decision about which categories of stakeholder were to be surveyed. Germany for instance targeted mostly secondary (accredited DKD) calibration laboratories:

Universities:	11
Extra-University Research Labs:	71
Stakeholder associations:	4
accredited DKD [http://www.dkd.info/en/_index.htm] labs:	372

while Sweden surveyed mostly other kinds of industrial stakeholder. This should be borne in mind, since there will probably be a considerable sample bias for the survey work.

To the survey which asked for an estimation of annual expenditure on traceable measurement related activities in the respondent's organisation, typical responses were of the order of 30 k€ but with a span of 1 k€ to 40 M€, depending of course on the type of organisation.

2.3 Benefits of different mechanisms of metrology knowledge transfer

One main question to stakeholders [Annex A] was to rank the benefit of the various mechanisms for knowledge transfer. The corresponding question to NMIs [Annex B] was their own judgment of the efficacy of the different KT mechanisms. In each case, a choice of three levels of benefit – little, moderate or much – was available as well as a 'no experience' option.

2.3.1 Relative and absolute benefit scores for different KT mechanisms

[†] 'EU' denotes responses from other countries (mostly EU) but excluding Germany (DE) and Sweden (SE)

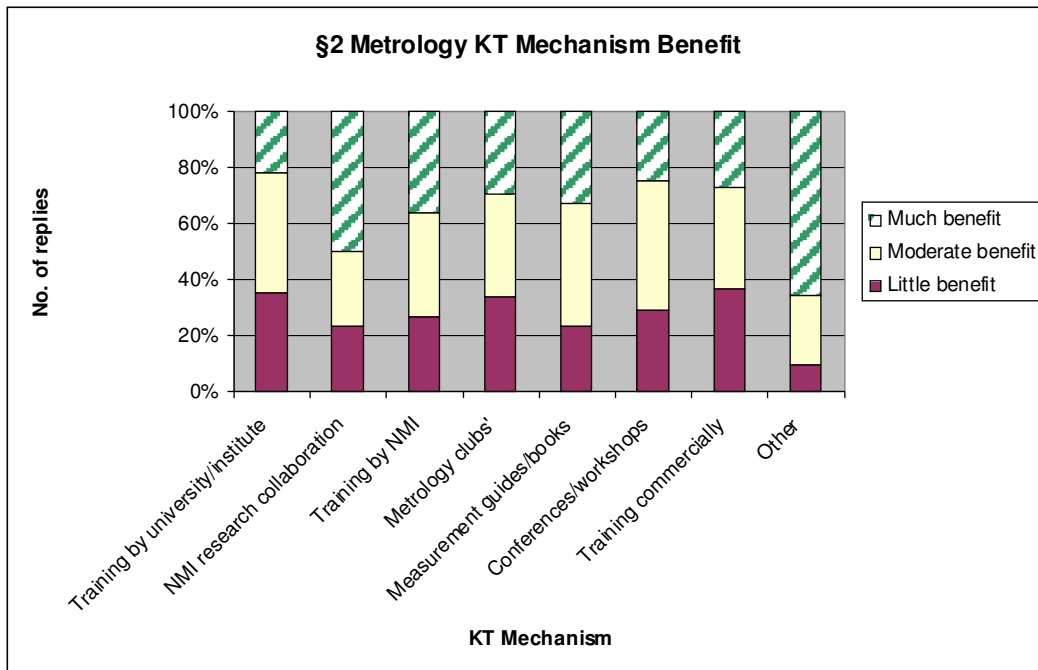


Figure 6(a) Ranking (relative) benefit of different **KT mechanisms**

To obtain absolute rankings, the number of responses, x_i , in each level i :

$$x_0 = \text{little}; x_1 = \text{moderate}; x_2 = \text{much}$$

is weighted with a factor w_i , in the sum of scores of benefit for each mechanism:

$$Score = \frac{\sum_i x_i \cdot w_i}{\sum_i x_i} \tag{1}$$

So as to be able to judge the statistical significance of eventual differences between the different scores, a 95% confidence interval $CI_{95\%}$ in each score is calculated with the following expression based on the standard deviation, s , of the score:

$$CI_{95\%} = Score \pm 2 \sqrt{\frac{s}{\sum_i x_i}}; s = \sqrt{\frac{\sum_i x_i \cdot \sum_i (w_i - Score)^2}{\sum_i x_i - 1}} \tag{2}$$

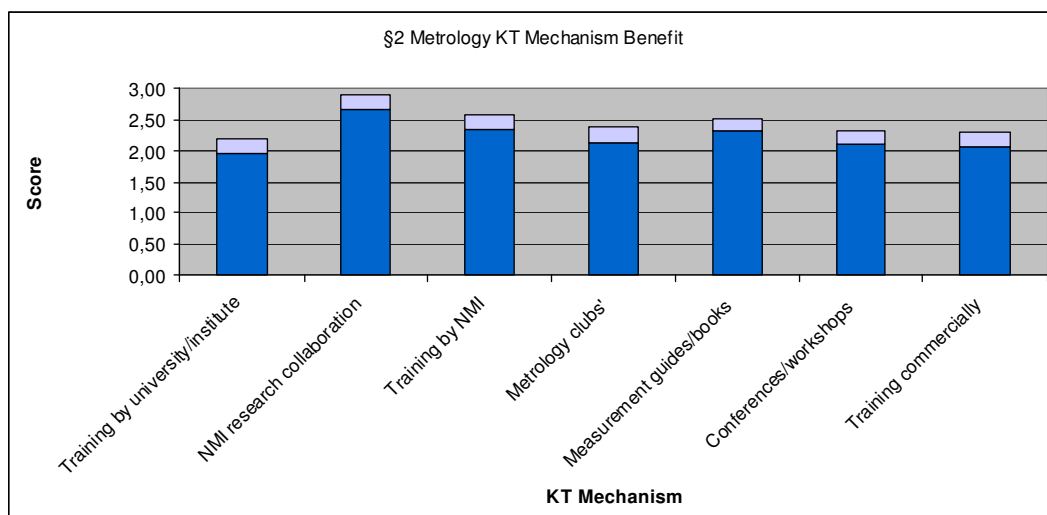


Figure 6(b) Ranking (absolute[‡]) by stakeholders of the benefit of different **KT mechanisms**

As may be seen in [figure \[6\(b\)\]](#), there are no great differences overall amongst the various mechanisms in the benefit as perceived by stakeholders. Nevertheless, university training in metrology is ranked significantly lower than say NMI research collaboration in terms of benefit of these mechanisms of metrology KT, since the respective scores, including quoted confidence intervals clearly do not overlap.

2.3.2 Different stakeholders appreciation of a metrology KT mechanism

Taking one particular KT mechanism – university training – and examining the relative benefit indicated by different categories of stakeholder [[figure 7](#)], it is evident for example that NMIs and universities themselves appreciate university training more than most industrial stakeholders who have little experience of such training.

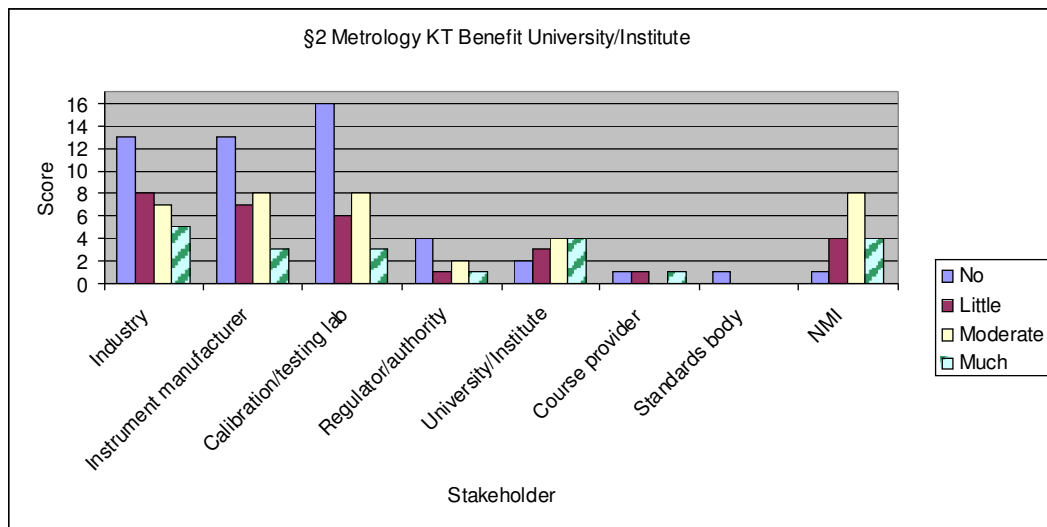


Figure 7 Ranking (absolute) by different categories of stakeholder of the benefit of university training

2.3.3 Eventual correlation between stakeholders and NMIs perceived benefit of different KT mechanisms

[‡] as scores and associated 95%-confidence intervals calculated with equations (1) and (2), where $w_1 = 1$; $w_2 = 2$ and $w_3 = 4$

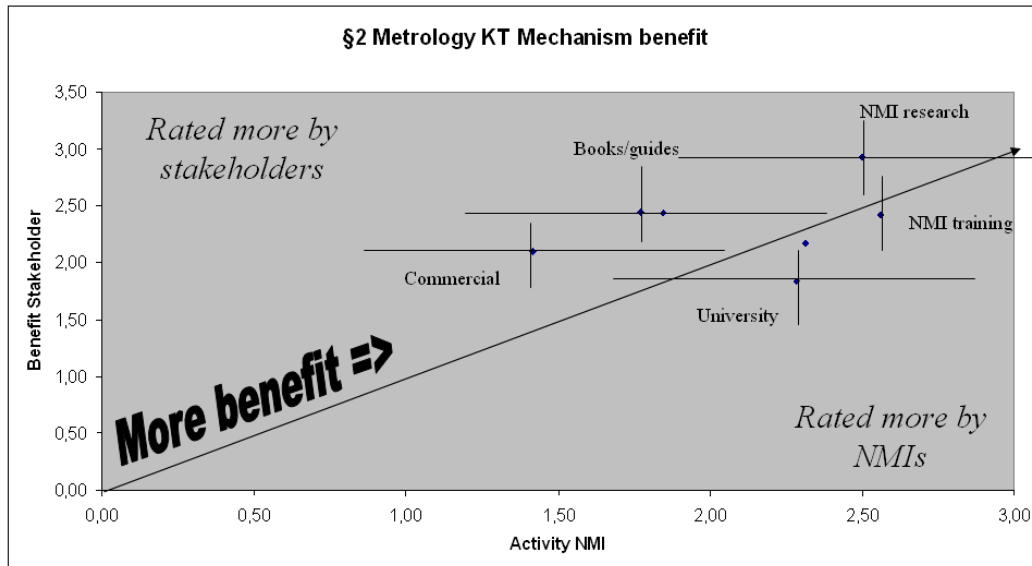


Figure 8 Ranking (absolute) by stakeholders and NMIs of the benefit of different **KT mechanisms**[§])

A plot of absolute scores [figure 8] of the benefit of different KT mechanisms as rated by stakeholders against corresponding scores of NMIs, who are one of the main providers of such KT, can reveal the extent of correlation between them. If perfectly correlated, that is, where provider's ambitions and recipient's benefit of the KT match exactly, then all point would lie on a straight line through zero and with a slope of +1. Points lying above this line would indicate a higher rating amongst stakeholders than amongst NMIs, while points lying below this line indicate a lower rating amongst stakeholders than amongst NMIs for a particular KT mechanism.

As is evident from figure 8, university metrology training is rated somewhat higher by NMIs than stakeholders, while commercial training, books/guides and NMI research are rated higher by stakeholders than NMIs. Confidence intervals at the 95%-level in the score, as given by equations (1) and (2), are also shown on this plot to aid judgment of the significance of these observations. For clarity, confidence intervals are shown only on some of the points in figure 8, but these intervals are of similar size for the remaining points.

NMIs were also asked to estimate the level of activity (in terms of FTE – full time equivalent) with respect to each KT mechanism. Of those NMIs who gave estimates, typical levels lay about 0.2 FTE/year per KT mechanism, with a wide range between 0.1 FTE and 20 FTE.

[§] as scores and associated 95%-confidence intervals calculated with equations (1) and (2), where $w_1 = 1$; $w_2 = 2$ and $w_3 = 4$

2.4 Demand for different measurement subjects

A second main question to stakeholders [Annex A] was to rank the need of the various measurement subjects for knowledge transfer. The corresponding question to NMIs [Annex B] was their own judgment of the need of the different measurement subjects. In each case, a choice of three levels of benefit – little, moderate or much – was available as well as a ‘no experience’ option.

2.4.1 Relative and absolute benefit scores for different measurement subjects

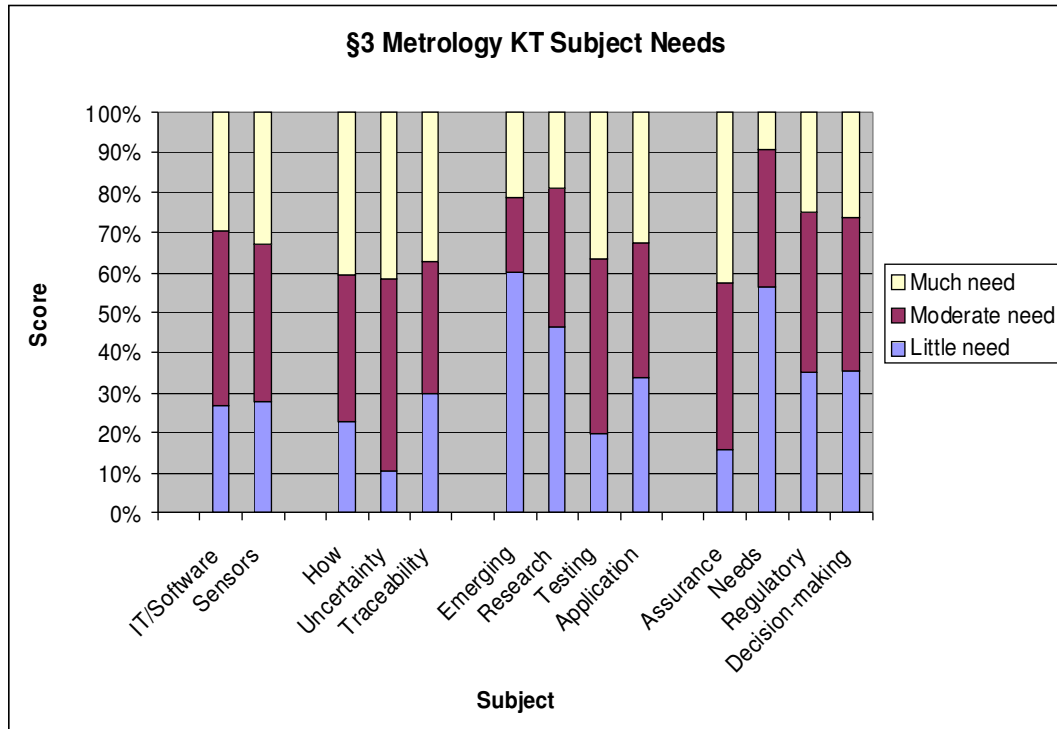


Figure 9(a) Ranking (relative) need of different **measurement subjects**

To obtain absolute rankings, the number of responses, x_i , in each level i :

$$x_0 = \text{little}; x_1 = \text{moderate}; x_2 = \text{much}$$

is weighted with a factor w_i , in the sum of scores of need for each subject:

$$\text{Score} = \frac{\sum_i x_i \cdot w_i}{\sum_i x_i} \quad (1)$$

So as to be able to judge the statistical significance of eventual differences between the different scores, a 95% confidence interval $CI_{95\%}$ in each score is calculated with the following expression based on the standard deviation, s , of the score:

$$CI_{95\%} = \text{Score} \pm 2 \sqrt{\frac{s}{\sum_i x_i}}; s = \sqrt{\frac{\sum_i x_i \cdot \sum_i (w_i - \text{Score})^2}{\sum_i x_i - 1}} \quad (2)$$

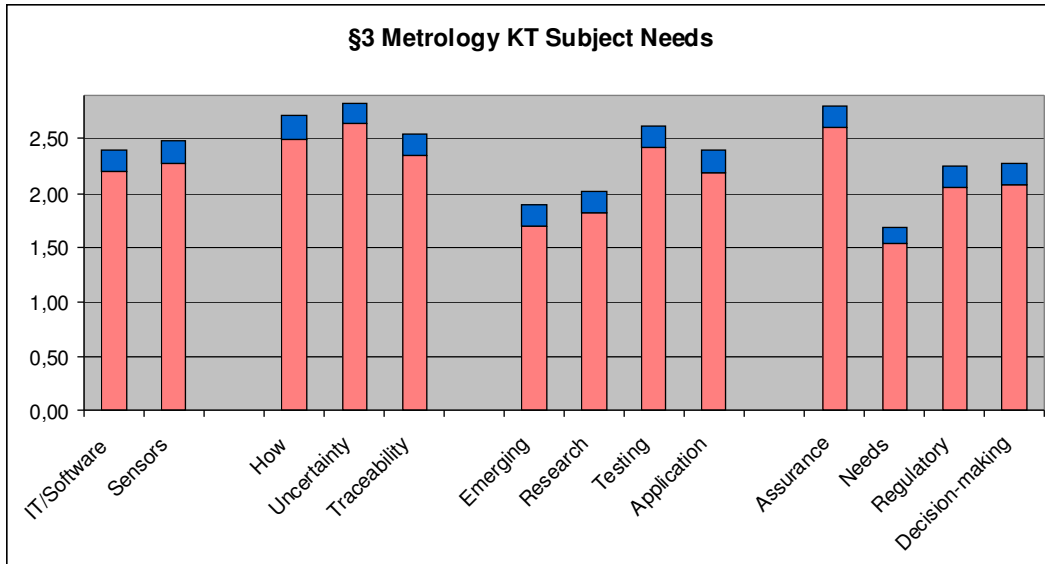


Figure 9(b) Ranking (absolute**) by stakeholders of the benefit of different **measurement subjects**

As may be seen in [figure \[9\(b\)\]](#), there are no great differences overall amongst the various subjects in the need as perceived by stakeholders. Nevertheless, metrology training in the emerging technologies (such as bio, nano, etc) and in societal needs are ranked significantly lower than say training in measurement uncertainty and quality assurance, since the respective scores, including quoted confidence intervals clearly do not overlap.

2.4.2 Different stakeholders needs of a metrology KT in emerging technologies

Taking one particular KT metrology subject need – training in the emerging technologies (such as bio, nano, etc) –, which had one of the lowest rankings in this survey in terms of perceived need [[§2.4.1](#)], and examining the relative needs indicated by different categories of stakeholder [[figure 10](#)], it is evident for example that calibration laboratories appreciate the subject more than most industrial stakeholders. The overall low ranking is to be expected of an emerging technology and is in line with investigations of the overall awareness of European citizens in emerging technologies such as nanotechnology, where according to a recent study [[EUROBAROMETER 2005](#)] only about 9% had an interest in these – although admittedly interest had doubled since 2001. Emerging technologies such as nanotechnology are typically more of a research issue than an industrial concern at the early stages of development, and perhaps calibration laboratories are arguably more research-oriented than industry.

** as scores and associated 95%-confidence intervals calculated with equations (1) and (2), where $w_1 = 1$; $w_2 = 2$ and $w_3 = 4$

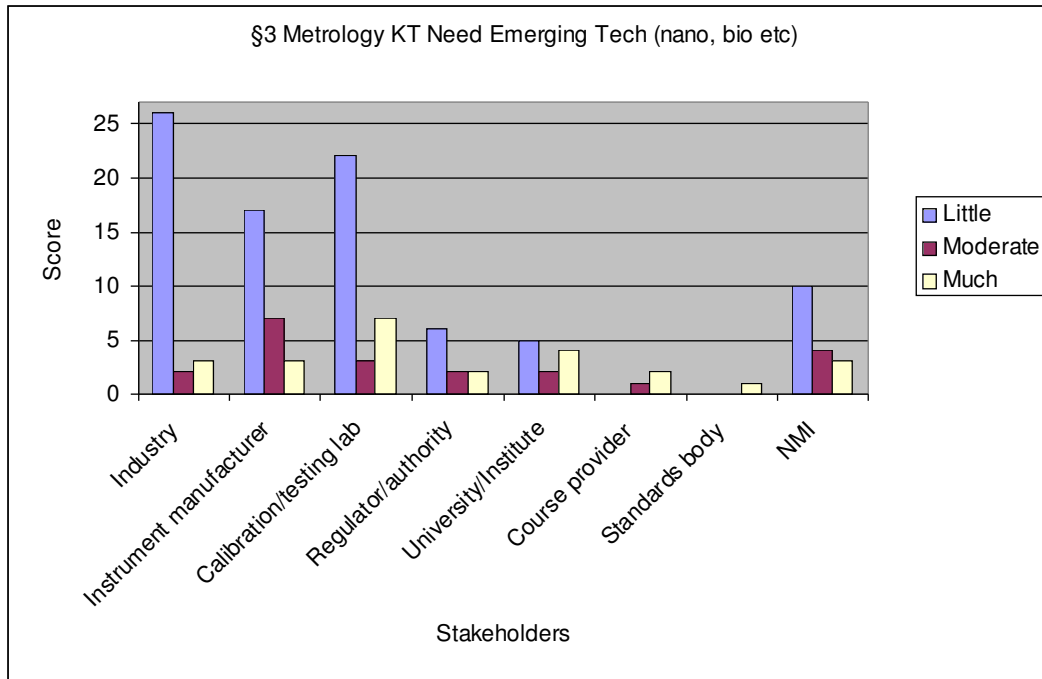


Figure 10 Ranking (absolute) by different categories of stakeholder of the need of metrology KT in the emerging technologies (such as bio, nano, etc) as scores per need level

2.4.3 Eventual correlation between stakeholders and NMIs perceived need of different metrology KT subjects

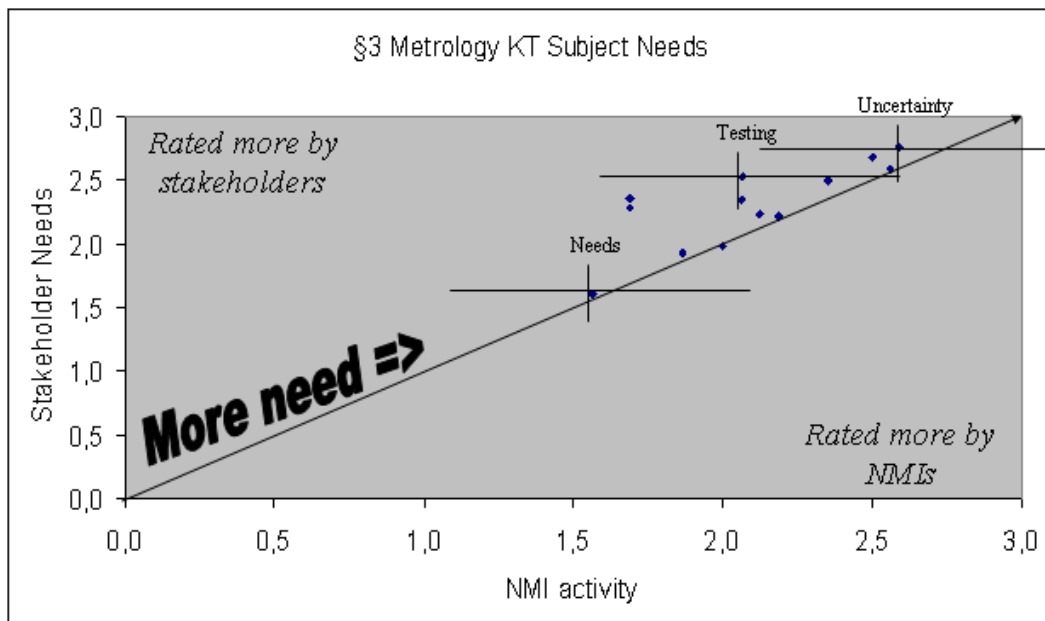


Figure 11 Ranking (absolute^{††}) by stakeholders and NMIs of the need of different metrology KT subjects

A plot of absolute scores [figure 11] of the needs of different metrology KT subjects as rated by stakeholders against corresponding scores of NMIs, who are one of the main providers of such KT, can reveal the extent of correlation between them. If perfectly correlated, that is, where provider’s ambitions and recipient’s needs of the KT

^{††} as scores and associated 95%-confidence intervals calculated with equations (1) and (2), where $w_1 = 1$; $w_2 = 2$ and $w_3 = 4$

match exactly, then all points would lie on a straight line through zero and with a slope of +1. Points lying above this line would indicate a higher rating amongst stakeholders than amongst NMIs, while points lying below this line indicate a lower rating amongst stakeholders than amongst NMIs for a particular metrology KT subject.

As is evident from [figure 11](#), there is a good correlation between stakeholders and NMIs in their perceived needs of metrology training in the different subjects. There is a slight trend that stakeholders give higher ranking than NMIs for each subject – for instance for a subject such as measurement and testing. Confidence intervals at the 95%-level in the score, as given by equations (1) and (2), are also shown on this plot to aid judgment of the significance of these observations. For clarity, confidence intervals are shown only on some of the points in figure 11, but these intervals are of similar size for the remaining points.

NMIs were also asked to estimate the level of activity (in terms of FTE – full time equivalent) with respect to each KT subject. Of those NMIs who gave estimates, typical levels lay about 0.1 FTE/year per KT subject, with a wide range between 0.05 FTE and 3 FTE.

3 Assessing the Quality and Impact of European Metrology Knowledge Transfer

In the present iMERA KT surveys [§2], the benefit of various KT mechanisms and the perceived need of different measurement subjects were ranked on a qualitative scale – little, moderate or much – together with a ‘no experience’ option.

Other measures, perhaps more quantitative, of the quality and impact of KT can of course be used.

In another task [1.5] of the [iMERA](#) project, studies are being made of the impact of national metrology research programmes in the project group. In addition to impact measures in economic terms, metrics such as of scientific impact (publications, exams, new methods); dissemination of knowledge (courses, lectures, conferences); and international co-operation (EU-projects, [EUROMET](#) participation etc) are also covered.

Another recent example of different measures of metrology KT is from a survey of the Impact of the UK National Measurement System (NMS) [[DATABUILD 2006](#)], where impact is given in financial terms, both for measurement businesses as well as measurement users where the NMS was considered to have been essential or helpful. Other questions in the Databuild survey asked respondents to identify the main driver to measurement-related changes in their business. The extent to which say, technology push or market pull are met through better measurement could also be a measure of impact.

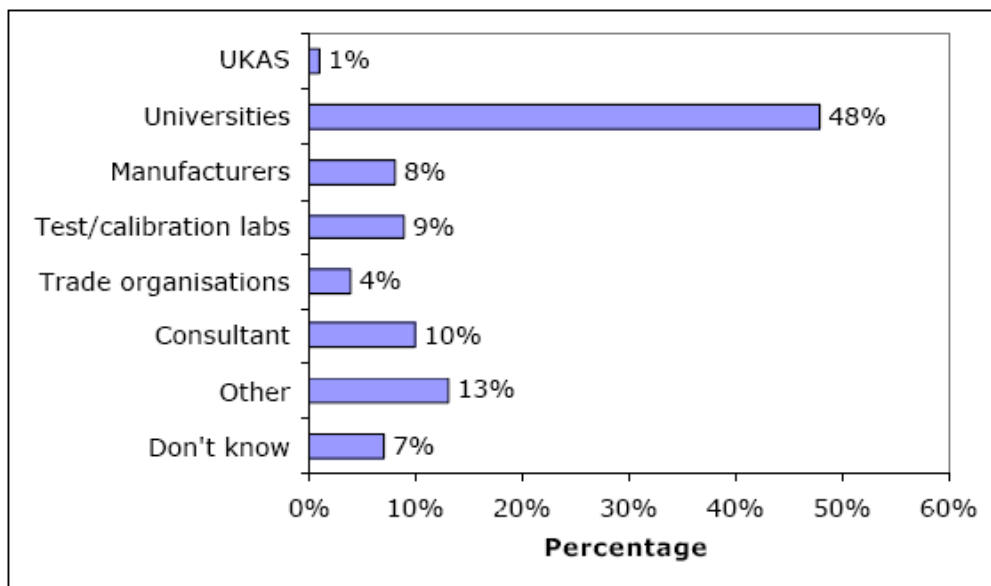


Figure 22: Have you used any other providers of knowledge about measurement? [[DATABUILD 2006](#)]

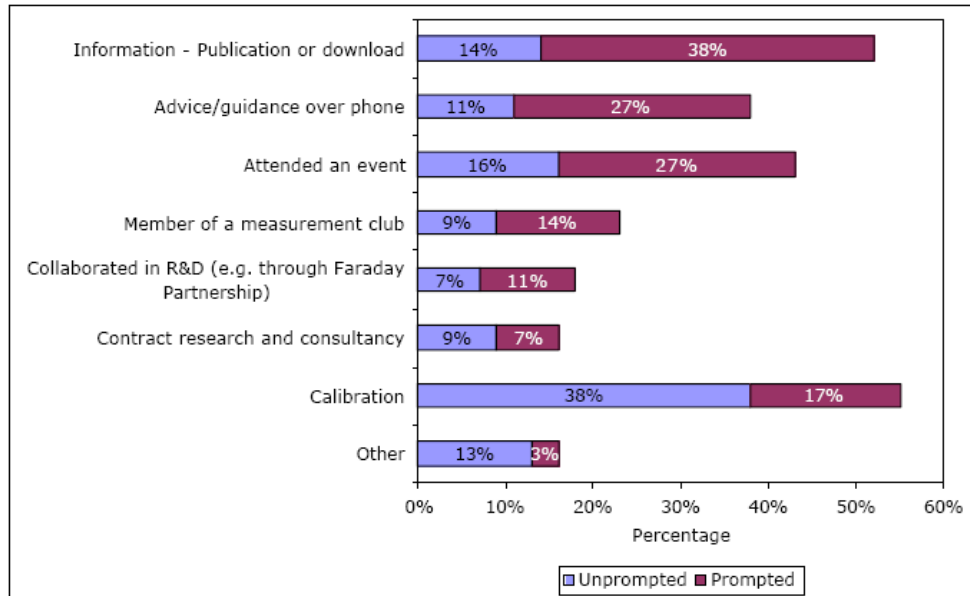


Figure 23: Recorded users: unprompted and prompted use of NMS services [DATABUILD 2006]

The Databuild survey included a study of use of the NMS both in terms of the various NMS services (information – publication or download; measurement club, contract research etc) as well as use of other providers of knowledge about measurement. These results [DATABUILD 2006, figures 22 and 23] can be compared with the iMERA results on KT mechanisms of the present survey, as discussed in §2.3 above. Universities in the UK were seen as a principal measurement KT provider according to DATABUILD [2006], while the iMERA survey ranked academic Metrology KT lower [figure 6(b)]. Collaboration in NMI research, which was amongst the highest rated KT mechanisms of the iMERA survey, was ranked lower in the Databuild survey, in comparison with publication and advice which scored higher marks in the UK NMS survey. However, in another section [DATABUILD 2006 §7.2], when asked about areas of potential improvement, over half of UK NMS users (53%) would like to be consulted by the NMS when they are developing their research programme.

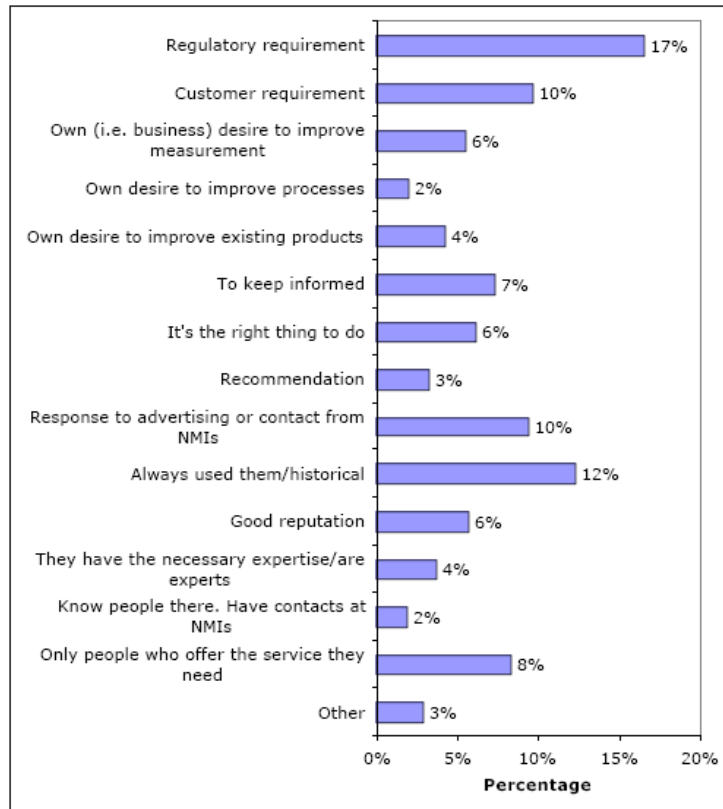


Figure 31: What prompted you to use the NMI's services? [DATABUILD 2006]

In a corresponding study of drivers and barriers (such as regulatory requirements, process improvement, measurement improvement etc) to the use of the UK NMS [DATABUILD 2006, figure 31], the survey provides results which can be compared with the iMERA results on KT subjects of the present survey, as discussed in §2.4 above. Regulatory requirements ranked highest amongst UK metrology stakeholders while these requirements came in second place in the iMERA survey [figure 9(b)] to subjects such as measurement in Quality Assurance and access to NMI expertise in for example how to treat measurement uncertainty.

To this may be added the results of an earlier [OPTIMAT \[2003\]](#) study of international best practice in NMS KT mainly in five countries – Australia, Canada, Germany, Sweden and the USA. In that study, the value of knowledge transfer is considered in terms of potential economic benefits. At the ‘micro’ level, an emphasis on commercial transfer of knowledge (‘move ideas out of laboratories and into the marketplace’) and a suggested role for ‘entrepreneurial activists’ in research-focussed organisations are suggested, using MIT as a global benchmark [Kelly 1999]. At the global level, high value-added products drive a large section of European and international commerce and measurement has a significant impact in economic terms^{‡‡}.

In a guide to external quality assessment in Higher Education, [Vroeijenstijn \[1995\]](#) points out that ‘First, quality means different things to different people. Second, quality is relative to “processes” or “outcomes”’. Translating this to metrology KT, various aspects of quality of KT, in terms of:

- Input (number of KT participants, budget, NMI staff)
- Process (aims, content of courses, KT organisation)
- Output (pass/fail rate, increased competence)

^{‡‡} “Our econometric estimates of the economic impact of measurement activity show that this spending generates almost €230 billion of directly estimable benefits ...equivalent to 2.7% of EU GDP.” Cited from [Williams G et al., 2002]

will be rated differently by different stakeholders, be they the participants themselves, the KT providers or their respective managers.

4 Existing Metrology KT in Europe

In addition to the iMERA T1.4 KT surveys [§2] which gave insight into existing metrology KT in Europe, this iMERA project also organised a one-day workshop [agenda is given in [Annex C](#)] which allowed presentations of existing metrology KT in Europe. The workshop also included a number of poster presentations.

Some general observations from the workshop were:

- there were different understandings of the meaning and scope of KT
- there were different levels of engagement in the innovation agenda
- few NMIs had dedicated KT staff and projects
- the analysis of impact was patchy
- that the high development costs of training and the development of guides etc was not being maximised at the European level
- that metrology KT across national boundaries was important for raising competitiveness across the EU
- that there was good support for taking KT forward into article 169 especially from those that would find it more difficult to engage in the research agenda

4.1 Policy and future trends in Metrology KT at the European NMIs

The iMERA KT survey asked NMI respondents to indicate policy, including trends, in the support given to metrology KT.

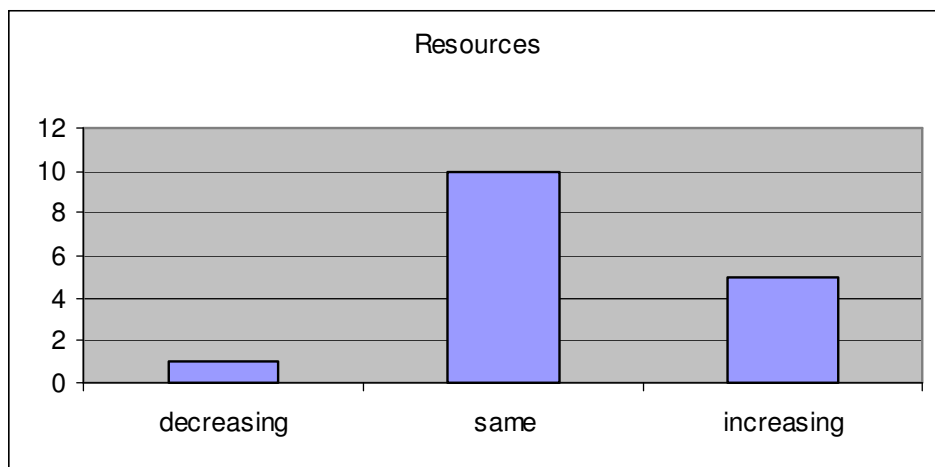


Figure 12 Trends in resources apportioned to Metrology KT at European NMIs

A majority of European NMIs asked in this iMERA survey responded that resources dedicated to metrology KT would stay largely unchanged in the next five years [[figure 12](#)].

Metrology KT was not only given priority in the context of education but also within innovation and regulation, as seen in [figure 13](#). Metrology in the context of innovation has recently received increased emphasis [[DTI 2003](#)].

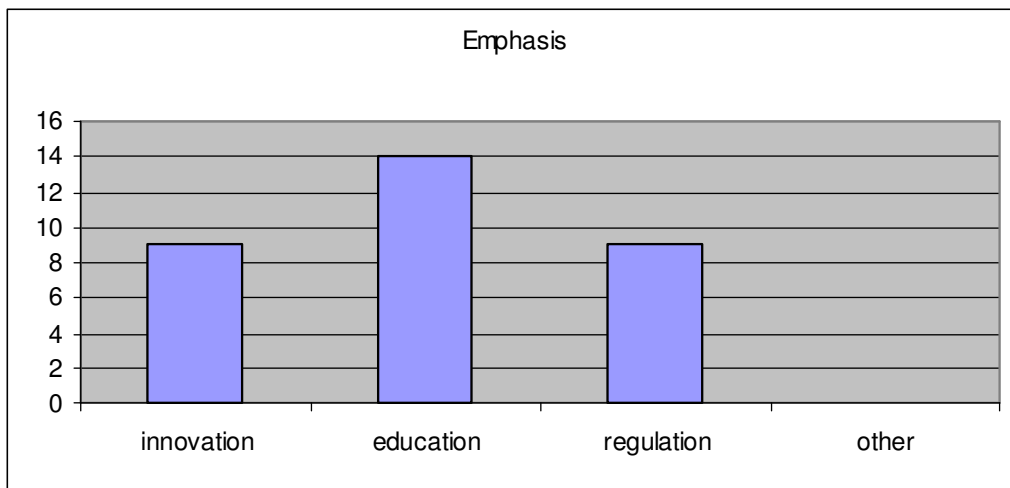


Figure 13 Emphasis apportioned to Metrology KT by European NMIs

At the iMERA KT Berlin workshop, four invited speakers gave their views of various aspects of metrology KT, and their presentations are summarised in the next sections.

4.2 Perspectives of Metrology KT

Mr. Vladimír Ludvík (COSMT, CZ) from the Office of Standards, Metrology and Testing [www.unmz.cz], which is an organisation within the Czech Ministry of Industry & Trade, reported on responses in the Czech republic to the iMERA T1.4 KT survey [§2]. Among the conclusions drawn was the need to encourage more cooperation between stakeholders (in sectors such as transportation and healthcare) and CMI, the Czech NMI. The responses to the KT survey also revealed significant differences in the views of metrology KT between a university and a major Czech manufacturer.

Dr Klaus-Dieter Sommer ([LMET, DE](#)) in a talk entitled, “Implementing the GUM in Germany’s Industrial Metrological Laboratories and in University-Study Courses”, presented a summary of metrology KT development. Starting with the motivation for courses in the treatment of measurement uncertainty; some historical perspective was given of for instance the formation 1999 by PTB (the German NMI) of a working group with both institute, university and industrial members, in response to a somewhat hesitant implementation of the GUM approach to the evaluation of uncertainties in German DKD (accredited) laboratories. Courses have in recent years been given in not only German but also Austrian and Swiss industries, government bodies and other institutes. Some of the latest developments include a new university course (28 hours) in Measurement data analysis and uncertainty determination. Dr Sommer concluded with an invitation to collaborate in teaching material, possibly under the iMERA umbrella.

4.3 Case studies of Metrology KT

A case study of teaching Metrology in Chemistry based on the extensive experience of Dr Philip Taylor of the EC Joint Research Institute IRMM (BE) and his colleagues was reported in a talk entitled “European Shareware Training & Education Initiatives for Metrology in Chemistry: TrainMiC and AcadeMiC 2001 – 2005”. Motivation for this programme can be found in requirements on measurement in various EU directives and the need for a uniform implementation. Experience gained in for example interlaboratory comparisons and proficiency testing shows that there is still some work to be done to improve the metrological competence of analytical laboratories, for instance. This motivated the development of two sets of metrology KT – [TrainMiC](#) directed towards

analytical laboratories and more recently AcadeMiC, at the university level – as a pan-European effort driven by EU enlargement.

The NPL in the UK has the vision of becoming the NMI that delivers the highest economic and social impact within its remit, and excellence in knowledge application is a key thrust, reported Ms Glenis Tellett ([NPL](#), UK) in her talk, entitled, "Measurement for Innovation – a New Programme for Knowledge Transfer". About 15% of NPL's budget is devoted to knowledge transfer, covering a wide range of activities, including joint industry projects, secondments and consultancy, and involving both large and small private companies and public sector agencies. Glenis shared some of their experiences gained in this programme, including the advice to make metrology KT as 'light touch and non-bureaucratic' as possible.

5 Future of Metrology Knowledge Transfer in the European Research Area

5.1 Identifying opportunities for Metrology KT

The one-day iMERA KT task 1.4 workshop [agenda is given in [Annex C](#)] included a session of break-out discussions followed by a synthesis and recommendation formulation in plenum. The next sections contain a summary of the points raised by the break-out discussions concerning what is considered to be metrology KT; what would be considered as a European (as opposed to a sum of national) KT programme and finally what steps are necessary towards such a European KT activity.

5.1.1 What is KT?

KT is the dissemination of measurement knowledge generated through research to the user who can generate wealth and welfare in society

KT is a flow of information about measurement knowledge in a TWO WAY PROCESS

Generators of metrology knowledge are:

- NMI
- Universities
- Practitioners of metrology (local inspectors, policemen, consultants)

Users of metrology knowledge:

- SME
- Big Enterprises
- Calibration of Test laboratories
- Regulators (Healthcare, Food, ...)
- Universities and educational institutions (train the trainers)
- Practitioners of metrology (local inspectors, policemen, consultants, ...)

Distinguish between vertical and horizontal

- Horizontal measurement KT – between NMIs - is also covered by T1.7, T3.2 and Marie Curie

Broad definition:

- Publish papers, training courses, proficiency testing, university study, hands-on / on-site training, consultancy, guides & books, workshops, applied or joint research, funding post-doc positions, secondments to/from industry, e-learning/distance learning
- Education (courses.....)
- Information (clubs, lectures, publications, web-sites)
- Joint R&D, including spin offs
- Secondments
- Services
- Calibration and testing
- PT provision
- Consultancy
- “Metrology in short”, text books;
- Magazine, web site (availability of EUROMET documents);
- EUROMET guidance notes/harmonized procedures;
- Calibration
- Training (including Ph. D)

- Spin-off companies
- Clubs
- Collaborative research and development
- Inter-laboratory comparisons
- Consultancy
- Seminars and workshops
- Standardization
- Publishing, websites
- Roadshows
- Promotional information

5.1.2 How can KT be improved to increase European cooperation?

General model: European level projects (eg preparation of training materials) combined with national level distribution [\[Pendril 2003\]](#)

- European parts funded in Article 169 EMRP?
- EUROMET WG on KT
 - Procedure for how to deal with KT in 169
- Create KT research projects within iMERA
 - Training knowledge base (on-line support for training à la DFM)
 - Inventory of material for teaching
 - Uncertainty training
- Marie Curie – will it be more attractive?
- Joint R&D projects (external to NMIs)
- Linkage with international/European/sectoral bodies eg WMO, WHO, UNIDO, Olympics, WELMEC, EA, CEFIC.....
- Increased coordination & info sharing between the NMIs
- Secondments
- Just do it.....

Barriers:

- Language
- Competition between NMIs for calibration market
- What is the access to EMRP research output for NMIs not involved in a particular project?
 - Easy enough for published results
 - Other KT mechanisms rely on more – e g consultancy, on the job training

Education

- Common teaching and training materials
- Are we prepared to put our existing material in a common pot?
- Availability in local language(s)?
- Shared availability of training experts
- Could EUROMET have a KT database available on the web?
- Could we do more of it?
- Development of European metrology clubs;
- TrainMIC extended to other fields of metrology

Information

- Sharing of existing KT mechanisms and toolkits, clubs, publications, courses.....
- Publicity of activities across borders, systematic sharing of information
- Sharing information about key areas and how effective they are, measurement of impact
- Standardised measurement procedures and guides (EUROMET/EA guides)
- Improved linkage to related websites
- Roadshows

- Promotional information

IS THERE A COMMON EUROPEAN SOLUTION?

- No, but there may be in some cases or for groups of countries
- Full common policy to be implemented with a federal approach: limits of variability such as languages, organization, ...

5.2 Metrology knowledge transfer as a means of mitigating ethical, gender and societal concerns

Providing for efficient knowledge transfer is one of the key actions in any programme addressing ethical, gender and societal aspects [[Pendrill & Havrlantova 2006](#)] of rapidly-developing technologies, such as metrology.

In studies of Science and Society [[EURAB 2005](#)], the importance of knowledge transfer with the following parts of society is emphasised:

- *Europe's future depends on the young*
Cultivating an interest in science & technology at an early stage and the ability for critical thinking. New/improved means of transferring knowledge about metrology (and its societal implications)
- *Improving public engagement with research*
New/improved means of transferring knowledge about metrology (and its societal implications)
- *Embedding the societal dimension in science*
Implementing societal concerns in the proposed EMRP, for example
- *Institutional links between science and society*
Involving civil society in research activities

To this list could be added out-reach activities directed to other sectors of society proportionally under-represented in science and technology, such as women, minorities and the developing world.

6 Conclusion and Recommendations

Metrology knowledge transfer:

- Should be an important element in the European Metrology Research Programme since new measurement knowledge, created in research, needs to be transferred to be useful.
- is a key factor in metrology's impact on modern society since better measurement is an essential component in promoting innovation, growth and welfare.
- is a two-way information exchange between NMIs and metrology stakeholders (universities, practitioners, industry, regulators).
- covers a wide range of measurement needs/subjects as well a broad spectrum of KT mechanisms.

This calls for a **specific, proactive coordinated action** of metrology KT in Europe, over and above the usual knowledge transfer attached to any project. There is need for some creativity since, to date, relatively few NMIs have dedicated KT staff and projects; there are different levels of engagement in the innovation agenda; the high development costs of training and the development of guides etc is not being maximised at the European level and metrology KT across national boundaries was important for raising competitiveness across the EU. There is good support for taking KT forward into article 169 especially from those that would find it more difficult to engage in the research agenda.

A number of recommended actions to this end are given below.

6.1 What are the best mechanisms of transferring and aspects of metrological knowledge?

In the iMERA KT survey of 2005, no great differences overall were found amongst the various metrology knowledge transfer mechanisms in the benefit as perceived by stakeholders. Nevertheless, university training in metrology is ranked significantly lower than say NMI research collaboration in terms of benefit of these mechanisms of metrology KT.

Similarly, there are no great differences overall amongst the various subjects of metrology in the need as perceived by stakeholders. Nevertheless, metrology training in the emerging technologies (such as bio, nano, etc) and in societal needs are ranked significantly lower than say training in measurement uncertainty and quality assurance.

Taking one particular KT metrology subject need – training in the emerging technologies (such as bio, nano, etc) –, which had one of the lowest rankings in this survey in terms of perceived need [[§2.4.3](#)], it is evident for example that calibration laboratories appreciate the subject more than most industrial stakeholders. This is in line with investigations of the overall awareness of European citizens in emerging technologies such as nanotechnology as well as that it is more a research issue than an industrial concern at the early stages of development.

The survey also investigated the rating of the various metrology KT mechanisms [[§2.3.3](#)] and subjects [[§2.4.3](#)] by stakeholders compared with NMIs. In most cases, stakeholders appeared to give higher ratings than NMIs, that is, NMIs have a tendency to underestimate the value of metrology KT.

There are different measures of the benefit of various mechanisms: in addition to a purely qualitative measure such as used in the iMERA surveys, more quantitative terms can be used. There is some overlap with consideration of the impact of metrological R&D as studied in the iMERA T1.5 task.

The following points were raised at breakout discussions at the iMERA [KT workshop](#) in Berlin, 1st December 2005:

6.2 What would a European metrology KT programme achieve?

As opposed to a simple collection of existing national metrology KT programmes, a European programme would include the following aspects:

Getting metrology engrained into European activity

- Contribute to meeting and satisfying common requirements
- EU legislation and standards etc... (development of and implementation of)
- Increased skills and knowledge base

Instrument in regional policy

- Contribution to building an integrated metrological infrastructure of EU
- Emerging countries:
 - special type of KT (standards, conformity assessment,...),
 - special information on metrology used for emerging technologies

Common approach/harmonized procedures

- Effectiveness of KT/Improving knowledge level of metrology;
- Reduce the national interpretation/ create a "unified" vocabulary;
- Increase of efficiency
 - By common use of resources
 - Common generation of training material
- Exchange of best practices
- Access to broader knowledge base
- Facilitation of specialisation

6.3 How should metrology KT be part of the future European Metrology Research Programme?

6.3.1 Workshop recommendations

Most NMIs see a programme of metrology knowledge transfer as not merely a 'service' to industry, but rather as an essential activity associated with their research.

Some general observations from the workshop were:

- there were different understandings of the meaning and scope of KT
- there were different levels of engagement in the innovation agenda
- few NMIs had dedicated KT staff and projects
- the analysis of impact was patchy
- that the high development costs of training and the development of guides etc was not being maximised at the European level
- that metrology KT across national boundaries was important for raising competitiveness across the EU
- that there was good support for taking KT forward into article 169 especially from those that would find it more difficult to engage in the research agenda

Vehicles for KT

- Focus group related to INTMET, then TC if needed.
- *Should make space in EMRP for KT projects*

- KT coordinators to meet, perhaps activity should be undertaken as an ad-hoc group under INTMET

Identify KT contact person per NMI

- Full support of one single person per country with clarification of the content of KT (all stakeholders including Society, NMIs (exchange of personnel)), responsibility of giving information ...
- KT contact – need a facilitator role
 - In larger NMIs – too much for one person
 - Smaller NMIs – too expensive to fund full person
- At present not every country can name someone, but it would be helpful if they could

Project ideas:

- GUM course
- e-learning: central server or template for material
- Share on-the-job training capability across borders
- European metrology PhD
- EUROMET metrology newsletter
- European metrology journal
- EUROMET/EA guides (funded activity)
- Improving mechanisms for secondments
- Marie Curie series of Conferences and Training Courses

6.3.2 Proposed Metrology KT programme (part of EMRP)

6.3.2.1 WP 1 Metrology KT Coordination

Provide overall coordination of European Metrology KT programme. As mentioned in the draft^{§§} Article 169 decision EMRP, this includes:

- “Activities related to the joint RTD programme as delivered by the national metrology institutes, and the institutes designated by them.
 - d) Supporting metrology Knowledge Transfer (KT) activities
- Activities aimed at the wider EUROMET community promoting participation by non-partner EUROMET members in KT and training activities
- RTD and KT activities in association with the Institute of Reference Materials and Measurements - IRMM - (part of the Joint Research Centre of the European Commission).”

Activities would include KT capacity building among NMIs; collaborative research including secondment, etc.

A new KT Group is proposed to be formed for this coordinated proactive European Metrology KT programme. The Group will be populated by KT contact persons per NMI where available. An initial piece of work would look at objectives, strategy, operational framework and ensuring the work is inclusive, and to set some success measures to be evaluated at the end. The cost of each of the KT activities is not equal e.g collaborative research is very expensive, so there is also a 'what is most cost effective?' question.

Deliverable: Coordination plan for Metrology KT in iMERA Art. 169/EMRP

6.3.2.2 WP 2 External funding of Metrology KT

^{§§} RTD-B2 Article 169 decision EMRP 12 December 2005, DRAFT, ANNEX relating to the European Metrology Research Programme

A variety of potential sources of external funding/support for developing metrology KT are available, including EU/Marie Curie/Science & Society etc.

Deliverable: Proposal to EU Marie Curie 1.4 Conferences/Training

6.3.2.3 WP 3 Metrology KT & Innovation

Better measurement is an essential component in promoting innovation, growth and welfare. This WP aims to explore existing and potential future actions where the principal aim of metrology KT is innovation, rather than education or regulation. Actions could include mechanisms for metrology KT for innovation as well as impact assessment (including coordination with iMERA task T2.5 Addressing intellectual property issues and iMERA T1.5 Impact).

Deliverable: Collation of existing national studies of KT & Innovation. Proposed Metrology KT innovation Action in EMRP

6.3.2.4 WP 4 Metrology KT & Regulation

Metrology KT is motivated in part by its support to the implementation of regulation (quality assurance, health & safety, infrastructure for innovation, trade, etc). How can Metrology KT be improved in a dialogue with regulators – for instance standardisation bodies, accreditation bodies – and actors in quality-assured measurement and conformity assessment (secondary calibration laboratories, testing laboratories, notified bodies, etc)? Coordination with iMERA task T2.8 Ethical, gender and societal issues.

Deliverable: Input to proposed EUROMET INTMET project “Embedding best measurement practice in regulatory activity – EMBPRA” [NPL].

6.3.2.5 WP 5 Metrology KT & Research

Collaboration in research is one important mechanism of Metrology KT between NMIs and major research teams at universities, institutes, industries etc. It enables the development of new SI definitions; metrology in the emerging technologies (bio, nano etc) and more^{***}. This WP explores means of making more effective coordinated mechanisms between NMIs and these major research teams, which to date have however been few and rather *ad hoc*. International coordination with corresponding actions in CGPM/IUPAP etc.

Deliverables: Metrology KT Impact study (in coordination with iMERA T1.5). International conference on Physics & Metrology

6.3.2.6 WP 6 Metrology KT & Education

Metrology KT is part of wider educational and training activities in the European Union. Coordination between Metrology KT actions by NMIs with other actors in education and training is to be explored. Areas could include: inventory of university material for measurement teaching/KT; industrial training courses; continued support for European MÉTROLOGIE 2009 congress; etc

Deliverable: Proposal to EU Marie Curie 1.4 Conferences/Training

6.3.2.7 WP 7 Metrology KT development of material by NMIs

Development of Metrology KT material in a coordinated action amongst NMIs. Areas

^{***} [Pendrell L R 2006](#)

could include: inventory of NMI material for teaching/KT; e-learning template for KT material; need for European Metrology journal/newsletter/guides; secondments^{†††} between NMIs and stakeholders (university, industry)

^{†††} Secondments 'horizontally' between NMIs dealt with in iMERA Tasks 1.7 + 3.2

Acknowledgments

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The partners wish to acknowledge and thank the European Commission for supporting the project [iMERA project](#) (EU contract no 016220, project coordinator NPL) as an ERA-NET Coordinating Action under “Coordination of Research Activities” of the 6th Framework Specific Programme “Integrating and Strengthening the European Research Area” in which much of this work was performed.

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Annex A

European Metrology Knowledge Transfer consultation

The **present survey** is of stakeholders' views of measurement knowledge transfer generated by metrological R&D activities.

Please send your responses to the Task Leader (address below) by: **28th October 2005**

1. Measurement needs and interests			
Does your organisation have an interest in quality-assured measurement? - if yes, specify which quantities:			<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
<input type="checkbox"/> Mass	<input type="checkbox"/> Length/dimension	<input type="checkbox"/> Time & frequency	<input type="checkbox"/> Electricity
<input type="checkbox"/> Amount of substance/chemistry	<input type="checkbox"/> Photometry/radiometry	<input type="checkbox"/> Temperature	<input type="checkbox"/> Derived quantity <i>specify:</i>
Estimate annual expenditure on measurement-related activities in your organisation where metrological traceability plays an important role:			€
Organisation <i>(voluntary reply)</i>	Name:	E-mail:	Phone:
Type of organisation	<input type="checkbox"/> Industry <input type="checkbox"/> Instrument manufacturer <input type="checkbox"/> Regulator/authority	<input type="checkbox"/> University/ institute <input type="checkbox"/> Course provider <input type="checkbox"/> Standards body	<input type="checkbox"/> NMI <input type="checkbox"/> Other <i>specify:</i>

2. How much have you benefited from different mechanisms of KT in metrology?						
<i>KT Mechanism</i>	No experience	Little benefit	Moderate benefit	Much benefit	Activity (€/year)	Comments
Direct research collaboration with national metrology institute (NMI)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
'Metrology clubs'	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement guides/books	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement training provided by national metrology institute (NMI)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement training provided by university/institute	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement training by commercial course provider	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement conferences/workshops/summer schools etc	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other measurement KT activities <i>Specify:</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Send your responses to:

iMERA WP1.4, c/o Dr L R Pendrill, SP Box 857, SE-50115 BORÅS, Sweden

email: leslie.pendrill@sp.se, tel. +46 (0)33 16 54 44 by **28th October 2005**

www.sp.se/metrology

Annex A

3. Measurement Educational Needs				
<i>Measurement subject</i>	Little need	Moderate need	Much need	Comments <i>*Use separate page if needed</i>
MEASUREMENT QUALITY				
Measurement & quality assurance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement & societal needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Legal and regulatory metrology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Decision-making and conformity assessment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MEASUREMENT OF QUANTITIES				
How to measure a specific quantity (mass, length, electricity etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement uncertainty	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement traceability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MEASUREMENT BY APPLICATION				
Measurement in Emerging Technologies (e.g. nano, bio etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement in research & science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Measurement & testing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
How to measure for a specific application (process control, industrial production, energy, pharmaceuticals, etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
MEASUREMENT SYSTEMS				
Measurement & software/IT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Instruments and sensors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other <i>Specify:</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Thank you for your replies!

"iMERA – Implementing Metrology in the European Research Area"

Modern society requires reliable measurements that give the same answer wherever they are made. This is achieved by use of the International System of Units (SI) which is based on and, in turn, supports continual and long-term research in fundamental science and technology. The new EU ERA-NET project "iMERA – Implementing Metrology in the European Research Area" [<http://www.euromet.org/projects/imer/>] aims at encouraging and supporting metrology research initiatives undertaken by several countries and developing synergy between national metrology institutes (NMI) and their existing activities.

Recognising the importance of knowledge transfer (KT) activities in this context, an iMERA task group (WP1.4) is advising on KT aspects relevant to the project.

Send your responses to:

iMERA WP1.4, c/o Dr L R Pendrill, SP Box 857, SE-50115 BORÅS, Sweden
 email: leslie.pendrill@sp.se, tel. +46 (0)33 16 54 44 by **28th October 2005**
www.sp.se/metrology



Additional comments



Annex B

European Metrology Knowledge Transfer landscape

The **present survey** is of national metrology knowledge transfer (KT) generated by metrological R&D activities.

Please send your responses to the Task Leader (address below) by: **28th October 2005**

0. Identification of respondent			
Organisation:	Name:	E-mail:	Phone:
Type of organisation			
<input type="checkbox"/> Government ministry <input type="checkbox"/> National metrology institute (NMI) <input type="checkbox"/> Other <i>specify:</i>			

"iMERA – Implementing Metrology in the European Research Area"

Modern society requires reliable measurements that give the same answer wherever they are made. This is achieved by use of the International System of Units (SI) which is based on and, in turn, supports continual and long-term research in fundamental science and technology. The new EU ERA-NET project "iMERA – Implementing Metrology in the European Research Area" [[http://www.euromet.org/projects/imera/](http://www.euromet.org/projects/imer/)] aims at encouraging and supporting metrology research initiatives undertaken by several countries and developing synergy between national metrology institutes (NMI) and their existing activities. Recognising the importance of knowledge transfer (KT) activities in this context, an iMERA task group (WP1.4) is advising on KT aspects relevant to the project.

1. Policy for metrology KT	
Resources for KT in next 5 years	
<input type="checkbox"/> decreasing <input type="checkbox"/> same <input type="checkbox"/> increasing	
Policy emphasis of KT	
<input type="checkbox"/> KT to support innovation <input type="checkbox"/> KT to support education <input type="checkbox"/> KT to support regulation <input type="checkbox"/> KT to support other <i>specify:</i>	
Do you have a KT national coordinator?	Are you prepared to present your activity at the iMERA KT Workshop?
<input type="checkbox"/> YES <input type="checkbox"/> NO	Poster: <input type="checkbox"/> YES <input type="checkbox"/> NO Short oral (20 min): <input type="checkbox"/> YES <input type="checkbox"/> NO
Does your KT activity represent best practice?	If 'yes', which aspect of your KT activity?
<input type="checkbox"/> YES <input type="checkbox"/> NO	

iMERA T1.4 Metrology Knowledge Transfer Workshop
PTB Berlin-Charlottenburg, Berlin (DE)
Thursday 1st December 2005



2. Scope of different mechanisms of KT in metrology in your country						
<i>KT Mechanism</i>	No activity	Little activity	Moderate activity	Much activity	Level of Activity (FTE/year) ^{***}	Comments
Direct research collaboration between NMI and stakeholders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Secondments (exchange of personnel) between NMI and stakeholders	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
'Metrology clubs'	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement guides/books	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement training provided by national metrology institute (NMI)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Exploitation of measurement Intellectual Property (IP)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement training provided by university/institute	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement training by commercial course provider	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement conferences/workshops/summer schools etc	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other measurement KT activities <i>Specify:</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

^{***} FTE = Full time equivalent (so that a person working half time = 0.5 FTE)

Send your responses to:

iMERA WP1.4, c/o Dr L R Pendrill, SP Box 857, SE-50115 BORÅS, Sweden
email: leslie.pendrill@sp.se, tel. +46 (0)33 16 54 44 by **28th October 2005**
www.sp.se/metrology

Annex B

3. Measurement Educational Topics					
<i>Measurement subject</i>	Little activity	Moderate activity	Much activity	Level of activity (FTE/year) ¹	Comments <i>*Use separate page if needed</i>
MEASUREMENT QUALITY					
Measurement & quality assurance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement & societal needs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Legal and regulatory metrology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Decision-making and conformity assessment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
MEASUREMENT OF QUANTITIES					
How to measure a specific quantity (mass, length, electricity etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement uncertainty	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement traceability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
MEASUREMENT BY APPLICATION					
Measurement in Emerging Technologies (e.g. nano, bio etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement in research & science	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Measurement & testing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
How to measure for a specific application (process control, industrial production, energy, pharmaceuticals, etc)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
MEASUREMENT SYSTEMS					
Measurement & software/IT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Instruments and sensors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Other <i>Specify</i>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		

Thank you for your replies!

Send your responses to:

iMERA WP1.4, c/o Dr L R Pendrill, SP Box 857, SE-50115 BORÅS, Sweden

email: leslie.pendrill@sp.se, tel. +46 (0)33 16 54 44 by **28th October 2005**

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iMERA
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Implementing Metrology in the European Research Area

Annex C

Agenda
iMERA T1.4
Metrology Knowledge Transfer Workshop
PTB Berlin-Charlottenburg, Berlin (DE)
Thursday 1st December 2005

European Metrology Knowledge Transfer Landscape

- 08.30** **Registration** ([Foyer Helmholtz building](#))
- 09.00** **Welcome and iMERA Introduction** (Helmholtz plenary) Henson & Kühne
- 09.15** **Introduction iMERA T1.4 KT** Pendrill
- 09.30** **Landscaping European metrology KT. Survey results** Pendrill
- 10.00** *Poster Session^{§§§} with coffee* (Helmholtz mezzanine)
- 10.45** **Perspective of Metrology KT. I:** Mr. Ludvik (COSMT, CZ)
- 11.10** **Perspective of Metrology KT. II.** Dr Klaus-Dieter Sommer (LMET, DE)
- 11.35** **Case study of Metrology KT. I.** Dr Philip Taylor (IRMM, CE)
“Teaching Metrology in Chemistry”
- 12.00** **Case study of Metrology KT. II.** Ms Glenis Tellett (NPL, UK)
"Measurement for Innovation"
- 12.30** *Lunch*

Future of European Metrology Knowledge Transfer?

- 13.30** **Introduction to break-out group discussions** (Helmholtz plenary) Pendrill/Tellett
- 13.45** **Group discussions^{****}**
- What is metrology KT?
 - European KT collaboration
 - Next steps
- 15.30** *Tea*
- 16.00** **Synthesis of group discussions** (15 - 20 min. each) Group Leaders
- 17.00** **Conclusions and future work**

^{§§§} Posters should be brought to registration and will be mounted by local staff (Helmholtz mezzanine)

^{****} Prel. 3 – 4 groups of 10. Meeting rooms: Helmholtz plenary + New Helmholtz + Siemens Room + Coupole Room (+ Presidential room)



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KT Posters

All participants are invited to display at the Workshop a poster (90 cm wide x 120 cm high) of their metrology knowledge transfer activities.

Posters should be brought to registration and will be mounted by local staff (Helmholtz mezzanine).

KT Surveys – reminder

Reminder: Please reply to iMERA T1.4 KT surveys – your responses will provide valuable input to this Workshop and overall Task – thank you!

iMERA measurement KT stakeholder survey: ([MS WORD](#)) ([PDF](#))

iMERA measurement KT NMS landscape survey: ([MS WORD](#)) ([PDF](#))

Participation in KT Workshop

Please indicate by **11th November** at the latest whether you will attend the KT workshop. Replies please to iMERA Secretary, Deborah Lea, Deborah.Lea@npl.co.uk with a copy to iMERA T1.4 KT Task leader, Dr Leslie Pendrill, leslie.pendrill@sp.se

1-2 per iMERA partner	
+ 1-2 Invited speakers + Deborah Lea	<i>Total</i>

Berlin Excelsior Hotel
 Hardenbergstr. 14
 10623 Berlin
 phone +49 30 3031 55-0
 fax +49 30 303155 1002
www.adamhotels.com

40 single rooms at 82 Euro per night including breakfast not yet fixed number of double rooms at 107 Euro per night including breakfast

Arrival: not before November 30th. Departure: no later than December 4th

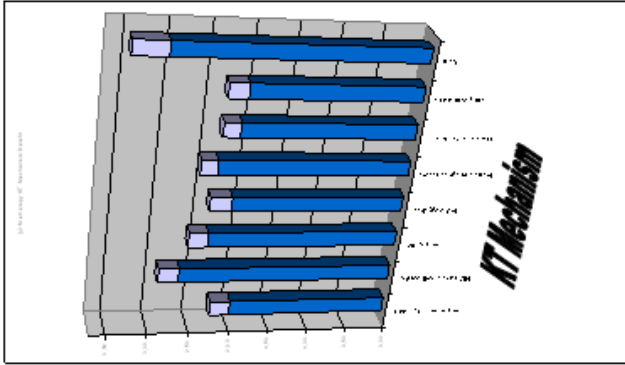
All expenses are covered by the guests themselves.

Please refer to the code "iMERA" for booking, the rooms will be held until **November 11th**.

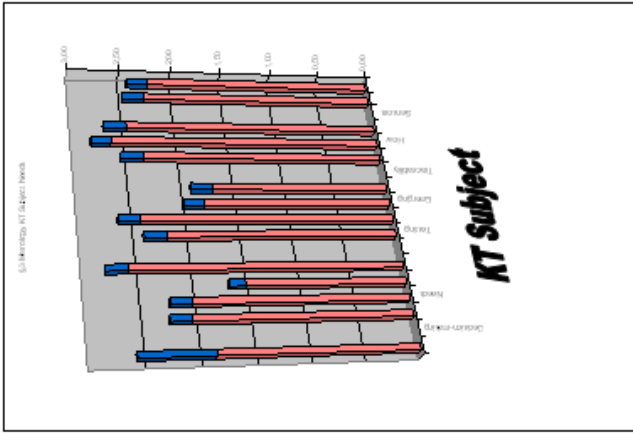
See you in Berlin!

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§2 Benefit



§3 Need



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