The future needs for Mass Spectrometry in the United Kingdom: an evidence-based vision collated and coordinated by the British Mass Spectrometry Society (BMSS)

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Aim

This short document provides an update on the BMSS's project to gather input from the society membership, and wider community that is also dependant on mass spectrometry, regarding future demands that will be made of mass spectrometry across all sectors within the UK. The objective of this research is to produce documented evidence from relevant experts and practitioners to predict the future landscape of mass spectrometry for UK policy makers and funding bodies. The report we deliver will support UKRI and government in their strategic planning, and enable the UK to lead in exploiting the future potential of innovations in MS.

Introduction

To seek input from the large diversity of scientists and engineers whose dependence on mass spectrometry gives them a vested interest in the future development and funding of this technology, the BMSS have established a Vision Committee to undertake a DELPHI study to come to some common views and themes from targeted experts and practitioners from across the field. To date two rounds of this study have been conducted; the first included a range of open questions regarding the current and envisaged future use and importance of mass spectrometry. The response summary and main themes were then circulated for further comment.

Community message thus far

There is clear consensus that mass spectrometry (MS) is a **major analytical measurement technology, is critical to a well-founded lab,** and is **strategic to all aspects of molecular science** in chemistry, physics, engineering, biochemistry, biology, medicine, clinical and pharmaceutical, agrichemical and environmental studies, forensics and security/safety, as well as being pivotal across academia, government/institutions, and UK industry. For the past 30 years, MS has seen exponential growth in instrument numbers and applications development as a result of key instrumental developments and a strong coupling between three principle sectors: (i) mass spectrometry manufacturers, (ii) life science industries and (iii) academia. This connectivity has created entire new industries (e.g. contract research organisations) and fields of science (e.g. proteomics and all other 'omics), both within the UK and beyond. Access to a wide range of mass spectrometry is still very much required to meet the growing demand from expanding and broadening scientific and industrial communities. As MS is involved in almost every area where measurements are necessary, demand is predicted to continue, and to increase rapidly.

Key points highlighted from the two stages of the DELPHI study

1. New mass spectrometry-based technologies are emerging continuously to meet the needs of evolving applications in three key sectors: academia, industry and society. Academia's role is seen as *"pushing the boundaries of science to drive new developments*". Continued development of hardware and software solutions is considered vital in the many research-fields outlined by the expert panel*. "MS transcends all industry sectors and research fields"* and *"is becoming the mainstream detection system in chemical and biological measurement and is beginning to replace other technologies".*
2. The DELPHI study has indicated a wide range of research initiatives deemed important for mass spectrometry. Those that have been most commonly cited in the DELPHI study thus far include:

a. Blue skies research for instrument design and new application areas: the latter mostly driven through academia; the former through academia allied with instrument manufacturers
b. Method development including integrating allied technologies and software solutions to deliver *"faster analyses, greater sensitivity, more on-line separations"* alongside aspects such as *"quantification without the need for standards*"
c. Areas where the panel felt significant growth is to be expected is with (i) development of small and simple mass spectrometers *"for in-situ measurements e.g. use in surgery/out in a field/in space/in production line"* and noting that *"homeland security and controlled substance detection has never been higher … MS is at the forefront of this area and so funding is of paramount importance"* and (ii) mass spectrometry imaging and direct analysis will *"drive MS into new applications"* and (iii) life science, particularly moving into more environments, such as point-of-care diagnostics.
d. Specialist capability in MS, housed with experts and made available to those needing it on a less regular basis. Testbed laboratories for new equipment enable proof-of-principle data collection and are seen as drivers to growing the technology, impact and sustainability
e. Approaches to combine, handle, process and draw conclusions from big data is seen as a grand-challenge: to develop AI and other computational tools to share, analyse, and interpret data remotely using a web-browser interface or other non-proprietary software

3. Responses to the DELPHI exercise to-date has highlighted logical subsets of mass spectrometry infrastructure that were felt to be important components of the wider provision. These subsets can be roughly grouped into the following tiers:
    a. Tier 0 – Rugged, portable or benchtop instruments for non-experts
    b. Tier 1 – Single research group equipment
    c. Tier 2 – Local or regional mass spectrometry facilities for routine MS
    d. Tier 3 – Specialist centres with largely unique equipment, methods, or expertise, focussing around a technology or application theme, and providing access to these specialist capabilities across the scientific and industrial communities in the UK.

    Tiers 0, 1, and 2 are, to some degree, already in existence, although there are gaps both locally and nationally, as well as significant funding challenges at each level. Additionally there are currently no funded specialist centres or resources in mass spectrometry (Tier 3). A recent call for Community Statements of Need showed that the previous model for a single National Mass Spectrometry Facility was no longer appropriate for the needs of the community, and thus a future need for multiple specialist centres or resources has been suggested by several respondents. The final vision document will discuss these in more detail, as well as propose some solutions.
4. Training in mass spectrometry is identified as a significant and continuous problem at all levels. National training courses such as those run by BMSS are cited as being important, alongside the need to develop stronger integration between academia and industry to bridge the gaps at UG and PG levels. Training, it is felt, could be also facilitated through local, regional, or specialist centres as hands-on and expert-led teaching for such a practical skill would be key. This training needs to be underpinned by developments of e-learning tools or courses.

Next steps:

Based on the responses and conclusions drawn from the second round of the DELPHI study, the coordinating committee have undertaken a SWOT analysis on each of the four tiers outlined above. The outcome of this SWOT analysis is provided in Appendix 1, and will inform the third round of the DELPHI study, focussing on resourcing the future vision. The timeframe for start of this third round will be May 2019. Results will be collated through June 2019, and unless significant new areas of discussion are raised this is proposed to be the final round of input. A draft report will be prepared in time for discussion by the MS community at the BMSS Annual Meeting in September 2019. Following community wide acceptance of the Vision for UK MS the final report will be presented to EPSRC and wider UKRI organisations in October 2019.