

# Survey of UK technology transfer activity in laser materials processing to the SME community

*Helping Small and Medium size Enterprises exploit laser  
materials processing in manufacturing*

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## The Association of Laser Users

*The Association of Laser Users (AILU) was formed in 1995 as a technology-driven organisation dedicated to maximising the effectiveness, efficiency and competitiveness of manufacturing industry through appropriate application of laser technology for materials processing. AILU's core membership comprises companies and individuals who use industrial lasers for manufacturing processes. In addition to this core membership, other members include equipment suppliers, educators and researchers in the field. Over 80% of AILU members are based in the UK.*

*In its work, AILU:*

- *Establishes and communicates best practice.*
- *Helps members to identify and achieve 'world class' performance in terms of process effectiveness and efficiency.*
- *Disseminates research results to users and potential users and collates user needs for the benefit of researchers.*
- *Nurtures the use of laser technology to minimise the adverse environmental impact of manufacturing, through replacement of chemical processes and the introduction of (near) net-shape manufacturing technologies.*
- *By use of its existing web site, its quarterly magazine and by regular promotion of high profile workshops, AILU provides one of the best technology platforms in Europe for dissemination and networking in the field of laser materials processing.*

*AILU's motivation is to be effective, particularly in the UK, in promoting the competitiveness of European manufacture and products and, through this, employment and prosperity in Europe. In the course of its activities, AILU maintains a close awareness of established manufacturing processes and the state of their current development to ensure that laser based solutions are only promoted in areas where they are likely to realise commercial advantage for users. The broad background, expertise and experience of the officers of AILU and its membership, encompassing photonics research, development, manufacturing, sales and service, as well as its underpinning knowledge about the industrial uses of lasers, enables AILU to connect researchers and potential exploiters of that research. This dissemination and evaluation of research is currently facilitated by various means, including many workshops conducted in research institutions in the UK and the association's magazine, *The Laser User*.*

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## Table of Contents

<b>1</b>	<b>Executive summary</b>	<b>5</b>
<b>2</b>	<b>The transfer of laser materials processing technology transfer to SMEs</b>	<b>6</b>
2.1	The need to improve LMP technology transfer to UK SMEs	6
2.2	The role of research and development	7
<b>3</b>	<b>Overview of UK technology transfer activity in LMP</b>	<b>8</b>
3.1	Analysis of AILU workshop attendees	8
<b>4</b>	<b>Survey of UK technology transfer activity</b>	<b>13</b>
4.1	Selection procedure	13
4.2	Questionnaire responses	13
4.2.1	<i>Potential technology transfer supplier organisations</i>	13
4.2.2	<i>Potential technology transfer recipient organisations</i>	15
<b>5</b>	<b>Survey results</b>	<b>16</b>
5.1	Results and analysis for potential recipients of LMP technology transfer	16
5.1.1	<i>Interest shown by UK SMEs in the Manufacturing Sector</i>	16
5.1.2	<i>Participation of UK SMEs in the Manufacturing Sector</i>	16
5.1.3	<i>Barriers to technology transfer activity</i>	17
5.2	Results and analysis for providers of LMP technology transfer	18
5.2.1	<i>Publications and Events</i>	18
5.2.2	<i>Face to face discussions</i>	19
5.2.3	<i>Advanced services</i>	21
5.2.4	<i>Total UK activity</i>	24
5.2.5	<i>Motivation</i>	25
5.2.6	<i>Foreseen changes in technology transfer services</i>	25
5.2.7	<i>Knowledge Transfer Partnerships</i>	26
5.2.8	<i>Case studies</i>	26
5.2.9	<i>ESP KTN membership</i>	26
<b>6</b>	<b>Conclusions and recommendations</b>	<b>27</b>
6.1	Facts and figures for UK technology transfer activity	27
6.2	Recommendations for improving UK technology transfer	28
6.2.1	<i>Workshops and seminars</i>	28
6.2.2	<i>Internet services for networking</i>	28
6.2.3	<i>Database maintenance</i>	28
6.2.4	<i>R&amp;D by suppliers and subcontractors</i>	28
6.2.5	<i>Research in universities</i>	29
6.2.6	<i>Education and training</i>	29
6.2.7	<i>Design for laser manufacture</i>	30
<b>7</b>	<b>Appendix 1: Questionnaires</b>	<b>31</b>
7.1	Laser Materials Processing Technology - Supplier Questionnaire	31
7.2	Laser Materials Processing Technology – Potential Recipient Questionnaire	33

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## 1 Executive summary

The key objectives of this study were:

1. To identify the level of technology transfer in LMP between the laser processing research community and SMEs.
2. To improve the technology transfer process in LMP in order to transfer process know how that will make efficient use of laser tools in the value creation process
3. To seek to identify what are the main obstacles to the transfer of laser processing know how and put forward recommendations as to how these obstacles may be overcome.

Laser Materials Processing (LMP) is the largest application for lasers (35% of total laser sales worldwide). A recent review by AILU for the Photonics KTN demonstrated the importance of LMP in 21<sup>st</sup> Century Manufacturing. However, whilst the UK has contributed significantly to the development of many industrially robust laser processes Germany, the leading country in the use of LMP technology, uses LMP between 5 and 10 times more than the UK per unit of manufactured output.

There are several processes that are now “utility” processes, e.g. laser cutting and laser marking, where the laser systems are highly developed and the process relatively deskilled. These features make these processes attractive to SME’s and the UK has a good number of laser cutting job shops. There are many other relevant laser processes that cannot be considered as utility processes, and will only be taken up to benefit production where technology and process knowledge of sufficient quantity and quality is transferred to the end user. This is particularly important to SME users.

This report takes a broad view of technology transfer, and set out to recognise that technology transfer is not limited to a one directional flow from Universities (HEIs) and other Research & Technology Organisations (RTO) to a user. A survey of members was undertaken, encompassing all suppliers of knowledge and experience, and this demonstrated that suppliers and existing subcontractors “job shops” play a vital role in introducing, promoting and supporting LMP in end users.

The survey showed that there was a healthy research community in LMP in the UK that contributes well to technology transfer, with several universities participating in regionally funded activities supporting technology transfers, particularly to SME’s. However, it is clear that companies of all sizes have a preference to deal with other industry partners rather than HEI’s when it comes to obtaining knowledge of LMP.

In its conclusion the report identifies that at the time of writing, the landscape of technology transfer is changing rapidly, with the demise of the Regional Development Agencies, and the introduction of Technology Innovation Centres (TIC’s) funded by the Technology Strategy Board. The conclusion section includes recommendations based on wide ranging discussions held by the authors with members of AILU.

## 2 The transfer of laser materials processing technology transfer to SMEs

### 2.1 The need to improve LMP technology transfer to UK SMEs

Laser Materials Processing (LMP) is the largest application segment for global laser sales by value (35% of total laser sales), especially in high value manufacturing (particularly in the automotive, aerospace, energy, medical, solar and microelectronic industries). As a manufacturing tool, the laser offers unique features, including non-contact processing, ultra-fast surface coverage, micron-scale resolution and a range of processes from surface melting through to ablative ejection (“cold machining”). A recent AILU report<sup>1</sup> identified LMP as a key technology in 21<sup>st</sup> Century manufacturing and listed over 130 industrial applications of lasers, of which 31 were identified as having critical importance in the context of applications in KTN and TSB themes; in key industries and in key products. The key industrial sectors identified in the report to benefit from LMP are listed in the text box below.

#### **Key industrial sectors for which the 21st Century report identified significant LMP potential include:**

Biotechnology • Chemical • Clothing and footwear • Communications • Defence • Electrical equipment • Electronics • Environment • Energy production and storage (e.g. Nuclear, Wind, Solar) • Food and drink • Healthcare • Jewellery • Manufacturing technology (e.g. Precision engineering) • Medical (e.g. Medical tools, Medical implant, Dental implant) • Metals and engineered metal products • Pharmaceuticals • Photonics (e.g. Displays & lighting, Power photonics, Fibre optics, Scanning optics) • Polymers • Process manufacturing (e.g. Tube, Glass, Paper, Furniture, Printing), Security, Sensors, Transport (e.g. Automotive, Aerospace, Marine, Rail).

Laser marking, engraving and cutting LMP systems of relatively low laser power and low cost are well established, so many and from so wide a range of suppliers that it is hard to estimate numbers in use. Statistics are however available for levels of sales and use of what may be termed ‘high value laser materials processing systems’; systems costing in the range of £200 – 1000k. These systems typically offer state of the art laser processing in terms of throughput, quality and degree of automation and control. A study carried out by AILU in 2009<sup>2</sup> estimated that there were ~2500 such high value laser materials processing systems in use in the UK. Approximately 50% were in use in the UK’s estimated 350+ SME laser job shops, where they create an estimated income of ~£500M/annum and many times that in the final sale of the laser-manufactured component. The remainder are dispersed throughout UK manufacturing industry. **To put these figures into context, Germany, the leading country in the use of LMP technology, uses LMP between 5 and 10 times more than the UK per unit of manufactured output.**

Small and Medium size Enterprises (SMEs)<sup>3</sup> are an essential part of UK business activity and no more so than in manufacturing. In 2009, SMEs represented almost 99% of the 102,000 UK businesses active in the manufacturing industry sector<sup>4</sup>. The effective transfer of LMP into SME manufacturing organisations is therefore of great importance

<sup>1</sup> ‘Exploiting laser technology in 21st century UK manufacturing’ pub. AILU 2010

<sup>2</sup> ‘UK Laser Materials Processing statistics 2009’ pub. AILU

<sup>3</sup> There are many definitions of the term SME. In the present context we have in mind an independent business with under 250 employees

<sup>4</sup> ‘SME Statistics for the UK and Regions 2009’ pub. Department for Business Innovation and Skills

but it is also a great challenge. Indigenous UK laser machine integrators, themselves SMEs, only survive by exporting of the order of 85%+ of their products.

## 2.2 The role of research and development

As a research area, LMP involves a critical mix of several otherwise disparate areas of science and technology; in particular: photonics (laser source and beam delivery); materials; and movement and control systems. For example, for additive manufacturing to be an industrial process a highly stable laser source is required, so too is a means of providing digital control of laser power and beam position; as well as reliable delivery of ultra-fine powder material and sub-micron positional control of the laser beam in relation to the powder bed. In addition, the metallurgy of the powder melting and reforming process and design restrictions has to be properly understood.

Even setting aside the non-laser aspects of LMP that have to be got right in a successful industrial application, the intense interaction of laser light with a material is a complex, dynamic, multi-state of matter process; very different and more complex in character than the mechanical means of processing. It should therefore not be surprising to find that achieving good results can require significant process optimisation, well beyond the capability of the majority of UK SMEs.

Fortunately, some LMP machines, so-called 'utility' machines<sup>1</sup> can provide the high degree of quality and reliability demanded by modern industry. These are commercial machines that (a) have a proven production capability and (b) can serve a wide range of applications. A commercial flatbed laser machine cutting out components from a flat metal or polymer sheet will satisfy the LMP needs of a wide range of applications. Invariably a large market for the applications they serve will drive the sale of such machines. A recent addition is the additive manufacturing utility machines that offer near 'off the shelf' laser processing solutions.

The attraction of utility machine for the SME is the reliability and relatively small amount of skill required to use machines. The role of technology transfer for such processes is simply of making the SME aware of the opportunity, possibly providing demonstrations and sample parts, helping in the matter of selecting the right machine and possibly helping the SME take advantage of the laser process to improve the design of components to add maximum value from the laser process. The confirmation that the laser process will provide the desired result and advice on optimising designs for laser manufacture is something that the machine supplier may provide free of charge, or that a laser job shop could certainly undertake. Indeed, through the very act of providing industrial SMEs with laser-manufactured parts, laser job shops play a big part in the technology transfer process.

However, to exploit the plethora of non-utility processes the SME must accept that a significant amount of process development will be entailed and without a fast, low cost option this condition may be sufficient to rule out laser processing. Indeed, on this latter point, SMEs have always faced a particularly challenging time from under-capitalisation, made worse by the current challenges of accessing external finance<sup>5</sup>. Lasers represent a high initial capital investment that can make their purchase hard to justify, especially if pay back is required within 1 to 2 years of investment.

This study attempts to quantify current UK technology transfer activity and makes recommendations on how to improve the current situation.

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<sup>5</sup> 'Financing a private sector recovery' pub. HM Treasury and BIS (2010)

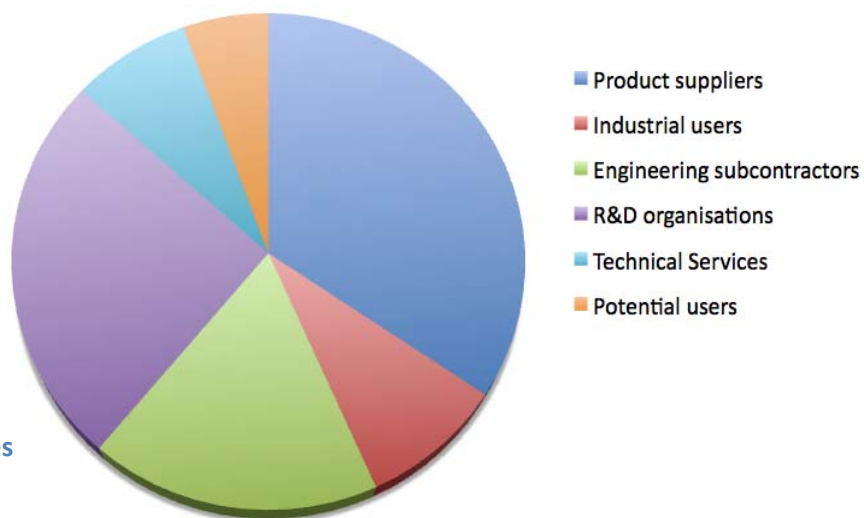
### 3 Overview of UK technology transfer activity in LMP

Table 3.1 below summarises UK technology transfer activities in laser materials processing with examples. In particular, it attempts to paint a broad picture of the scope of technology transfer including in particular the central role of subcontract engineering companies (laser job shops) and laser machine suppliers. Initiatives are colour coded to indicate their assessed current growth status. Motivations vary between commercial benefit and government strategic funding.

Where companies take up laser technology it will be carefully planned and executed, and will hopefully be successful. For the smaller companies however, the necessary investments to develop processes, products and introduce manufacturing capacity can be daunting. There will also be the need to train staff. There are a number of government schemes available to assist companies undertake R&D activity in general. Some offer grant support to R&D project funding, some offer financial support for companies undertaking R&D. Schemes exist to assist in “Knowledge Transfer” or Knowledge Exchange and may be relevant to R&D activity.

#### 3.1 Analysis of AILU workshop attendees

Among its many technology transfer activities, AILU has been conducting technical LMP workshops for 13 years. The figure below is a breakdown of the 4052 attendees/events over this period. Of the individual delegate/workshop events that occurred during this period: 31% involved suppliers of products; 16% engineering subcontractors; 23% R&D organisations; 7% technical services and (only) 8% were industrial users and 5% potential users.



**Figure 3-1:**  
Analysis of AILU  
workshop delegates

Within the 8% of industrial users attending technical workshops, corresponding to 312 attendee/workshop events, there were only 84 distinct UK-based organisations involved, of which only 44 organisations were manufacturing SMEs using lasers. This result is presented only to illustrate the challenge of engaging with the SME community.

Further lessons drawn from this analysis and table 3.1 are provided in the conclusions and recommendations.

**Table 3-1LMP technology transfer to industry in the UK**Perceived status of initiative: **Green**- growing; **Black**- current and steady; **Red**- in decline; **Grey**: ceased to function**General initiatives**

Ref.	Typical duration	TT activity	Organisers	Motivation of organisers	Assessment of industrial benefit	Degree of explicit focus on SME needs	Examples (NOT intended to be comprehensive) and comments
<b>Information, networking and presentations</b>							
A1	<1 hour	Use of online information	Material supplied FOC	Free advertising Creating improved awareness	+ Free +24/7 access	High	Wikipedia AILU's Design for Laser Manufacture web site provides pictures, videos, downloaded documents of case studies, data sheets Rofin-Baasel (laser source and system manufacturer) offers a wide range of YouTube video clips on LMP; the most popular has had over 30,000 viewings.
A2	<1 hour	Use of online forums and general networking	Organisation committed to technology transfer	Altruism, increased market size for products and services	+ Free + Wide range of knowledge accessible - Unreliable sources of information - Possible commercial motive unclear	High	LinkedIn has a number of relevant groups in laser materials processing AILU hosts a technical forum and a number of specialist forums including medical, micro-nano, additive manufacturing and product and process innovation
A3	2 hours	Breakfast meetings: short presentations and opportunities for follow up discussions  Typical delegate cost: free attendance (funded by ERDF)	University	Satisfying the requirements of the body funding TT activity	Industry – academic networking	Medium	Manchester University currently run free breakfast meeting within the KE-LAS project funded by ERDF

Ref.	Duration	TT activity	Organisers	Motivation	I industrial benefit	SME needs	Examples and comments
A4	½ day	Sponsored open ½ day briefing meetings to update SMEs on the results of collaborative projects, with contributions describing funding initiative and experiences.  Typical delegate cost: Free to £50	Project participants and sponsors.	Project requirements for government funded project	+ Funded project possibility + Low attendance cost - Such events are few and far between.	Medium	Commercial participants may be unwilling to reveal details and application areas of interest. There is generally little motivation to pass the utilisation of the process over to SMEs  SME focus varies with programme; but there is generally a large academic involvement in the presentations.
A5	½ day	Open ended technical networking meetings	Clusters and regional associations	Government targets for growth of jobs and business	+ Industrial networking	High	Decline in regional associations following lack of RDA and KTN support
A6	1 day	Presentations, possibly with an exhibition and tour	Laser product and service providers	Sponsors selling equipment and services	+ Access to information and suppliers - Cost - Commercial presentations and limited range of sponsors	High	'Make It With Lasers' programme: presentations, exhibition and tour ; typical delegate cost: £100. Terminated due to falling numbers of SME attendees  Open days organised by machine suppliers. Free to attend.
A7			Researchers and suppliers	Altruism, increased market size		Medium-High	AILU technology workshops. Relatively poor attendance by SME manufacturers (see XX).
A8			University group/collaboration	Meeting project targets for dissemination	+ Contact with local specialists in the field	Low - Medium	Liverpool + Manchester collaborative project. NWLEC funding finished in FY2008/09.  Liverpool + Manchester KELAS project finishes in 2012 and is limited to NW SME's
A9			Exhibition organisers	Raising attendance at exhibition	+ Free to attend +Wide range of attendees + large exhibition	High	MACH, MM Live and many other UK and international shows include free seminars and conferences
A10	> 1 day		Associations/institutes	Registration income	+ large number of delegates - Cost (time and money) - academic presentations	Low - Medium	ILAS (UK), Photon (UK), CLEO (Europe), ICALEO (USA)

Ref.	Duration	TT activity	Organisers	Motivation	I industrial benefit	SME needs	Examples and comments
<b>1:1 process demonstration and development</b>							
A11	< 1 year	University - industry collaboration	TICs, Advanced manufacturing centres (e.g. MTC, AMRC, ANMRC)		+ TRL 4 -9 development - Possibly too expensive for most SMEs, as a membership model seems to apply. Such cost may be satisfied as "in-kind, match" funding	Low - Medium	Programmes unclear at present
A12		University support in developing laser applications	University	Income for research provided by funding body	+ free access for limited duration to equipment and university R&D support - Expensive after initial free period	Medium - High	<b>KELAS project – ERDF funded collaboration between Liverpool and Manchester KELAS finishes in 2012 and is limited to NW SME's only</b>  SME supported by Innovation Voucher for ≤£3000 to fund universities to provide answers to SME questions. This scheme was operated by the NWDA and similar schemes by other RDAs.
A13		University support in joining collaborative funded R&D projects e.g. TSB, EU		Successful research project	+ free support in preparing grant applications + small access fund to support work towards grant application - success of grant application is not guaranteed	Medium - High	<u>Liverpool John Moores University*</u> ERDF funded GERI outreach project <u>Manchester+ Liverpool Universities*</u> ERDF funded project to 2012. Support limited to NW SME's (and a small number of larger NW companies). Resulting grant applications are only limited by the rules of the grant funder, so these applications can include non NW partners. EPSRC funded KTA project at Manchester* * Resulting grant applications are only limited by the rules of the grant funder, so these applications can include non NW partners.  (N.B. In addition to these examples of specific technology transfer projects, there are many university-SME collaborative R&D projects around the country)

Ref.	Duration	TT activity	Organisers	Motivation	I industrial benefit	SME needs	Examples and comments
A14		Network of university groups and RTOs with external agency funding	Network - appointed committee	Meeting targets of funding body	+ Research - Clear understanding of requirement needed	Medium - High	Virtual European Laser Institute (VELI): Terminated at end of EU funding (no indication of any UK SME involvement)
A15		University undertaking 1:1 research for SME	University	Commercial contract research	+ To assess the feasibility of a process of interest to the SME - high cost, long lead time - low TRL limit	High	The Laser Initiative at Lairdside Laser Centre (University of Liverpool), completed 2007.  KELAS funding offers 1:1 research for SME with incubator facility for ongoing support. ERDF funding due to finish 2012
A16		RTO (not HEI) undertaking 1:1 research for SME	RTO	Commercial contract research	+ To assess the feasibility of a process of interest to the SME - high cost	High	TWI member services (research, consultancy). Typical member cost: £1000+ per year
A17	< 1day	Job shop trials and batch manufacture	Laser job shop	Sale of service	+ Can inspect & test finished part + low cost entry for laser manufacturing.	High	
A18		Commercial application trial	Machine supplier	Sale of machine	+ User gains confidence in the laser route and can plan costs. + Demo and possible supply of machine. - Demonstrator may claim IP.	High	
A19		University undertaking free 1:1 demonstration for SME	University	Attract research if demo is successful	+ To assess the feasibility of a process of interest to the SME + Fast turn around to demonstrate feasibility. - Can give a false negative result - Demonstrator may claim IP	High	Most, if not all, University groups will have a look at an application; but may not be "Production state of the art" equipment.
<b>LMP courses</b>							
A20	< 1 year	Postgraduate courses open to mature industrial students	University	Course fee	+ Fuller understanding of laser materials processing and beam delivery	Low - Medium	Courses and higher degrees based on LMP provided by: Heriot Watt, Liverpool universities et al.
A21	1 day	CPD laser processing course for industry	Machine suppliers	Course fee new research contacts for collaboration	Laser processing introductions	Medium-High	Run by the University of Manchester Trumpf run courses on design for laser welding

## 4 Survey of UK technology transfer activity

Two questionnaires were produced for this study: one for potential suppliers of technology transfer activities and the other for UK SMEs in manufacturing, as potential recipients.

### 4.1 Selection procedure

Following the technology transfer initiatives listed in table 3-1, table 4.1 below summarises the principal LMP technology transfer activities in the UK, for each of the organisation types indicated in § 3.1.

Type of organisation	Principal LMP technology transfer activities
Research and Technical Organisations (RTOs) active in LMP. (N.B. In the survey results, university research groups (HEIs) are separated from other RTOs)	R&D projects Consultancy Written and spoken presentations on LMP
Suppliers of LMP-related equipment	Equipment Presentations Simple proof of principle Participation in R&D projects
Suppliers of LMP subcontract services	Presentations Proof of principle Batch processing service Participation in R&D projects
Providers of knowledge networking and consultancy services incorporating LMP matters (including associations and institutes)*	Information on line Written material and presentations Workshops and other meetings Networking to link SME with a suitable expert
Facilitators excluding associations and institutes (publishers, event organisers)	Events (exhibitions + seminars) to attract SME and product and service providers

**Table 4-1: Summary of areas of LMP technology transfer activity by organisation type**

### 4.2 Questionnaire responses

Two on-line questionnaires were launched by the Association of Laser Users (AILU) on 30 June 2011. The PDF version of the two questionnaires are provided in Appendix 1; they were also made available on the AILU website in Survey Monkey format for online completion.

#### 4.2.1 Potential technology transfer supplier organisations

The announcement of the supplier survey was sent only to UK organisations with a knowledge and know-how in laser materials processing whom we believe to be active as providers of technology transfer in LMP. A total of 50 complete responses were received. These organisations are listed in table 3.2 and 3.3 by category, together with an estimate each of the

percentage the response represents of the total in the category. These totals are based on the AILU database of organisations active in LMP (the underlying assumption being that if they are active then AILU would know about them) and the RULARDO report of centres for academic and industrial research in the UK, prepared for the Photonics KTN in 2008 and updated in 2010<sup>6</sup>.

Organisation	Representative fraction of UK activity
<b>Higher Education Institute</b> Cardiff University Cranfield University Heriot-Watt University Imperial College London Liverpool John Moores University University of Hull University of Manchester University of Nottingham University of Strathclyde (Institute of Photonics) University of Warwick	<b>62%.</b> 10 of 16 HEIs identified in the RULARDO report (updated 2010) as having a strong LMP activity
<b>Research organisation not a HEI</b> TWI	<b>100%.</b> The only non-HEI research organisation listed in the updated RULARDO report as established academic and RTO groups with strong LMP activity
<b>Manufacturer/supplier of LMP technology</b> <u>Research active in LMP:</u> Oxford Lasers Ltd Spectrum Technologies PLC  <u>Not research active in LMP:</u> Air Liquide Amada UK Limited Applied Laser Engineering Ltd Brinell Vision Limited Laserite Ltd PowerPhotonic Ltd Pyramid Engineering Services Co Ltd Rofin Baasel UK & ES Technology Thinklaser Limited TLM Laser Ltd Trumpf Ltd ULO Optics	<b>11%.</b> 2 out of the 18 listed in the updated RULARDO report as established industrial groups with strong disclosed LMP activity  <b>8%.</b> 12 out of the 152 other UK-based manufacturers or suppliers of industrial laser sources or embedded laser equipment
<b>Consultancy providing technical assistance in the application of LMP technology</b> Grounded Innovation Ltd Nanophoton Technologies	<b>40%.</b> 2 out of 5 UK-based consultants with good LMP awareness

**Table 4-2 Responses to the technology transfer suppliers questionnaire (part 1)**

<sup>6</sup> 'Top level UK research in laser materials processing' pub. AILU 2008, updated 2010.

Organisation	Representative fraction of UK activity
<b>Sub-contract engineering organisation</b> 3P Innovation Attica Components Ltd Carlton laser services limited CHK PLC Essex Laser Hutchinson Engineering Hydram Engineering Ltd. Laser Expertise ltd Laser Micromachining Ltd. Laser Process Ltd Micrometric Ltd Midtherm Laser Ltd RLW Robinson Engineering Subcon Laser Cutting Ltd Trilogy Lasercraft Ltd Wallace McDowall Ltd	<b>5.4%</b> . 19 (incl. 2 that did not provide contact details) out of 350 UK-based laser engineering sub-contractors
<b>Association and institute with active interest in LMP</b> AILU South of England Photonics Network	<b>25%</b> . 2 out of 8 UK-based associations or institutes with an active interest in LMP

**Table 4-3 Responses to the technology transfer suppliers questionnaire (part 2)**

#### 4.2.2 Potential technology transfer recipient organisations

The SMEs organisations mailed in this survey as potential recipients of LMP technology transfer, a total of 72, were only those that had previously interacted with AILU in some way. Excluding laser job shops, those mailed represented only ~10% of SMEs estimated to be using high value laser materials processing systems for in-house manufacture. Of these, 15 complete responses (20% of those mailed) were received.

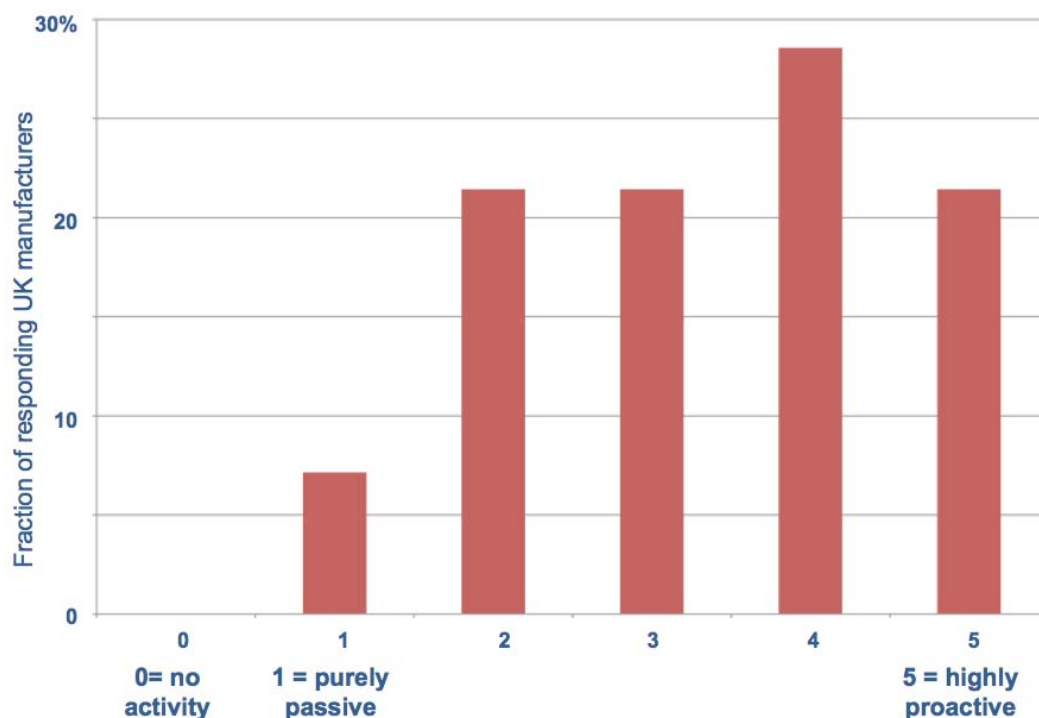
## 5 Survey results

### 5.1 Results and analysis for potential recipients of LMP technology transfer

Figures 5-1 to 5-3 below present the main results from the amalgamated responses from UK manufacturing SMEs as potential recipients of LMP.

#### 5.1.1 Interest shown by UK SMEs in the Manufacturing Sector

Figure 5-1 shows the self-assessed pro-activity of SME UK manufacturers to acquiring knowledge and technology in the area of LMP. The high self-assessment of pro-activity is impressive, though it implies a strong positive attitude that is certainly not reflected in the difficulty experienced by AILU and other such organisations in attracting SME manufacturers to technology events.

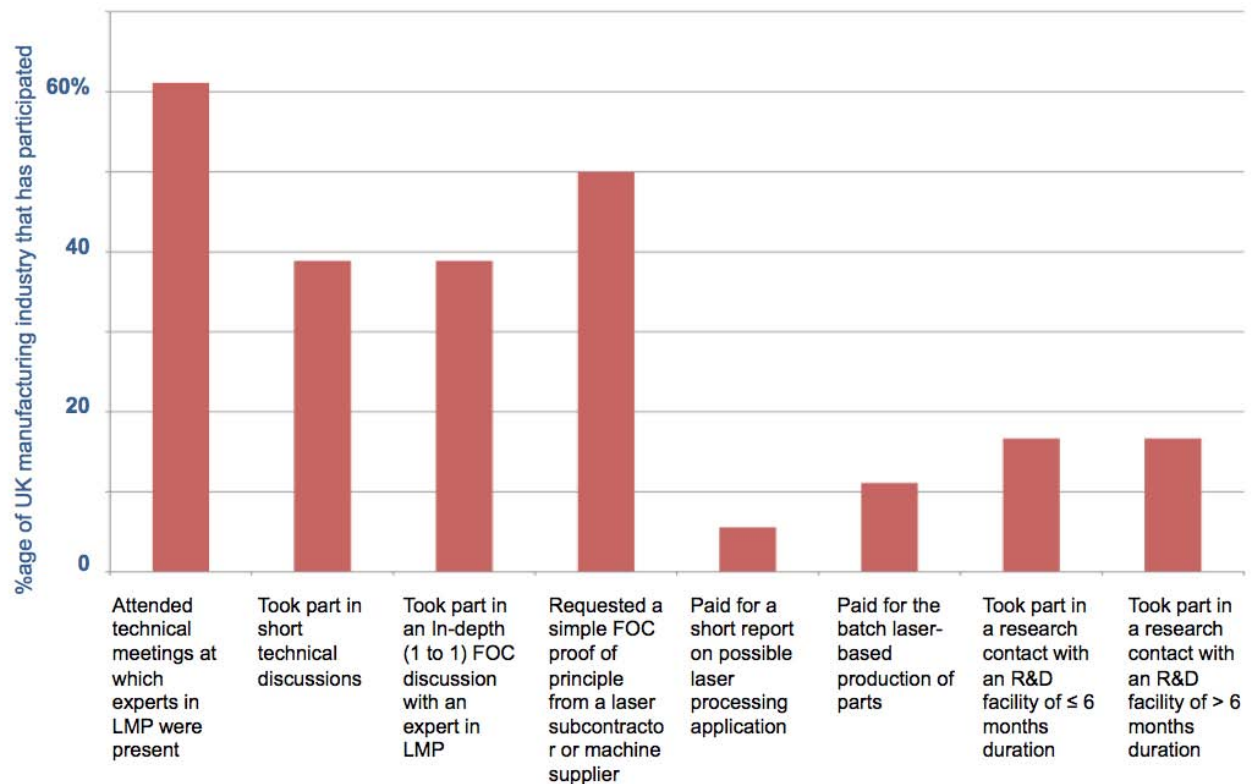


**Figure 5-1: Self-assessed pro-activity of SME UK manufacturers to the acquisition of knowledge and technology in the area of LMP**

#### 5.1.2 Participation of UK SMEs in the Manufacturing Sector

Figure 5-2 shows the popularity of the main forms of technology transfer with the exception of attending exhibitions or equivalent general technical events. The indication refers to types of activities participated in the last 2-3 years. For example, less than 40% of respondents took part in short technical discussions.

Referring to this figure, the left side first four forms of technology transfer are essentially free of charge and are seen to have been reasonably well supported; the remaining four cost significant time and money and presumably this is a significant reason for them being only weakly supported.



**Figure 5-2: Self-assessed SME UK manufacturing industry participation in technology transfer activities**

### 5.1.3 Barriers to technology transfer activity

Figure 5-3 shows that the expense of some technology transfer activities is the most common reason for non-involvement in technology transfer activities.

Interestingly, the survey found that IPR issues, cited by some universities as a problem area in establishing contractual arrangements for research activities, is the least common reason for non-involvement; perhaps this is because such issues only emerge in later stages of negotiation i.e. in most cases the expense and other factors are sufficient to put off the SME before IPR issues are raised.

Adding support to the current TIC initiative, the figure shows that after expense it is 'a lack of technical assistance available to take the research from feasibility to production' is cited as the most common reason, after expense, for non-participation in technology transfer activities.

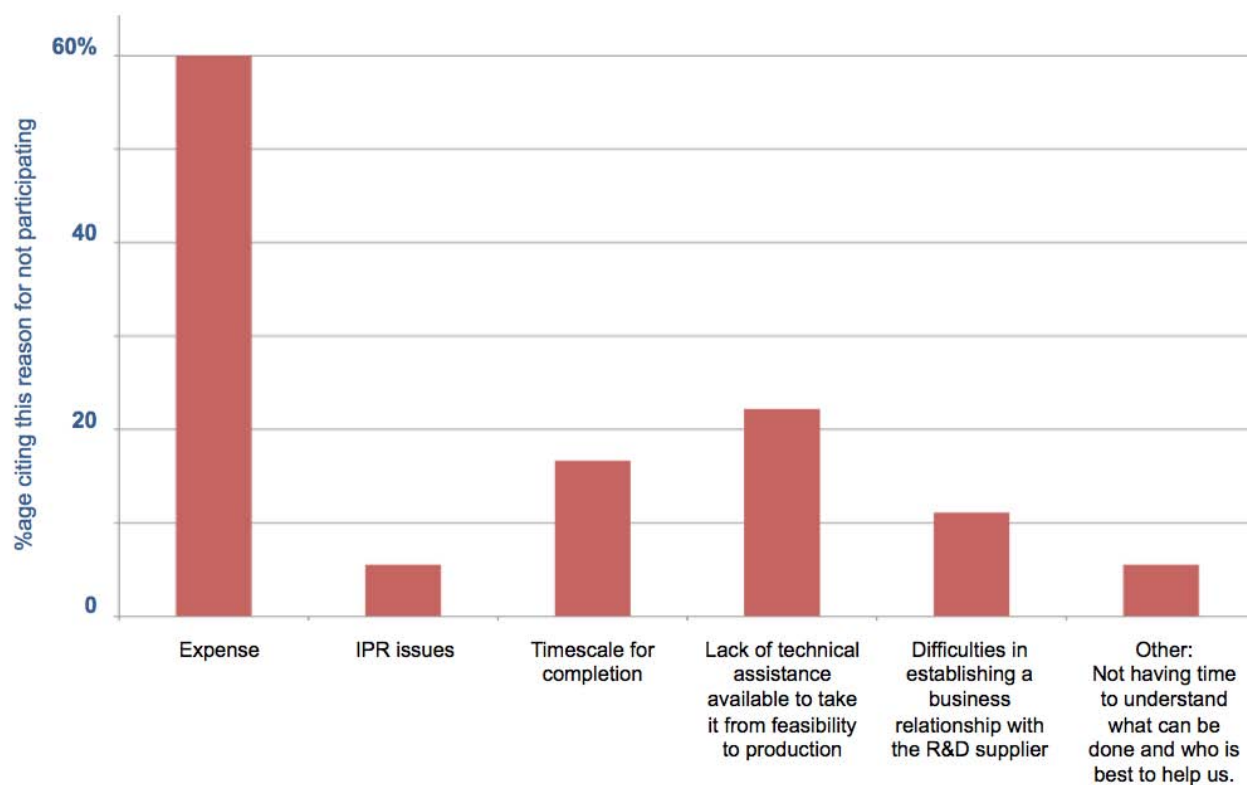


Figure 5-3: Reasons for UK manufacturing industry not taking part in technology transfer activity

## 5.2 Results and analysis for providers of LMP technology transfer

In each the following set of figures two plots are laid side by side: one set shows the average measure of technology transfer activity per organisational category (university group, laser manufacturer etc); the other set shows the estimated total UK activity, calculated by multiplying the average values by the assessed number of such organisations in the UK, as detailed in Tables 4-2 and 4-3. To the extent that a willingness to participate in the survey is indicative of interest in technology transfer activities, both sets of figures are likely to overestimate the average level of activity for the category and therefore the total UK activity. However, in the absence of more reliable information it provides at the best estimate available for total output; these total UK activity figures are summarised in table 5-1 in § 5.2.4.

### 5.2.1 Publications and Events

In figure 5-4, the relative sizes of in LMP-related academic output per organisation are as would be expected, with RTOs (including HEIs) dominating the picture, but it is at first sight surprising to see subcontract engineers and manufacturers and suppliers of laser equipment providing the higher estimated total output. Academics will rightly point out that their output is typically more detailed and of a higher quality than that of other types of organisation; subcontract engineers and manufacturers and suppliers of laser equipment may counter that their output is of a more practical nature and deals with topics of more immediate application.

Figure 5-5 relates to outputs that are much more accessible to SMEs and more easily digested. The average values from universities and RTOs are approximately half of the academic output; for other categories of organisation the output is higher, as expected. Nationally, manufacturers and suppliers of laser equipment together with subcontract engineers are estimated to contribute over 90% of UK activity in publications and presentations aimed at UK industry.

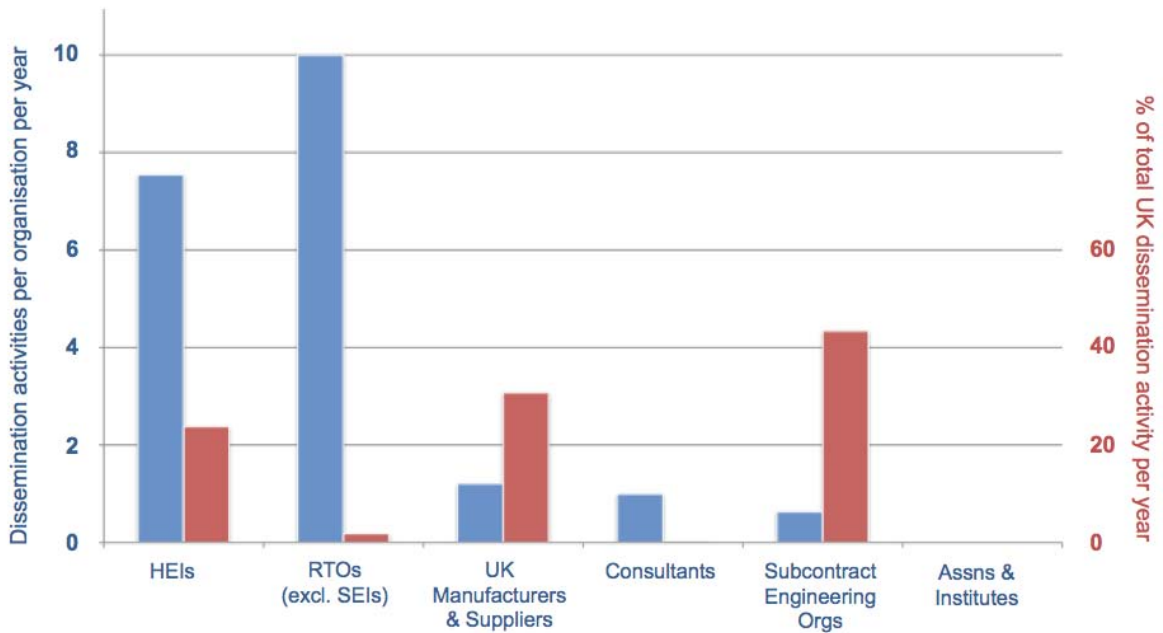


Figure 5-4: LMP dissemination through academic publications and conferences papers

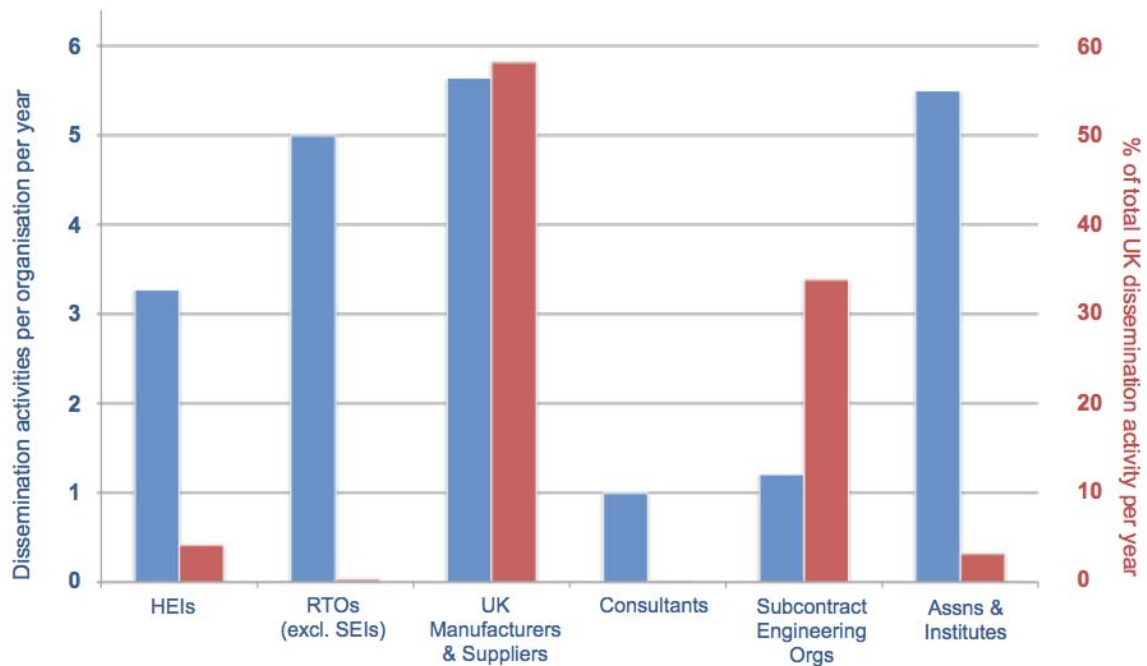


Figure 5-5: LMP dissemination through trade journals, magazines and presentations at events targeted at UK industry

### 5.2.2 Face to face discussions

In most organisations diary notes are made of formal and informal discussions but it is unreasonable in a survey to elaborate on the distinction and indeed to attempt to specify exactly what constitutes a discussion. In addressing this technology transfer mechanism in the survey it was hoped that variations in interpretation would average out.

Figures 5-6 (showing activity in informal discussions) and 5-7 (for more in-depth discussions) with SMEs are very similar in shape, with informal discussions a factor of 2 to 3 more prevalent. In contrast to written output and presentations of work per organisation shown in figures 5-4 and 5-5, the contribution of HEIs in verbal communication is almost negligible. In contrast the RTO (excluding HEIs) is markedly higher than that of other organisation categories.

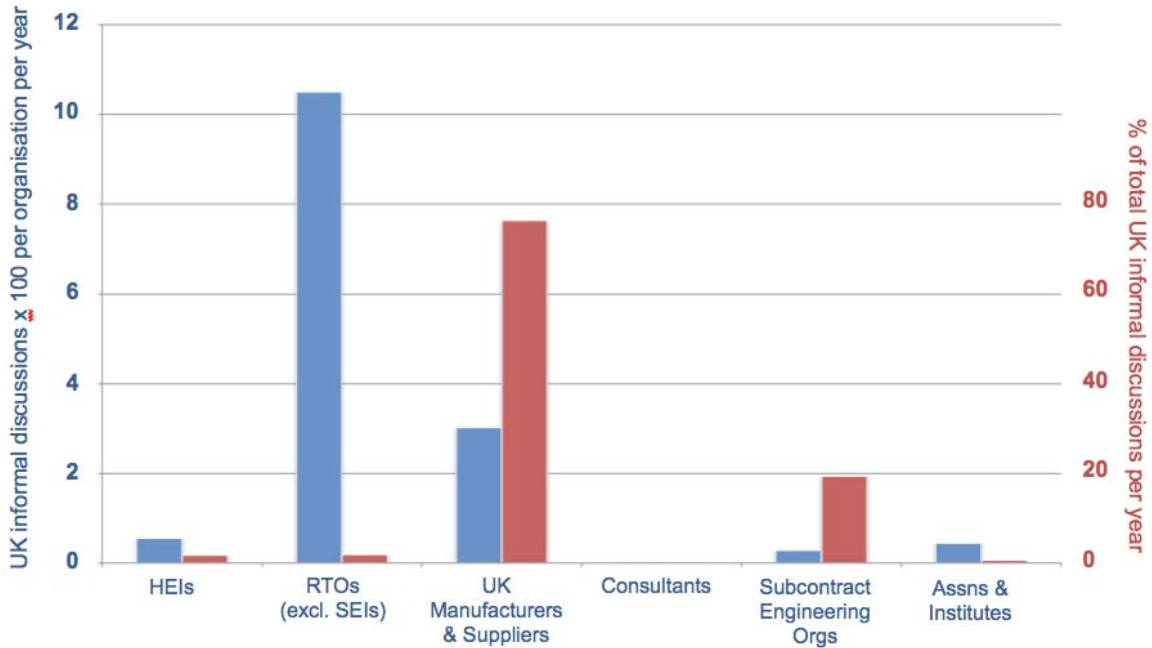


Figure 5-6: LMP dissemination through informal discussions with SMEs

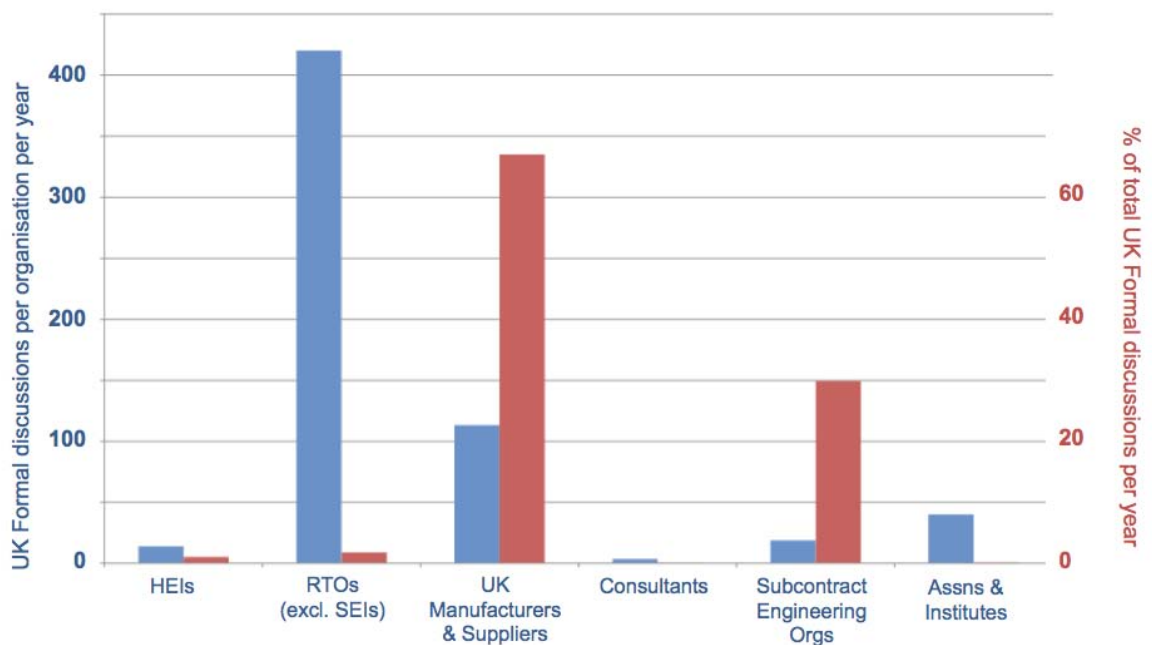


Figure 5-7: LMP dissemination through 1:1 in-depth discussions with SMEs

### 5.2.3 Advanced services

#### 5.2.3.1 Consultancy services with SMEs

As with communication activities, figure 5-8 shows HEIs to be relatively inactive in their dealings with SMEs, especially in comparison with other RTOs. Associations and institutes generally do not provide this service (though they do stimulate a lot of consultancy through networking with their members) and the low figure for consultants is simply a reflection of the few people in the UK involved in this activity.

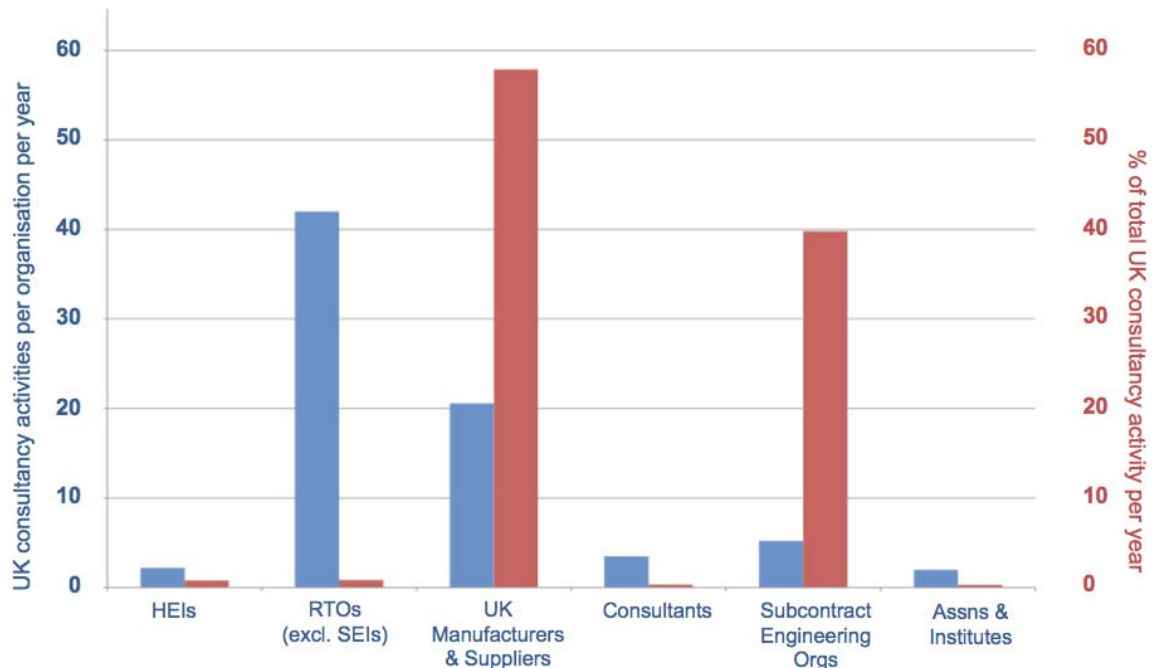


Figure 5-8: LMP dissemination through consultancy services with SMEs

#### 5.2.3.2 Demonstrations of laser materials processing

Being able to build demonstrators and carry out application development is of paramount importance to SMEs wishing to utilise LMP in manufacturing. A major challenge in the production environment is process control, and this can involve much R&D beyond the initial demonstration of the laser process. As a result, the laser used to prove the process may not be the laser type most appropriate for use in production.

As seen in figure 5-9, demonstrations performed by subcontractors are much lower in frequency for those provided at university and other RTOs, but all are much less than manufacturers and suppliers, where such operations are a key part of the sales process. As with presentations and discussions; the activities of manufacturers and suppliers of laser equipment and subcontract engineers dominate, contributing an estimated 95% or more of the total UK LMP demonstration activity.

The results for proof of principle activity in figure 5-10 are even more dominated by the activity of manufacturers and suppliers, with an average of over 180 such demonstrations per year. These include not only demonstrations of utility machines but also of bespoke machines produced by machine integrators, where a significant amount of R&D is required. Demonstration of proof of principle by subcontracting engineering companies can also entail significant R&D. In both cases, the R&D activity is driven totally by industrial demand, which for SMEs is generally linked to an incremental improvement in product design. Virtually none of this work addresses the need for R&D to manufacture products that are several years down the line.

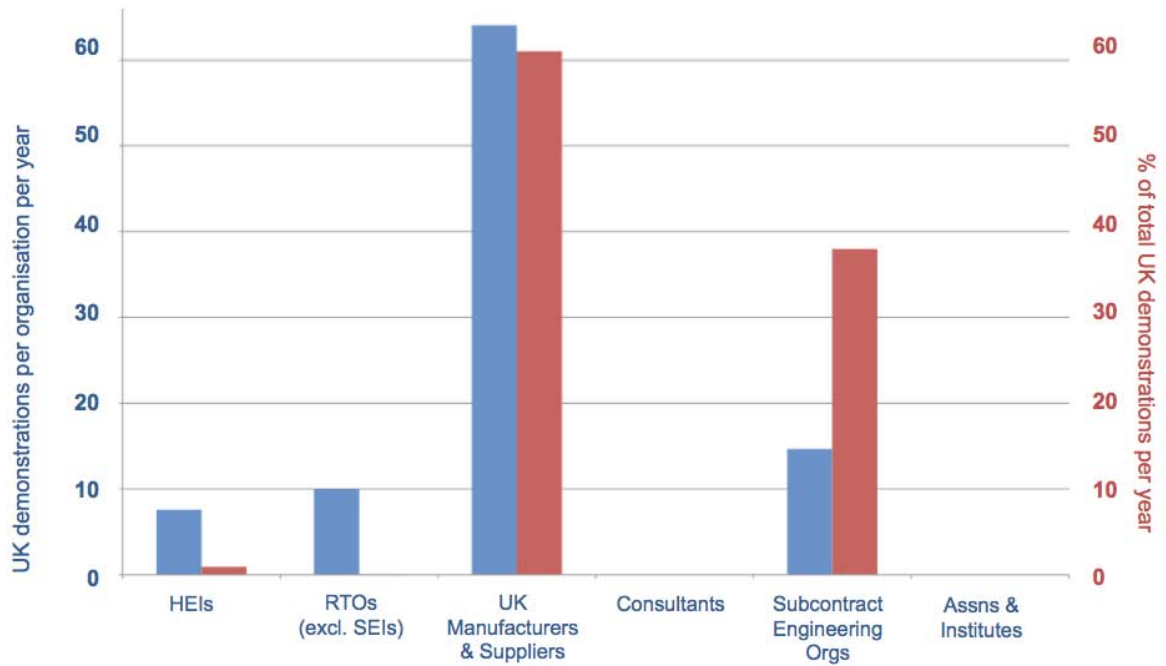


Figure 5-9: LMP dissemination through demonstration of process in action

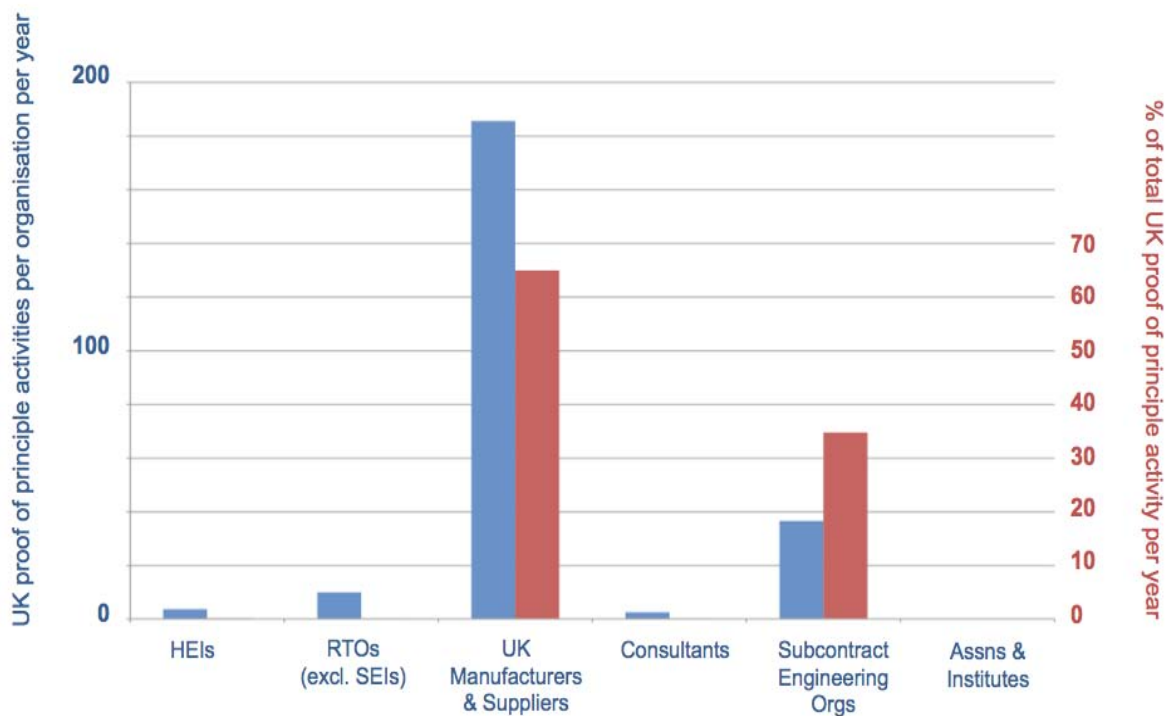


Figure 5-10: LMP dissemination through proof of principle

Figure 5-11 shows results for batch LMP activity. Subcontract engineering organisations are well established for this activity, whereas manufacturers of machines rarely are; and this is reflected in the figure. In some cases the subcontractors may exploit the flexibility of laser materials processing to produce a suitable product as a prototype; though the laser process used to do this (i.e. type of laser and beam delivery) may not necessarily be the best

arrangement for the final processing machine, should the client of the subcontractor wish to bring the manufacturing in house.

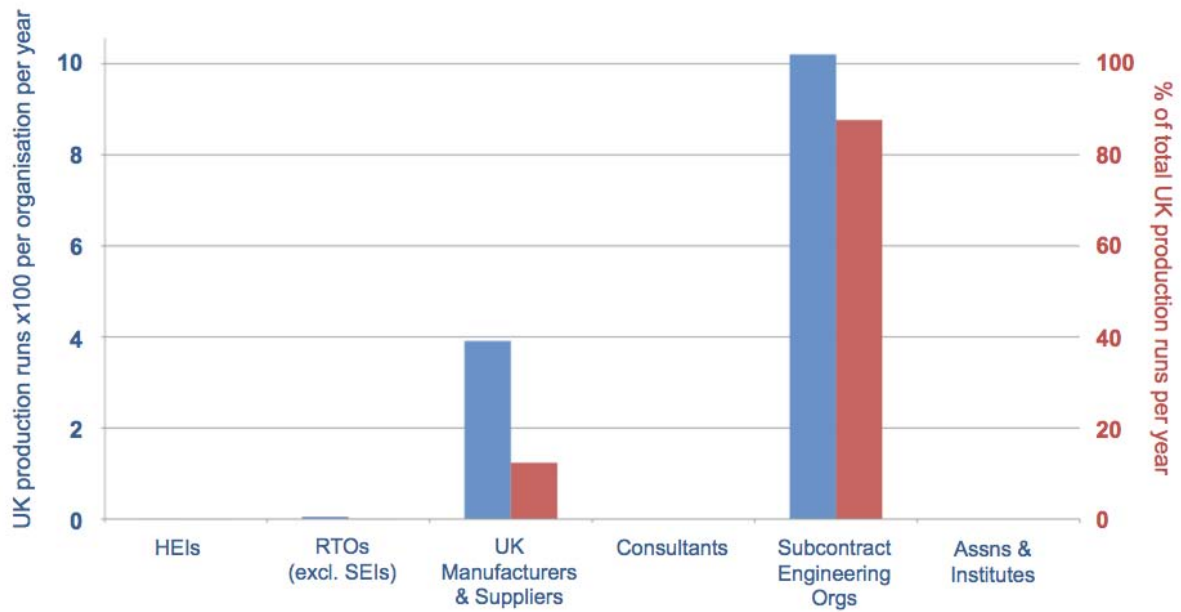


Figure 5-11: LMP dissemination through batch laser production for SME

5.2.3.3 Contract research

Figures 5-12 and 5-13 show short ( $\leq 6$  month) and long ( $> 6$  month) contract research activity in the UK.

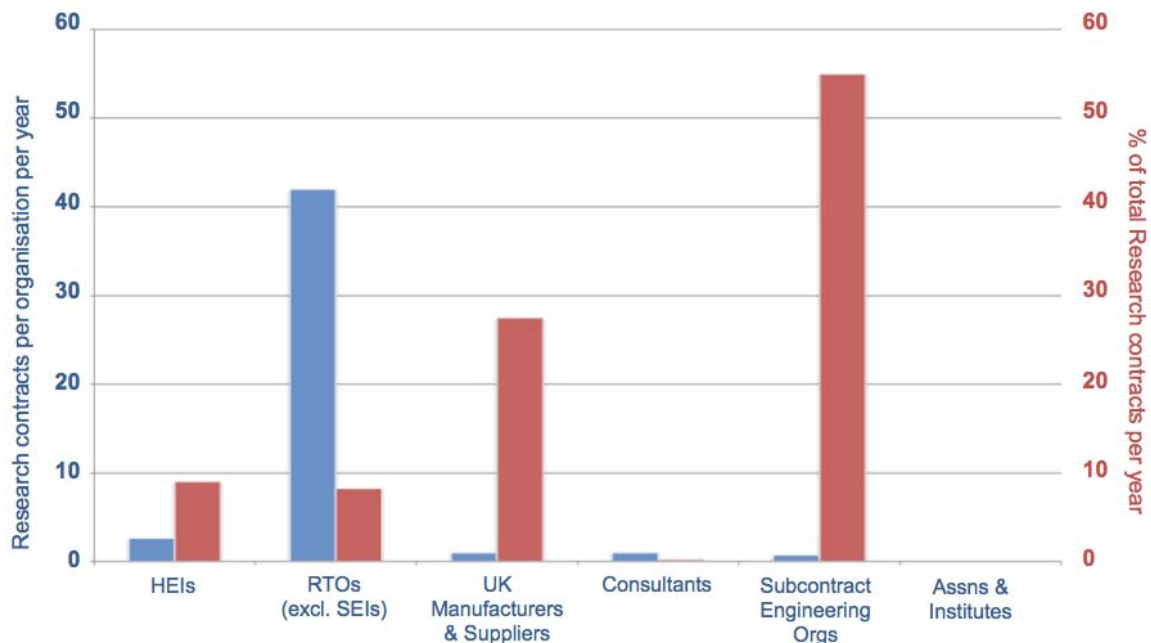


Figure 5-12: LMP dissemination through short ( $\leq 6$  month) contract research for SMEs

Non-university RTO's rely heavily on contracts for funding, and without the teaching commitment it is not surprising that their number of contracts per organisation per year, both long and short term, greatly exceeds the value for universities. The available effort for R&D

activities is generally low in engineering subcontractors as a whole, with the exception of job shops that specialise in non-utility processes, most commonly welding, drilling and micro-processing and makes up a significant part of the total R&D effort for SMEs.

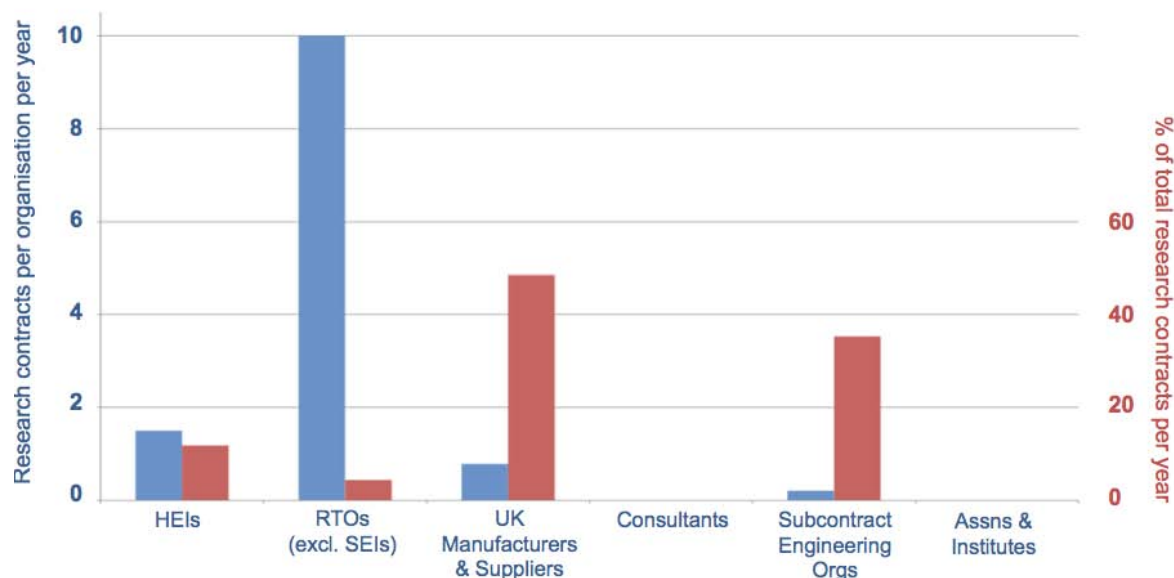


Figure 5-13: LMP dissemination through extended (> 6 month) contract research for SMEs

#### 5.2.4 Total UK activity

Table 5-1 summarises the estimated total UK activity in the LMP processes addressed in the questionnaire.

Laser materials processing technology transfer activity with SMEs	Estimated total activity by UK organisations per year
Academic publications and conference presentations	550 papers and presentations
Articles in industry magazines and presentations at industry events	1400 papers and presentations
Informal discussions with experts	55500 informal discussions per year
1:1 in-depth discussions	24000 formal discussions
Consultancy services	5000 consultancy actions
Proof of principle	44000 proof of principle
Demonstration of process in action	15000 demonstrations
Batch production	440000 batch production runs
Short ( $\leq 6$ month) contracts	500 short research contracts
Extended ( $> 6$ month) contracts	230 extended research contracts

Table 5-1: Estimated LMP dissemination activities per year by UK organisations for SMEs

### 5.2.5 Motivation

The results of the survey in regard to motivation for technology transfer are summarised in table 5-2. Interestingly, but not surprising to those working in this area, altruism and enthusiasm consistently remains one of the main driving forces of LMP technology transfer for over 90% of the community of those in LMP research, working as consultants or involved in running associations. Manufacturers and suppliers of laser equipment and subcontracting engineers, who as a group provide over 90% of UK LMP technology transfer activity to SMEs, the questionnaire results indicated that 'only' 30 – 60% were less driven by altruism and enthusiasm.

In view of the fact that such a small number of RTOs (excl. HEIs), consultants and associations & Institutes took part on the survey, it is not reasonable to make comparisons between technology transfer suppliers from these results.

	HEI	RTO (excl. HEI)	Manufact urers & suppliers	Consultants	Subcon. Engineers	Assns & Institutes
Sale of subcon services						
Sale of equipment						
Sale of consultancy & R&D						
Securing collab. Contract funding						
Complying with conditions of a contract						
Altruism and enthusiasm						
	10 – 30%	30 – 60%	60 -90%			> 90%

**Table 5-2: Sources of technology transfer motivation Colours indicate main motivators:**

### 5.2.6 Foreseen changes in technology transfer services

The questionnaire asked suppliers of technology transfer services to identify (in a free text response) changes they anticipate to be likely to influence planning decisions, but without setting a timescale for change.

Some HEIs regretted the demise of Regional Development Agencies, whose funding supported many of their activities with local SMEs. They pointed out that ERDF funds were becoming harder to gain and come with terms and conditions that make application work less viable and beneficial. There was a more general concern among HEIs that government funding may be diverted to the TICs and that this will restrict funding available to them to pursue research, with or without technology transfer to SMEs. Consultants hoped for new opportunities in LMP, to be provided by TICs.

For equipment manufacturers and suppliers the outlook was very positive; many anticipating an expansion and an increase in the export market. Of particular interest, there was significant anticipation of a growth in their LMP technology transfer activities; some aspiring to significantly increase the size of their technology transfer support team, others to growing the

consultancy side of their business and increasing their application and test capability. One respondent cited an expansion in activities to include LMP applications for processing composite materials.

Laser engineering subcontractors anticipated an increasing focus in their services on providing smaller parts and finer features; otherwise the general view is that their technology transfer activities to SMEs are unlikely to change.

### 5.2.7 Knowledge Transfer Partnerships

The questionnaire asked suppliers of technology transfer services to indicate if their organisation had been involved in any Knowledge Transfer Partnerships (KTPs) in the last 5 years.

Of the total of 50 respondents from suppliers of technology transfer activities:

- 18 had not participated in a KTP;
- 6 had participated and would be willing to provide further details;
- 5 had participated but preferred not to provide details.
- The remaining respondents did not reply to this question.

Details have been provided to Alastair Wilson (ESP KTN).

### 5.2.8 Case studies

Suppliers of technology transfer services were asked to indicate if they would be willing to provide information on a laser related case study carried out in the last 5 years, that the Knowledge Transfer Network and Technology Strategy Board could use to publicise the benefits of technology transfer.

Of those who replied:

- 12 respondents were willing to provide one or more case studies upon request
- 8 respondents were willing to provide one or more case studies but not at this time

Case studies will be produced and disseminated as a longer term objective of this work.

### 5.2.9 ESP KTN membership

Both questionnaires asked respondents if they or others in their organisation had joined the ESP KTN at the \_connect website.

Of the total of 41 who replied to this question:

- 22 were members of the ESP KTN
- 4 were at organisations where a colleague was a ESP KTN member.
- 5 were unsure if they were members or not

Of the remaining 19, six intended to join in the near term (2 will do this themselves). Details of the other four will be passed over to Alastair Wilson (ESP KTN).

## 6 Conclusions and recommendations

The general outlook for lasers in manufacturing is excellent and laser suppliers and job shops in the UK are very active. There are a number of well developed, versatile industrial laser machine types available (so called 'utility' machines) and a great many more LMP processes that have been successfully demonstrated but only up to the lower TRL values.

The utilisation of LMP technology in UK SME manufacturing is hampered, mainly by high cost capital investment costs (though prices are falling) but also by the cost and timescale of available technical assistance to take the laser process from feasibility to production. The majority of UK SMEs do not have the resources to carry out such R &D internally. Nevertheless, there is a thriving laser subcontract sector in the UK and between this sector and suppliers of laser equipment there is a massive technology transfer activity in the UK over and above that provided by universities and other research organisations.

### 6.1 Facts and figures for UK technology transfer activity in laser materials processing

The responses to the questionnaires for supplier and potential recipients of transfer activities in LMP revealed the following key conclusions:

1. An impressively high self-assessment by SMEs of pro-activity towards LMP technology transfer (see figure 5-1)
2. A high sensitivity of SMEs to the cost of technology transfer (see figure 5-3)
3. The majority of the technology transfer activity in LMP in the UK is carried out by the suppliers of laser equipment and by the laser job shops. (This is largely associated with the use of 'utility' machines)
4. Much development of laser processes is carried out by the suppliers of laser equipment and by the laser job shops. (e.g. work with ceramics, paper, thin film, precious metals, semi-conductors and other non-standard materials together with laser welding, hole drilling and micromachining and other such processes where a significant amount of preparation and testing is generally required)
5. Knowledge Transfer Partnerships (KTPs) play a role in the technology transfer process, with 22% of respondents indicating that they had been involved in a Knowledge Transfer Partnerships (KTPs) in the last 5 years.
6. Demonstrations of LMP performed by subcontractors were found to be similar in frequency for those provided by HEIs and other RTOs. Demonstrations by manufacturers and suppliers for were found to be significantly more frequent.
7. Of those responding to the questionnaire, proof of principle activities were found to be dominated by the efforts of manufacturers and suppliers (an average of 180 such demonstrations per organisation per year) and subcontracting engineering companies (40 demonstrations per organisation per year). These include not only demonstrations of utility machines but also of bespoke machines produced by machine integrators, where a significant amount of R&D is involved.
8. Laser-based batch production, for small batches at least, are dominated by the efforts of subcontracting engineering companies (an average of 1000 such demonstrations per organisation per year) and manufacturers and suppliers (400 demonstrations per organisation per year).
9. Laser subcontract engineering organisations provide an invaluable service to manufacturing industry, providing a rapid turn-around on batch production, prototyping, and important proof of principle of the laser route.

## 6.2 Recommendations for improving technology transfer

### 6.2.1 Workshops and seminars

Many free or low cost events are now available. Recently KTN-funded events have proliferated and increasingly publishers and other event organisers are providing free or low cost seminars and conferences to attract people to exhibitions.

Another challenge comes from the flexibility of LMP technology, covering sectors as far apart as medicine, communications and aerospace. Beyond giving a basic introduction to the subject, engaging audiences across such broad spectrum of industrial sectors, is a major challenge.

- R1. Despite their importance as a technology transfer activity, evidence indicates that 'traditional' specialist technical workshops do not appeal sufficiently to SMEs, with cost and time key deterrents. Links should be formed between publishers and other event organisers to exploit the opportunities that events linked with exhibitions provide.

### 6.2.2 Internet services for networking

Businesses are increasingly exploiting social networking internet sites; for example Linked In for business networking and forums, Wikipedia for information, YouTube for video demonstrations, Webinars for distance participation.

- R2. Associations and other organisations involved in technology transfer should investigate making maximum use of business networking sites for this purpose. Clearly there are security issues and matters of confidence in advice received must be considered but the ease of use, features and robustness of commercial sites are major attractions and are more likely to appeal to SMEs.

### 6.2.3 Database maintenance

Database maintenance is a major activity for many organisations, no more so than those selling equipment and services. The AILU database lists only 1530 persons in the UK active in LMP, representing 960 UK-based companies of which 180 are job shops and 130 others industrial users of lasers (of which 80 are SMEs). These figures compare poorly with what we estimate to be 400 laser job shops and 600 others industrial users of lasers in the UK.

One of the main activities of any organisation selling LMP equipment is to maintain a database of the actual and potential users of LMP; such a database is of great value and the information is unlikely to be divulged.

- R3. Associations and other organisations involved in technology transfer should work with LMP suppliers, singly if necessary, in joint technology transfer activities where the supplier will use its database in support.

### 6.2.4 R&D by suppliers and subcontractors

UK laser job shops and machine suppliers could play an even greater role in improving the laser uptake in manufacturing industry.

- R4. Machine suppliers and laser job shops provide direct and alternative solutions for exploiting laser materials processing and should be partnered more to provide technology transfer. Many options for LMP would indeed require significant development and/or the outcome would be uncertain, but utility laser processing machines, either purchased or the work subcontracted, may provide a solution for many and at little if any cost to the SME.

- R5. Some of the day-to-day work that suppliers and job shops undertake should be regarded as R&D. This would demystify the R&D process and make SMEs more open to consider R&D in collaboration with a RTO or HEI.
- R6. Trade bodies that support SMEs and suppliers, should be encouraged to strengthen their networking activities so as to improve the dissemination LMP information within the SME community.

#### 6.2.5 Research in universities

Setting aside the financial and time constraints, SMEs express difficulties accessing the expertise that resides in universities<sup>7</sup>. There could be a number of reasons for this, including:

- Costing of contract research based on longer timescales / multiples of “researcher years” both lead to higher prices;
- Top level priority of academics not aligned with offering contract research and development;
- IPR Issues;
- Equipment available is not to production standard and cannot demonstrate higher TRL level activity;
- Academic research activity is aligned to achieving international research leadership in national research assessment. This does not necessarily align with current UK industrial requirements.

Many of these issues are addressed by the concept of the Technology Innovation Centres, in particular the High Value Manufacturing TIC and a potential Photonics TIC. However the research and development activities of a TIC may be prioritised by a small number of (large) companies that become “members” of a TIC. Meanwhile university research groups that have invested in more production relevant equipment to provide higher TRL activity may find the TIC’s offering strong competition for research funding.

- R7. The UK industrial laser community should: (i) support LMP activities within TICs, such as that planned by the HVM TIC; (ii) promote a Photonics TIC that provides new laser sources, systems and processes for development to production level within the HVM TIC.
- R8. TIC’s should be encouraged to collaborate with any of the recognised LMP research groups based on their current experience / knowledge of the processes under development,
- R9. Research assessment exercises in UK universities should be modified to increase the importance of technology transfer (in the broadest category, not simply exploitation / spinning out of “in-house” research) and to give a higher ranking to the impact of research.
- R10. Government should provide new technology transfer funding for HEI’s to support technology transfer to industry. Such funding should be made available nationally and through regional or local economic partners.

#### 6.2.6 Education and training

Government funding is predominately used to support vocational training and training for 16-19 year olds. Unfortunately, the provision of training in sector skills relating to laser materials processing is very limited and engineering students (mechanical, manufacturing, production etc) may not have even been introduced to laser processing in their degree studies

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<sup>7</sup> The 2009 UK Innovation Survey asked companies to rate the various types of technology transfer organisations; only 4% of SMEs who responded rated universities as valuable sources of high value information.

- R11. Phased funding should be given for AILU to: (i) produce a review of the provision of knowledge in LMP in the engineering HEI sector; (ii) provide an approved mini-syllabus for HEI level engineering degrees; iii) collate necessary course material to cover the developed mini-syllabus.
- R12. Funding should be given for AILU to work with sector skills agencies to review provision of industrial training in LMP.
- R13. Funding should be given for AILU to participate in creating a working party to review and develop the use of LMP in secondary and tertiary education.

#### 6.2.7 Design for laser manufacture

To make best use of lasers in manufacturing, products need to be designed with an awareness of the capabilities of LMP in mind for the production of components and in their assembly

- R14. Funded support should be provided to promote AILU's design for manufacture web service (at [www.designforlasermanufacture.com](http://www.designforlasermanufacture.com)) and its message more widely.

## 7 Appendix 1: Questionnaires

### 7.1 Laser Materials Processing (LMP) Technology - Supplier Questionnaire

**1. Please indicate the description that best fits your organisation's activities in the context of LMP technology:**

- A Higher Education Institute (HEI)
- A research organisation that is not a HEI
- A manufacturer/supplier of LMP technology
- A consultancy providing technical assistance in the application of LMP technology
- A sub-contract engineering organisation
- An association or institute with an active interest in LMP
- Other (please specify)

**2. Does your organisation provide activities of any kind for assisting other organisations in the application of Laser Materials Processing (LMP) technology?**

Yes; we have knowledge and/or technology capability in LMP and part or all of our organisation's activities involves assisting transferring some of this knowledge and/or technology capability in LMP to other organisations.

No; whatever knowledge and/or technology capability in LMP our organisation possesses is for internal use only.

**3. On a scale of zero 0 and 5, how proactive is your organisation in meeting the technology transfer needs of SMEs in the area of LMP? (zero = no activity, 1 = purely passive (i.e. waiting for a SME to make contact), 5 = highly proactive (e.g. seeking out a potential SME recipient))**

**4. From the technology transfer activity headings in the list below please identify those that your organisation promotes to SMEs in the area of LMP technology (identify all that apply) and if possible give a rough indication of how frequently the identified activities are performed. (Please select from the drop down menus)**

- Provision of information in academic publications and conferences
- Provision of information in Trade journal and magazine articles, and presentations at events targeted at UK industry
- Availability of experts for informal technical discussions with SMEs
- Availability of experts for in-depth (1 to 1) discussions with SMEs
- Provision of advisory consultancy services (e.g. provision of reports)
- Simple proof of principle (e.g. providing individual samples of laser processed parts)
- Demonstration of operational laser equipment performing process(es) relevant to the SME's needs
- Batch laser-based manufacturing of parts for SME
- Conduct research contract/project ≤ 6 months duration
- Conduct research contract/project > 6 months duration
- No assistance on LMP technology readily accessible

**5. Please list any unique features of your organisation's LMP technology transfer activities:**

**6. What are the main sources of motivation for your organisation with regard to its current approach to LMP technology transfer activities with SMEs (tick all that apply):**

- Potential sale of subcontract services
- Potential sale of equipment
- Potential sale of consultancy and/or R&D services
- Potential securing of collaborative project funding
- Complying with the terms of an existing contract
- Altruism and enthusiasm for LMP
- Other (please specify)

**7. Do you currently receive support for your technology transfer activities from any of the following (tick all that apply)?**

- Research Council (e.g. EPSRC) Regional funding
- Technology Strategy Board Knowledge Transfer Network
- EU Commission (e.g. Framework 7)
- Other (please specify)

**8. What if any changes do you foresee in the services your organisation currently offers in LMP technology transfer?**

**9. Has your organisation been involved in any Knowledge Transfer Partnerships (KTPs) in the last 5 years?**

- No
- Yes, please feel free to contact me for further details
- Yes, but I prefer not to provide details

**10. Would you be willing to provide information on a laser-related case study carried out in the last 5 years that the Knowledge Transfer Network and Technology Strategy Board could use to publicise the benefits of technology transfer?**

- Yes
- Yes, but not at this stage
- No

**11. Have you or others on your organisation joined the ESP KTN at the \_connect website at <https://ktn.innovateuk.org/web/guest/home>? (tick all that apply)**

- Yes, I have already joined
- Yes, someone else from my organisation has joined
- I'm not sure if I have joined
- I am not aware of anyone else in my organisation who has joined
- No, I haven't joined but would like to; please send me more details
- No, I haven't joined but would like to; I will sort it out myself
- No, I haven't joined, and I won't be at present

## 7.2 Laser Materials Processing (LMP) Technology – Potential Recipient Questionnaire

**1. Please confirm: Is your company a Small to Medium Size Enterprise (SME) i.e. does it employ fewer than 250 persons and have a turnover of less than € 50M?**

Yes

No - skip to Q10

**2. Please confirm: Is your company currently engaged in manufacturing activities?**

Yes

No - skip to Q10

**3. Does your company currently make use of (in-house or by subcontract) Laser Materials Processing e.g. for marking, cutting, welding?**

Yes

No, but it is at least a possibility

No, and we do not currently have an interest in the technology – skip to Q10

**4. Does your company have any in-house knowledge/ expertise in LMP?**

Yes

No

**5. In the last 5 years has your company sought expert advice on a commercial application of LMP?**

Yes

No - skip to Q7

**6. Please indicate which technology transfer activities your company has engaged in to acquire LMP information: (tick all that apply)**

Attended technical meetings at which experts in LMP were present

Took part in short technical discussions

In-depth (1 to 1) FOC discussion with an expert in LMP

Paid for a short report on possible laser processing application

Requested a simple FOC proof of principle from a laser subcontractor or machine supplier

Paid for the batch laser-based production of parts

Took part in a research contact with an R&D facility of  $\leq 6$  months duration

Took part in a research contact with an R&D facility of  $> 6$  months duration

Other (please specify)

**7. On a scale of zero 0 and 5, how proactive is your company in seeking to acquire knowledge and technology in LMP? (zero = no activity, 1 = purely passive (i.e. waiting for a provider to make contact), 5 = highly proactive (e.g. seeking out a potential contact))**

**8. What do you see as the main obstacles/barriers (if any) to you gaining assistance to more fully assess the potential of laser processing in your business? (Tick all that apply):**

Expense

IPR issues

Timescale for completion

Lack of technical assistance available to take it from feasibility to production

Difficulties in establishing a business relationship with the R&D supplier Other (please specify)

**9. Have you or others on your organisation joined the ESP KTN at the \_connect website at <https://ktn.innovateuk.org/web/guest/home?> (tick all that apply)**

Yes, I have already joined

Yes, someone else from my organisation has joined

I'm not sure if I have joined

I am not aware of anyone else in my organisation that has joined

No, I haven't joined but would like to; please send me more details

No, I haven't joined but would like to; I will sort it out myself

No, I haven't joined, and I won't be at present