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THE UK ACOUSTICS NETWORK

UK ACOUSTICS:

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SOUND ECONOMICS

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“The acoustics industry, in its widest sense, is of huge value to the UK economy. It provides significant employment in consulting and manufacturing, generating extensive research opportunities and feeding into many aspects of cultural life, from the design of new entertainment venues to world-renowned sound systems for home, car and professional use.

“Acoustic materials enhance people’s lives by reducing noise levels and improving sound insulation and even help submarines to avoid detection by providing high-tech coverings. Acoustics touches nearly all aspects of our everyday lives – and the UK is at the forefront of developing, researching and growing the industry, helping to nurture socially and economically-sustainable businesses.”

Ian Knowles
Director, Acoustics, ARUP

“Britain is an island nation and is reliant on Sea Lines of Communication for trade and national prosperity. To support this we have a strong Naval Under Water Warfare Capability, an area which is built on our Acoustics Science and Technology base. Traditionally the UK acoustics community has attracted some of our brightest minds and this is something we must maintain to meet new and emerging global threats. I believe that the UK Acoustics Network has an important role to play in helping to develop the next generation of talent we require to build a strong and vibrant future for Underwater Acoustics research – an area which remains a vital part of my research portfolio and one of my priority areas for investment.”

Dr Simon Cholerton
Chief Scientific Advisor, Ministry of Defence



EXECUTIVE SUMMARY

The UK acoustics industry contributes £4.6 billion to the country's economy annually, employing over 16,000 people, each generating over £65,000 in value, in 750 companies nationwide.

Harnessing and controlling sound and vibration is essential to modern society. Acoustics makes a significant contribution to markets as diverse as healthcare, defence and construction, yet as an industry it is hidden from view. For the first time, the size of UK acoustics industry has been identified as having a collective £4.6 billion turnover, generated by more than 750 different companies.

Whilst those 750 firms are distributed throughout the UK, the largest concentration of acoustics industrial activity is in the North West, Scotland and South East regions. The industry is made up of over 98% small and medium-sized enterprises (SMEs), yet the 7% of medium and large operations generate over 80% of acoustics revenues. Productivity in gross value added (GVA) contribution per employee also rises from £65,000 for the industry average, to £73,000 in larger companies.

The acoustics industry is underpinned by a vibrant knowledge base with over 200 active research grants, worth in total in excess of £150 million and involving over 47 separate UK universities. This research is supported by seven different research councils under UK Research and Innovation (UKRI), reflecting the multi-disciplinary environment in which acoustics operates, from social and health to engineering sciences.

Society and the wider manufacturing industry are also increasingly recognising the importance of acoustics and investing in new capabilities. For example, Jaguar Land Rover have invested £150 million in new acoustics research capabilities and the ability of sound to contribute to mental health and well-being is increasingly recognised.

Acoustics feeds into many major global markets, including the \$10 billion market for sound insulation materials in construction, the \$7.6 billion ultrasound equipment market and the potential \$31 billion market for voice recognition. This is before the vital role of acoustics in automotive, aerospace, marine

and defence is taken into consideration, all major UK industries which leverage acoustics expertise, or the indirect environmental and societal value is considered.

The four Grand Challenges identified in the 2017 UK Industrial Strategy will all require acoustics innovation. The Industrial Strategy Challenge Fund (ISCF) focus areas all need support from acoustics as an enabling technology. Challenge leaders are encouraged to engage with the UK acoustics community through the Institute of Acoustics (3000 members) and the EPSRC UK Acoustics Network (500 members) as a priority to ensure that acoustics innovation is built into solutions at the earliest opportunity.

Acoustics defined

Acoustics is the generation, manipulation, control, transmission and detection of sound and vibration. Acoustics encompasses diverse and far-ranging applications, such as suppressing unwanted noise and vibration in the built environment and on transport, reproducing music and positive soundscapes, using audible soundwaves and ultrasonics in non-destructive testing and imaging in fluids, gases and elastic solids, medical ultrasonics and emerging applications such as speech and voice recognition and ultrahaptics technology, to name but a few.

The data reported here will, for the first time, ensure that acoustics is heard above the noise to inform policy, support agencies, researchers, career decisions and wider industry about the scale of acoustics capability available in the UK. As this report reveals, the direct economic value of acoustics is significant and the contribution leveraged from products which harness sound and vibration is even greater still. Fostering further growth in research and development within the acoustics industry is therefore vital to the continued growth of the whole UK economy.

INTRODUCTION

Every product, every location in the world from a car or machine, to a home, office or landscape, has sound or vibration characteristics.

Acoustic science interprets the level and source of sound, noise and vibration, and seeks to understand and control their generation, detection, modification and usage. The field of acoustics covers a wide spectrum, spanning from ultrasound to opera, random sub-audible vibrations to voice recognition, measurement to insulation and examining the impact of noise and vibration on people and machines.

Acoustics is ubiquitous. Built-environment acoustics is evolving from passive noise suppression to the active design of positive sound environments which enhance public well-being and mental health. In cars and transport, sound has long been managed to improve the driver experience and reduce environmental impact but now, voice control is rapidly becoming an integral part of the driver experience. Sound has a unique ability to travel through fluids and elastic solids which means that it can be harnessed for non-destructive testing, sonar imaging and medical diagnostics. Barely a baby is born, an aerospace part manufactured, or oil well drilled without the help of an ultrasound, sonar or seismic scan. Everything that exists outside of a vacuum has a sound signature and so acoustics also forms a critical part of our defence and security, enabling key capabilities in, for example, quiet submarines to remote perimeter monitoring. Acoustics shapes and supports every aspect of our lives.

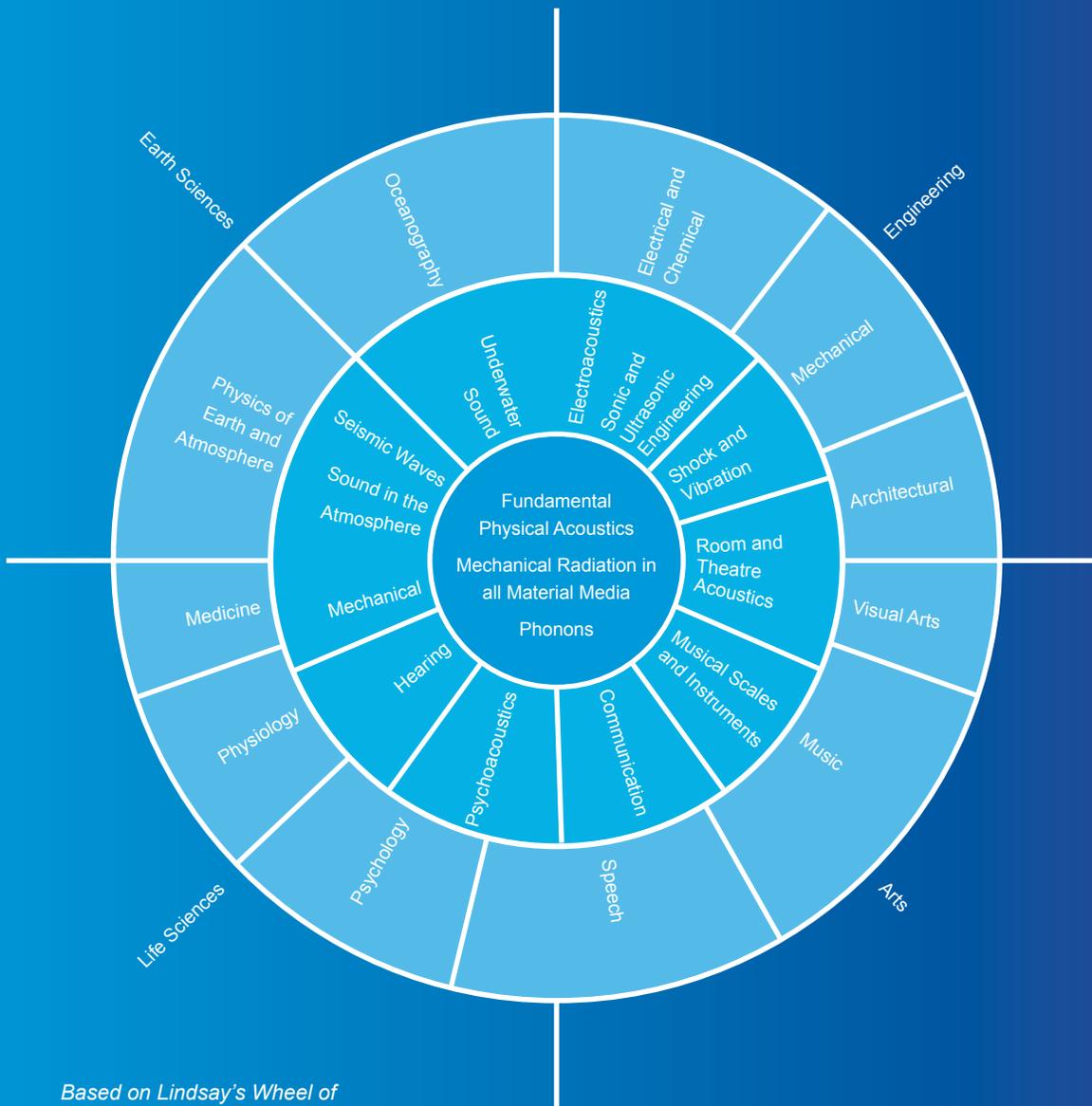
The ubiquitous nature of acoustics means that 'sound management' is frequently taken for granted in the development of new products and services and is often considered only in the latter stages of the design process. This can lead to missed opportunities for integrating advanced acoustic technology into new products. It has also contributed to the UK acoustics industry remaining relatively unheard of outside of the sector, an irony made even greater by the significant impact of acoustics technologies on day to day life.

As a result of being a 'hidden' industry, there have been no previous reports of the direct economic contribution of the acoustics industry and those analyses that have been produced tend to focus on a few selected applications, for example, medical ultrasound or building insulation.

In a world first, this report quantifies the direct economic activity involved in the manufacturing of acoustics products and services in the UK, irrespective of their ultimate end application. For the first time, key metrics are established and reported for acoustics revenue, the size of the workforce employed in the sector and the gross value added (GVA) to the UK economy.

This analysis is based on a robust, proven methodology that was previously developed for the purposes of quantifying the economic value of another enabling industry: photonics, or 'light technologies', in the UK and internationally. The methodology is designed to take into full account a highly-distributed industry landscape, comprised of many specialised Small and Medium-sized Enterprises (SMEs) operating alongside fewer very large companies which may engage in significant relevant activities within the target sector but as part of a far wider, highly-diversified remit.





Based on Lindsay's Wheel of Acoustics, Bruce Lindsay, 1964

The outcome of applying this approach is an accurate, reliable and valid estimate of the size and distribution of industrial acoustics in the UK. The strength of the UK acoustics knowledge base is separately captured by quantifying the value of active, acoustics-related research.

Acoustic properties and the technologies used to manage them are vital to keeping products competitive and compliant with environmental regulations. It is beyond the scope of this report to quantify the significant leverage of acoustics

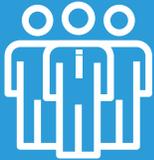
into all the many individual markets on which these technologies impact. However, it is evident that a strong, dynamic and growing UK acoustics industry needs to be in place in order to cater for the increasing use of sound and vibration as a key differentiating factor, used to distinguish between the performance of vehicles (planes, cars etc.), consumer goods (hair dryers, washing machines etc.) and many other products, as well as urban environments (buildings and city-scapes).

THE UK ACOUSTICS INDUSTRY

In 2017, the UK acoustics industry manufactured goods and delivered services worth a total of £4.6 billion.



16,000
people employed



£65k
value add per
employee



£4.6bn
acoustics output



750
companies



Behind this impressive output, the acoustics industry comprises some 750 companies and employs a total of 16,000 people in manufacturing, design and engineering jobs. In just one year, the UK acoustics workforce contributes to the economy £65,000 in gross value added (GVA) per full-time employee.

This analysis is based on data from 605 of the 750 companies identified as operating in UK acoustics, due to the availability of their turnover, profile and employment figures. The evaluation of industry size includes commercial industrial organisations only, with all publicly-funded research institutes and universities excluded from the data set (the value of UK academic acoustics research is analysed separately). For highly-diversified companies, the analysis includes only the proportion of their output directly attributable to acoustics (see annex: methodology).

Top 20 contributors to UK acoustics output

- Autoneum Great Britain
- BAE Systems
- Cirrus Logic, UK
- Electronic Audio Systems
- Ford, UK
- GKN Aerospace
- James Fisher and Sons
- Jaguar Land Rover
- Kingspan
- Knauf Insulation, UK
- Leonardo
- Nissan, UK
- Qinetiq
- Rehau
- Ricardo
- Rockwool
- Rolls-Royce
- Sonardyne
- Thales, UK
- Ultra Electronics

Companies within the top 20 largest contributors to the UK acoustics industry operate in seven of the ten identified key end-user markets. This emphasises both the diverse nature of businesses involved within the sector and the wide-ranging impact of acoustics technologies.



Dr Alan Curtis
Thales UK

“Acoustics is a key enabling technology. Its impact is evident across many areas of the UK economy, including in many industries not typically associated with acoustics. The aerospace and automotive industries, energy, building and construction sectors, suppliers of naval and other military equipment, and manufacturers of domestic and consumer appliances are just a few examples of the many types of businesses and products within which acoustics play a vital but often background role.”

METHODOLOGY SUMMARY

Acoustics plays an important role in many different industry sectors and features in a wide range of end products.

There is no one distinct 'Standard Industrial Classification' (SIC) code for economic activities relating to acoustics and analysis shows acoustics companies use a huge variety of SIC codes, covering many different industrial areas. As a consequence, it is not possible simply to refer to annual reports from the Office of National Statistics (ONS) in order to quantify the size of the UK acoustics industry. An alternative methodology is required that accounts for the distributed and embedded nature of the industry, as well as the diverse spread of companies which conduct business in acoustics in addition to many other types of products and services.

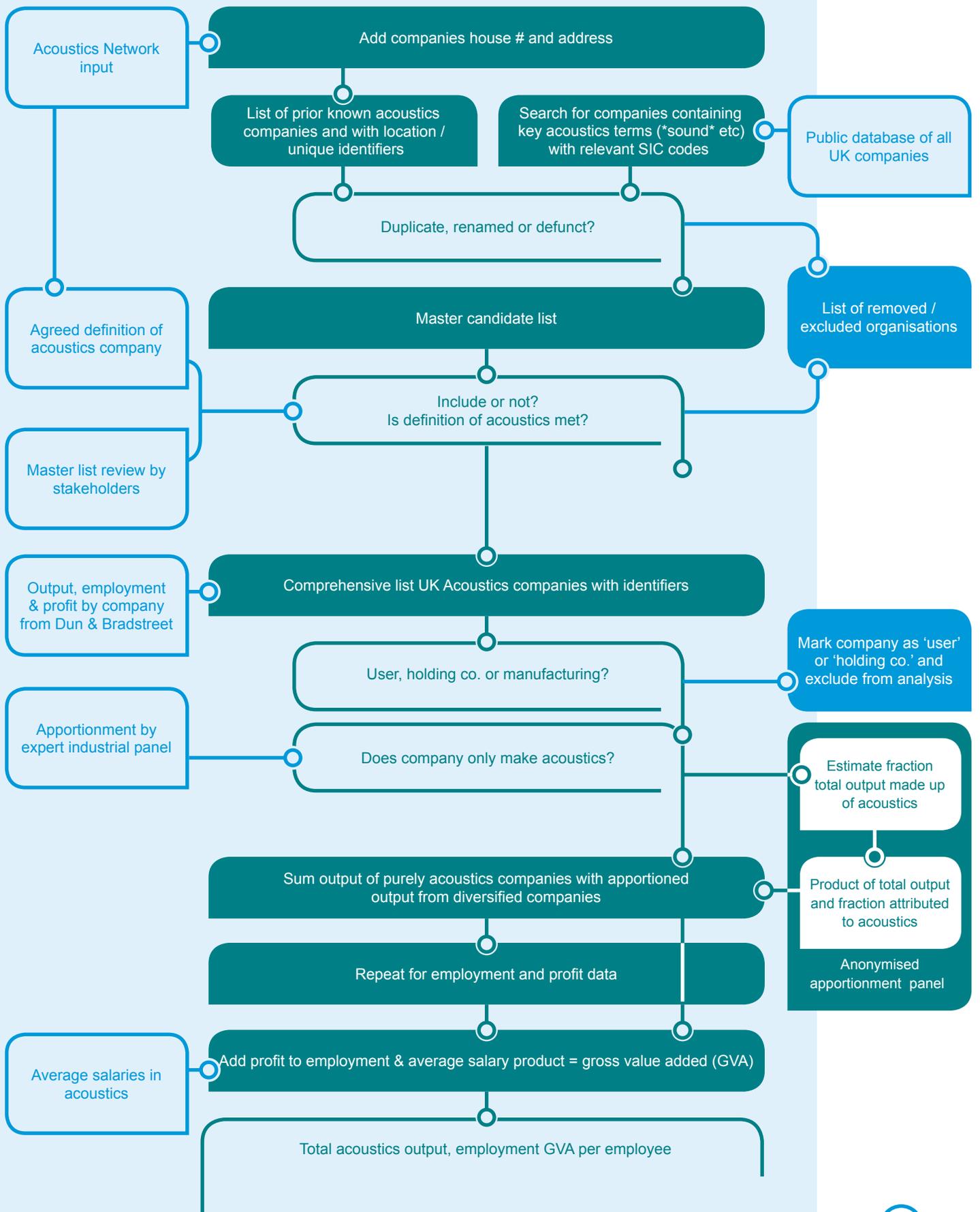
This report employs a proven methodology initially developed for use in quantifying the size and scale of another challenging, 'hidden' enabling technology sector, the photonics industry. Within photonics, it has been successfully applied both regionally and nationally in 'UK Photonics: The Hidden Economic Engine' (Harlin Ltd, The Photonics Leadership Group and The Knowledge Transfer Network, 2017). The same process has been deployed by SPIE, the international society for optics and photonics, as the international standard for estimating the global size of the photonics industry.

Methodology in five key steps (further detailed in annex):

- 1.** Agree a clear and specific definition of an acoustics company: 'businesses involved in the generation, manipulation, control, transmission and detection of sound and vibration'.
- 2.** Compile a comprehensive list of UK acoustics companies and companies with significant acoustics business activities. Source entries from existing membership networks and by conducting a thorough keyword search of UK company names using commonly-used terms from within the acoustics field. The full list is available from the UK Acoustics Network website (www.acoustics.ac.uk).
- 3.** Estimate output profit and employment data for the listed companies, based on data sourced from Dun and Bradstreet and matched on company name, company registration number and postcode.
- 4.** Through referral to an expert panel, apportion for diversified companies the fraction of their output, profit and employment numbers attributable to acoustics activities, recognising that many larger enterprises also produce non-acoustics type products.
- 5.** Estimate the gross value added (GVA) for acoustics by calculating the sum of the profit and total employee benefits paid by the industry. The latter requires an estimate of the average benefit paid per employee, obtained using the total employment costs and employee numbers reported to Companies House by the top ten uniquely (i.e. not diversified) acoustics companies.

This methodology enables the contribution from highly-diversified companies to be reliably included in the analysis without the excessive over-attribution of their full output to acoustics. It also circumvents the challenges which arise from the lack of association of acoustics with any one particular SIC code, since an analysis conducted on the basis of such classifications alone would overlook key parts of the industry. Financial data are based on the last full financial year ending in 2017 reported to Companies House for UK operations and validated by Dun and Bradstreet.

By establishing a master list of acoustics companies, accompanied by an agreed apportionment of acoustics activities for diversified businesses, the present methodology also provides a framework for future industry analyses and offers a basis both for comparing like-for-like growth and for the inclusion of new organisations, either missed in this initial scoping or newly entering the industry.



COMPANY SIZE AND DISTRIBUTION

The UK acoustics industry is dominated by small companies and operations. 98% of UK acoustics businesses would be considered SMEs, employing fewer than 250 people in the company as a whole or within the proportion dedicated to acoustics. 75% of UK acoustics operations are ‘micro’ in size, employing no more than ten people.

Size of acoustics companies and operations by employment



Over 16% of small and micro acoustics operations are part of larger, in some cases significantly larger, organisations. This is due to the critical role that acoustics plays in the products and services produced by some major organisations, for example those in the aerospace and automotive industries.

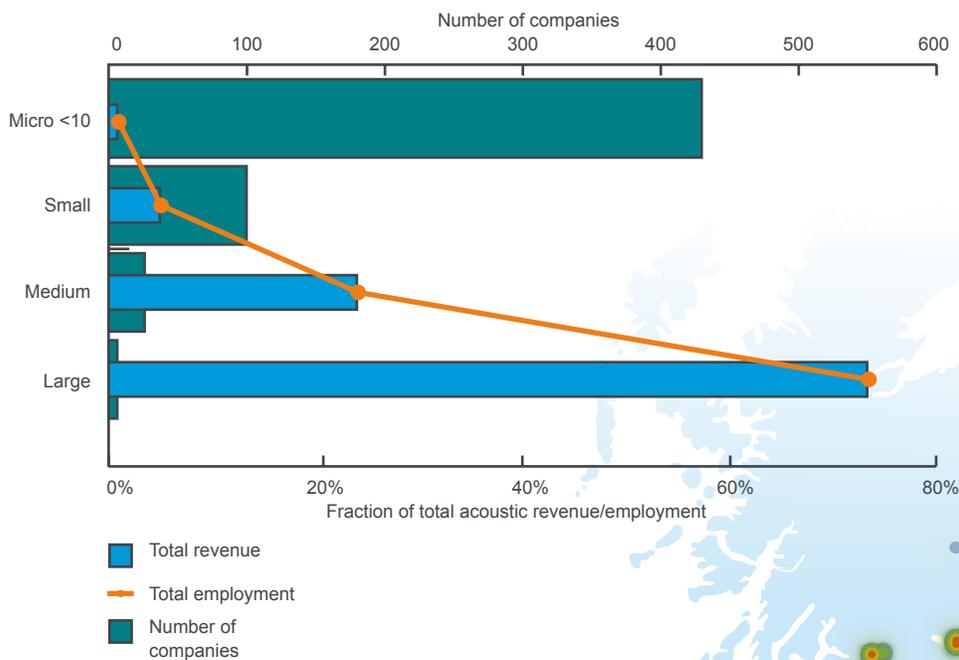
Only 7% of acoustics companies and operations can be classed as large or medium-sized enterprises, turning over more than £8.8 million (€10m). However, despite making up only a small fraction of the total number of acoustics companies, these large and medium-sized operations (each employing >50 people), generate 90% of all UK acoustics revenue and employ some 80% of the total acoustics workforce.

Even when combined, the total revenue from the many hundred small and micro-sized companies does not rival that generated by the few large industry players. This is consistent with the industry

landscape observed for other enabling technology industries, for example photonics, where small companies generate less than 3% of the total global revenue. That being said, this diminutive figure belies the critical role of small companies in supplying acoustics innovation and expertise to multiple larger organisations which may lack their own in-house specialists.

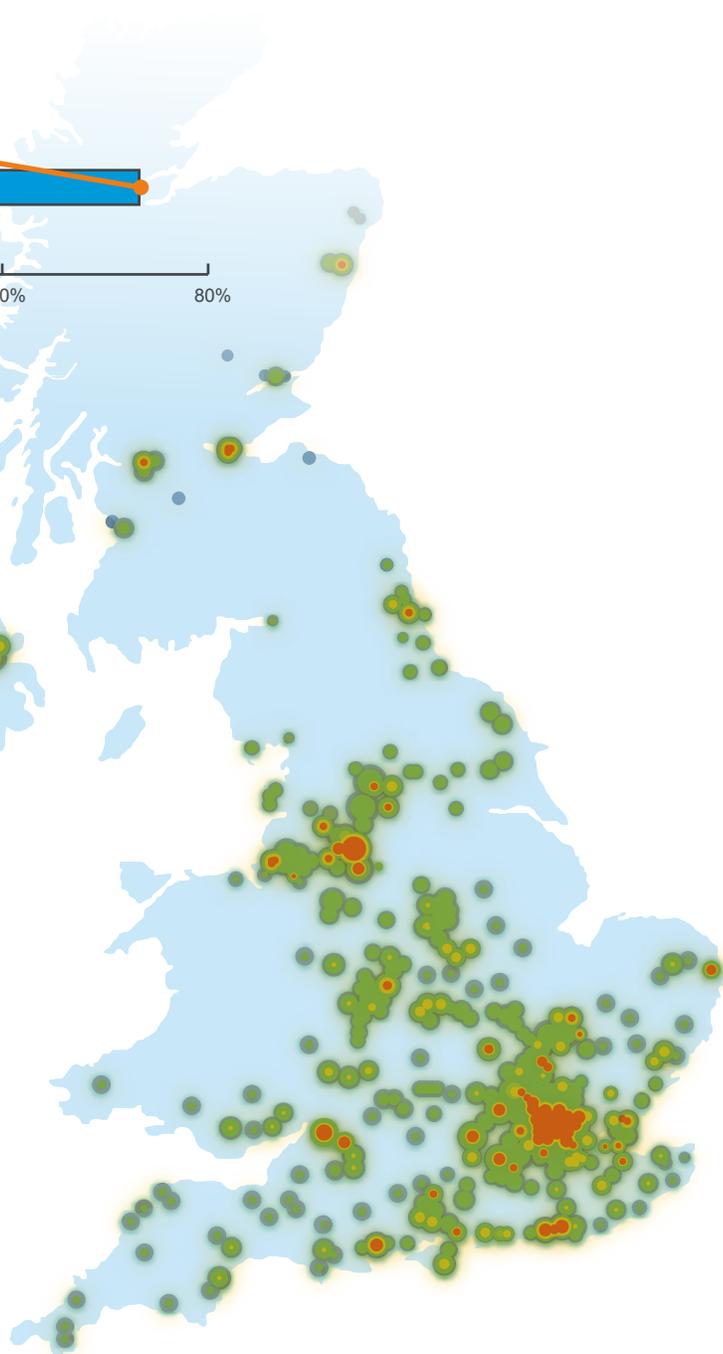
The percentage of total revenue generated by medium and large-sized acoustics companies is greater than the proportion of the total UK acoustics workforce that these companies employ, indicating greater efficiency within these larger organisations. Within large acoustics organisations, the GVA per full-time employee rises to £73,000 from the sector average of £65,000 per full-time employee. This finding is consistent with the higher rates of productivity typically afforded to businesses operating on a larger scale.

Total acoustics revenues by size of operation



The UK acoustics industry is distributed throughout the country, with companies active in all regional areas.

Based on the initial evaluation of location data, Scotland, the North West and South East regions generate the highest acoustics revenues. However, it should be noted that this analysis was conducted using the companies' registered addresses. These do not always pertain to a company's manufacturing location, as many larger businesses report their accounting figures via a central London headquarters and or operate from multiple sites. Regional distribution within the UK acoustics industry is therefore likely to be even greater than indicated here.



ANALYSIS: NATIONAL COMPARISON

The acoustics industry generates a total of £4.6 billion annually, equivalent to 2% of the total revenue from the entire UK engineering sector.

UK acoustics is responsible for 1.6% of the total UK engineering workforce and GVA contribution to the country's economy. Acoustics also accounts for approximately 0.6% of the whole UK manufacturing sector, both in terms of numbers employed and GVA contribution. Indeed, if acoustics were to be considered as a distinct manufacturing sector, then it would rank as the 20th largest in the UK, approximately one third of the size of the electrical equipment industry.

At £65k GVA per full-time employee, productivity within UK acoustics is higher than average UK labour productivity (£56.7k per employee), identical to productivity for the wider UK engineering sector and close to that recorded for UK manufacturing industries overall (£67k per employee). Acoustics productivity rates are also comparable to those observed in the electrical and machinery equipment manufacturing sub-sectors, two domains closely aligned to the acoustics industry as a core value-added engineering disciplines. Acoustics productivity is also similar to that of other enabling technologies, for example the UK photonics industry (£62k per employee in 2014).

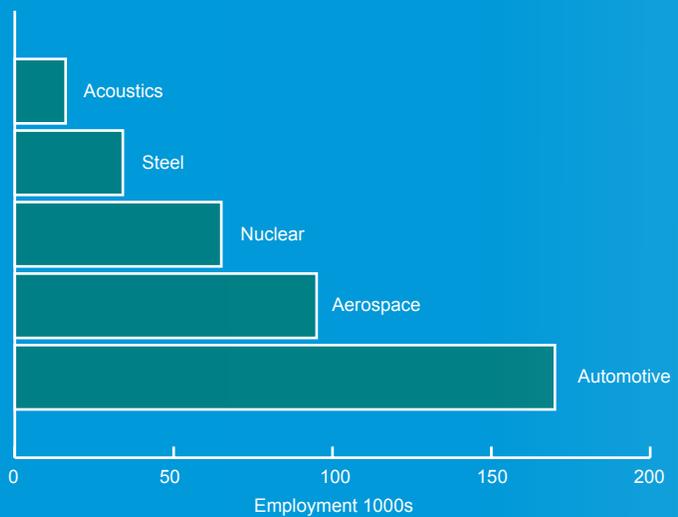
The employee benefit average for the UK acoustics workforce, £46k per full-time employee, appears significantly higher than the average UK manufacturing (£27,430) and engineering (£30,874) wages. However, this comparison is made with caution as the average employee benefit for the acoustics industry is derived from the total wage bill and employee count reported for acoustics companies. As a result, the calculation includes all employees, from managing director to apprentice, and all employee benefits, and is not selective to those working only in manufacturing roles.

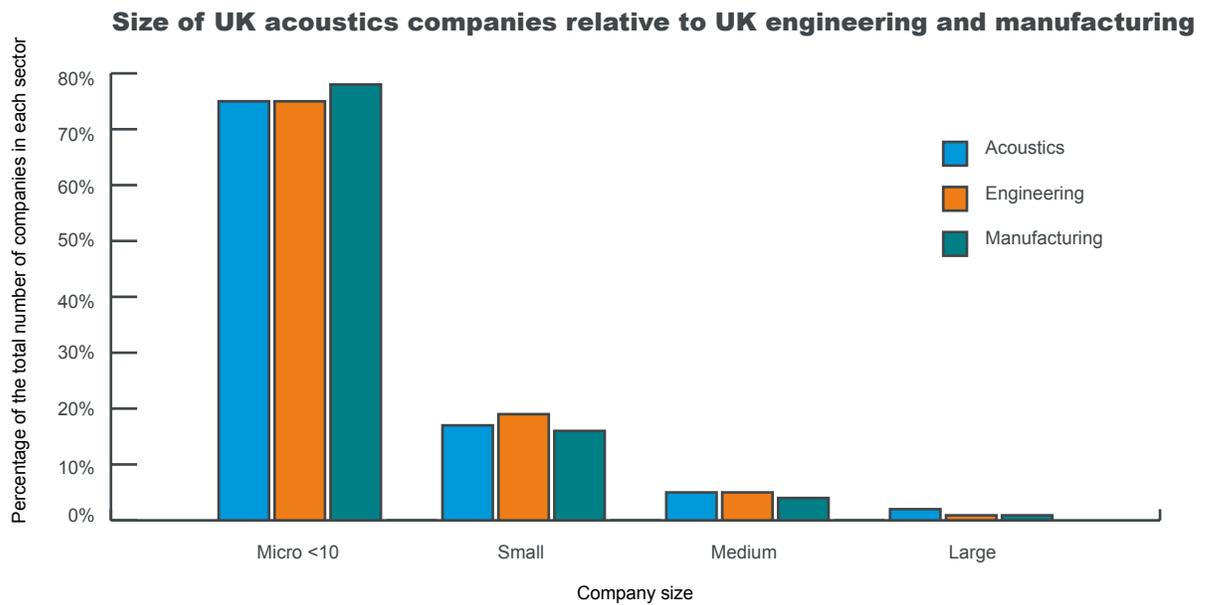
Relative to both the overall UK manufacturing or engineering sectors, the acoustics industry includes twice the number of large firms employing over 250 people. This is significant due to the higher productivity and economic impact of large companies and further illustrates the key role acoustics has in many large industries with major manufacturing operations.

As an indication of the scale of acoustics relative to other UK industries, acoustics employs around 50% of the total number of people directly employed



Employment in key UK manufacturing sectors





in the steel industry, 15% of the number employed in aerospace, 10% of the number employed in automotive and less than 1% of the number employed in construction.

Nevertheless, acoustics is vital to all these industries, impacting on the performance and market success of new aeroplanes, manufacturing plants,

naval vessels, cars and buildings. These sectors rely on acoustics knowledge to keep their products competitive, resilient and compliant with official noise regulations. Hence profitability and continued employment within several major UK industry sectors relies heavily on the contribution of a far smaller number of experts, directly employed in acoustics.

“Acoustic technologies pervade all aspects of life, affecting society in multitudinous ways ranging from reducing noise pollution from everyday objects, to enabling medical sensing and diagnostics, to how we perceive and recognise basic human functions such as speech, through to the design of structures and buildings. QinetiQ, as one of the largest UK research and technology organisations is heavily engaged in research and development of innovative acoustics solutions that benefit the UK community, as well as understanding the impact to society, through both service provision, analyses and product development.”

Dr Chris Hitchen
Head of Applied Science, QinetiQ

UK ACOUSTICS KNOWLEDGE BASE

The success of the UK industry is built upon research in the field of acoustics. Acoustics research spans a wide and diverse range of disciplines, from mechanical and electrical engineering and physics, to psychology and healthcare, design, architecture and construction.

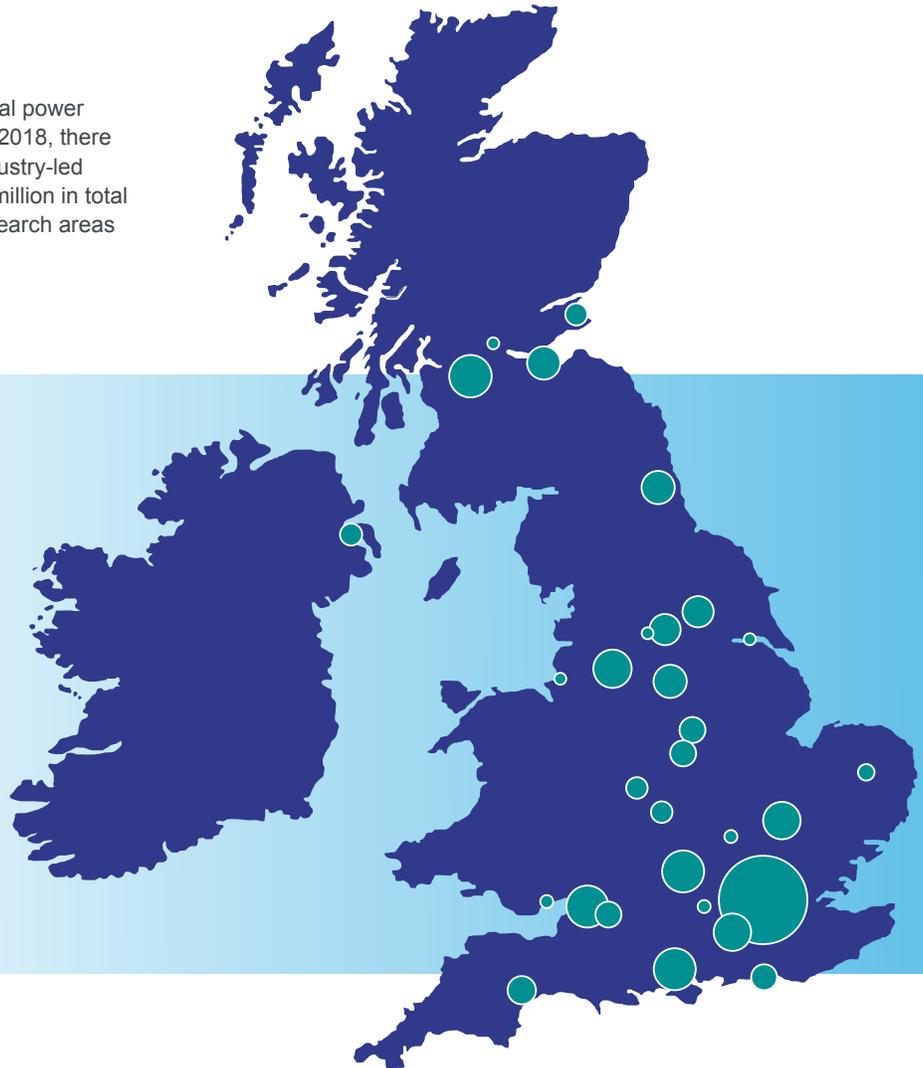
The breadth of subject areas reflects the pervasive and enabling nature of acoustics, and the many ways in which it impacts on our lives.

Within these disciplines, studies under the umbrella of 'acoustics' can be broadly grouped into five areas of investigative research:

- Audio, speech, sound and sonics
- Fundamental acoustics
- Ultrasound and ultrasonics
- Vibration
- Noise

The UK is a well-established international power house of acoustics-related research. In 2018, there were over 200 active university, and industry-led grants in the field, valued at over £150 million in total and dispersed across the five major research areas listed above.

During the last four years (2014-2018), the total value of research funding awarded to acoustics-related research has risen at an average rate of 6.8% in the most recent years 2014-2018, and increased significantly from the £25.6 million level in 2010. This enhanced investment reflects the renewed importance being placed on furthering acoustics knowledge in complex, often industrially-relevant areas, from speech recognition to the built environment.



The acoustics knowledge base is distributed throughout the UK. A total of 47 different institutions were responsible for heading up the 177 university-led research grants in the field of acoustics recorded as active in May 2018. These spanned the country from St Andrews in Scotland to Exeter in the South West region and included both historic Oxbridge and Russell Group universities (e.g. University of Bristol, Imperial College London) and many newer institutions (e.g. Northumbria University, University of Greenwich). The most prolific grant holders (by number) were the Universities of Bristol and Southampton, Imperial and University College London, with a total of 25 institutions in possession of more than one active grant in the field.

In 2018, fundamental acoustics and ultrasonics were the most active research areas, both in terms of the total value and number of grants awarded. Research funding awarded in the areas of fundamental acoustics and audio, speech, sound and sonics has demonstrated the most fluctuation over the last four years, whilst funding levels in ultrasound and ultrasonics have been more consistent.

Industrial engagement is increasingly prevalent in the broad field of acoustics research. In 2018, there were at least 29 active industry-led Innovate UK grants related to acoustics, many of which involving UK university partners.

The UK acoustics knowledge base has strength-in-depth and is highly interdisciplinary in nature, as illustrated by the numerous different funding bodies supporting research in the field. These include the Arts and Humanities Research Council (AHRC), Biotechnology and Biological Sciences Research Council (BBSRC), Engineering and Physical Sciences Research Council (EPSRC), Innovate UK, Medical Research Council (MRC), Natural Environment Research Council (NERC) and Science and Technology Facilities Council (STFC), which now sit under the common umbrella of UK Research and Innovation (UKRI).

The industry-led Institute of Acoustics and the EPSRC-funded UK Acoustics Network support the development and integration of the UK acoustics knowledge base. These organisations bring together the various acoustics research fields with the highly diverse user base to facilitate sharing of knowledge and best practice to maximise opportunities for commercially exploiting innovation.

Distribution of acoustics research in UK (size = number of active grants in 2018)



DELIVERING UK INDUSTRY STRATEGY

Acoustics is vital to delivering the 2017 UK Industrial Strategy and addressing the challenges of modern society.

Being so intricately linked to one of the five human senses, acoustics, either explicitly or implicitly, will be a part of almost every innovation developed within the Industrial Strategy Challenge Fund (ISCF) to address the Grand Challenges identified by government.

Engaging with acoustics is critical to maximising productivity and the benefits to society of technology solutions arising in response to the Grand Challenges, whilst also helping to accelerate pathways to commercial adoption and minimise unforeseen impact. Furthermore, modern acoustics will increasingly be the focus of these solutions, rather than an auxiliary consideration in their development.

Countless examples are already emerging to demonstrate the central role of acoustics in addressing the Grand Challenges:

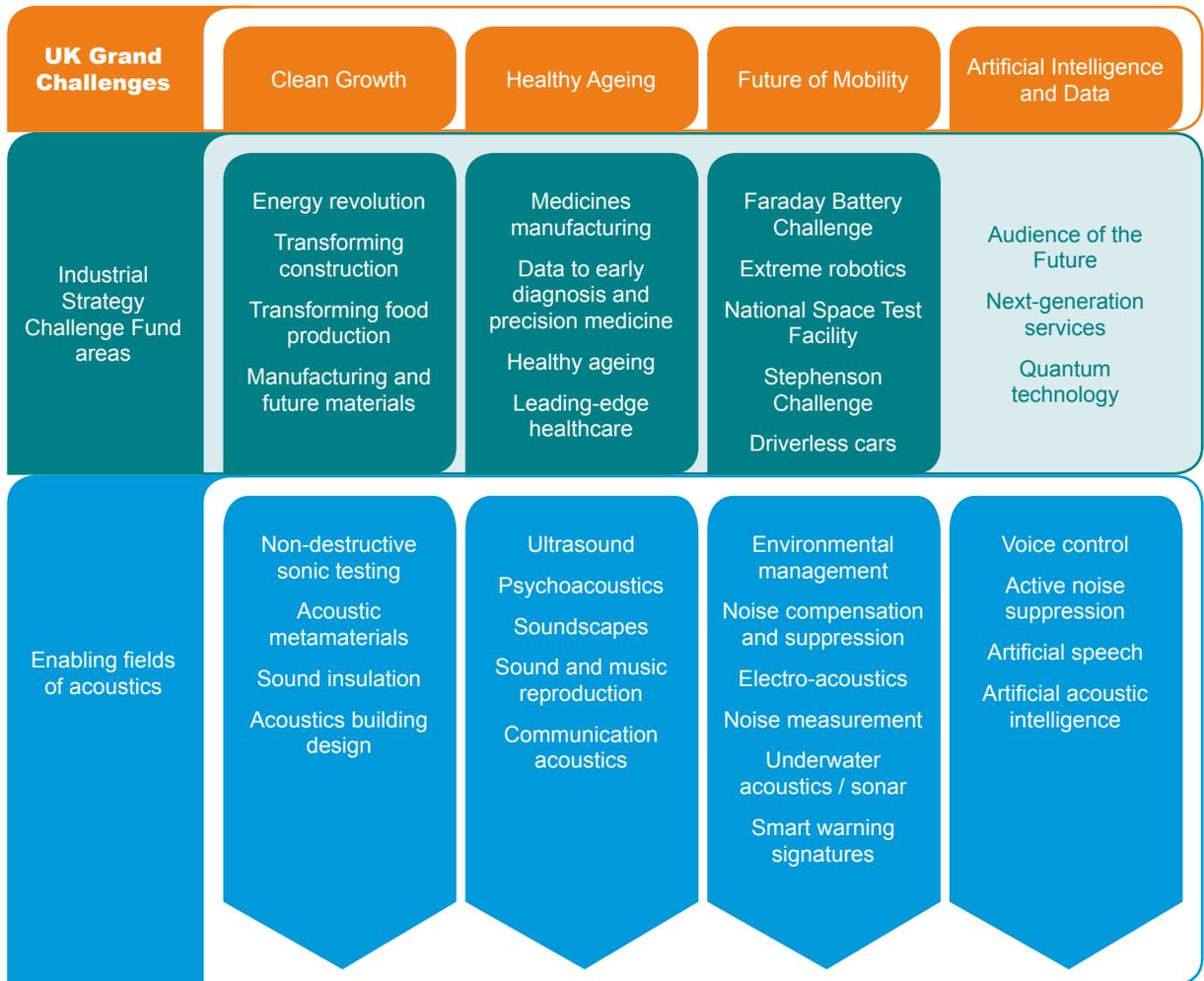
- Ubiquitous active voice-control generated significant interest at the 2019 Consumer Electronics Show (Las Vegas, January 2019). This innovation enables people of all ages to access technology, whether for convenience or for necessity, supporting everything from community care to entertainment.
- Noise has a significant impact on mental health and individual wellbeing. Managing sound will be central to the design and construction of future cities, improving health and productivity despite increasing city densities.
- Ultrasonic non-destructive testing is used increasingly in productive digital manufacturing, helping to avoid compromises to quality and safety.
- Sound and vibration management is an integral part of mobility, whether by air, land or sea. Enhancing the travel experience whilst minimising the impact on people, wildlife and the environment relies on passive and active acoustics.

- Voice recognition is already the most widespread use of artificially intelligent machine learning.
- Acoustics is essential to defence and security, providing new methods and tools which serve both to enable monitoring and detection whilst also facilitating remaining covert.

Acoustics is a multi-disciplinary and multi-billion pound global industry. It is a key element of vertical markets as diverse as aerospace, automotive, healthcare, construction, manufacturing and defence. The proportion of acoustics-related activity within each of these sectors is significant in itself, but when combined across these various industries, the market opportunity is vast.

The UK has well-established industry expertise in acoustics and an internationally-leading academic knowledge base distributed throughout the country. Whilst it is little-known outside of the profession, there exists a strong, self-organised UK acoustics community, supported by organisations such as the Institute of Acoustics, which provides professional support to over 3000 members, and the UK Acoustics Network, which brings together over 500 individuals from academia and industry and enables the knowledge base to unite and thrive.

The impact of the UK Industrial Strategy will be maximised by ensuring that acoustics is built into emerging programmes and initiatives at the earliest possible opportunity. Acoustics needs to be properly integrated within the focal areas of the ISCF and should be designated a UKRI priority area, in order to ensure that expertise in the field can be leveraged to its full potential. As acoustics research can increasingly provide solutions to Grand Challenges, the UK's valuable capabilities in this field need to be further connected to vertical markets in order to accelerate the uptake of the latest innovations necessary to securing the industry's international competitive-edge.



GLOBAL ACOUSTIC MARKETS

Acoustics addresses multi-billion dollar global markets.

Acoustics is a global industry but one that is rarely analysed in its entirety as a distinct market area. However, market forecasts are available for those key applications where acoustics contributes to a significant global end-product market.

The global market for acoustics materials, which includes products such as sound insulation used in new-build construction and the automotive industry, is estimated at \$10 billion (2016) and is projected to grow to \$16 billion by 2025. UK manufacturers include companies producing traditional sound-absorbing materials, such as Saint-Gobain Ecophon, as well as those making next-generation soundproofing meta materials, for example Sonobex.

The ultrasonic equipment market is reported to be worth \$7.6 billion (2017), growing at an annual rate of 7.6%. Whilst this particular market space is dominated by medical diagnostics products, for example hospital ultrasound equipment, it also incorporates technologies for non-destructive testing. UK manufacturers include EMS Physio, BK Ultrasound and Alba Ultrasound.

Current issues in the built environment

Acoustics is relevant to all of them

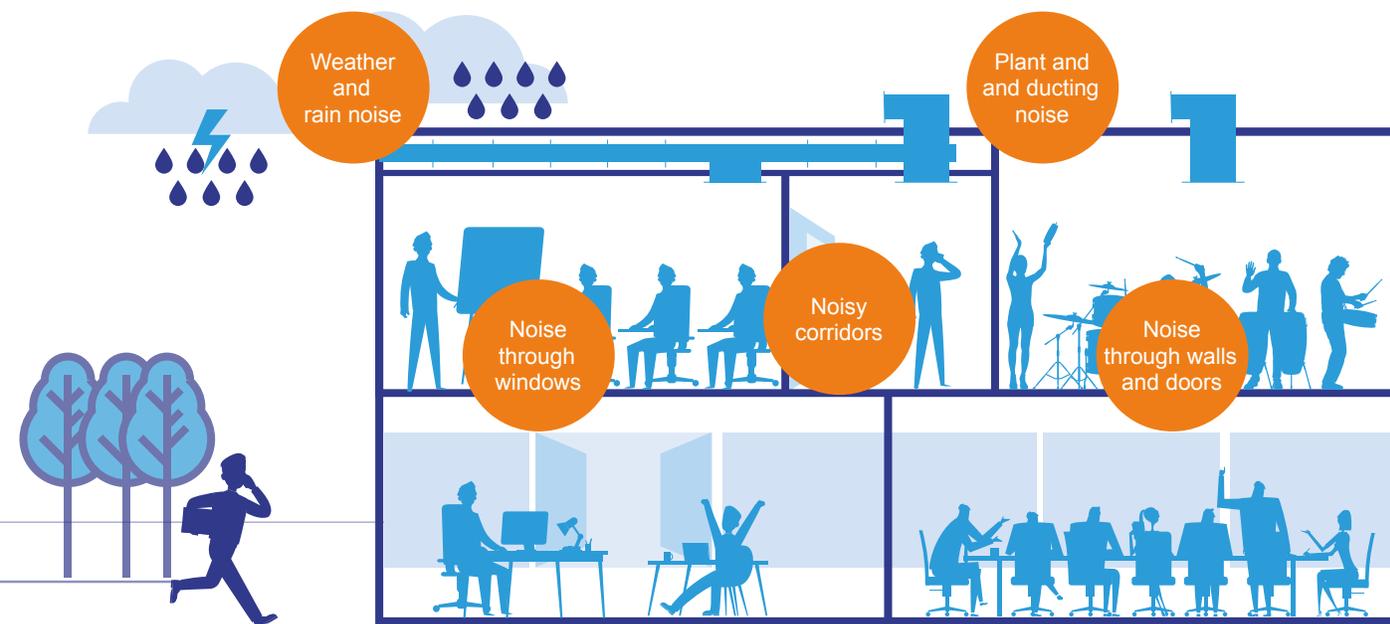
- Climate change
- Urban densification
- New construction methods
- Smart cities and intelligent buildings
- Health, wellbeing and quality of life



The speech and voice recognition market has grown very rapidly in recent years and is forecast to continue expanding with voice control used increasingly in cars and consumer electronics. This market has emerged from a powerful combination of acoustics and artificial intelligence and/or machine learning. The upsurge in incorporating far-field microphones, essential for voice recognition, into all manner of items, from televisions to cars, emerged as a dominant theme from the 2019 Consumer Electronics Show (Las Vegas, 2019). As a result, 17% year-on-year growth is forecast for the voice recognition market, which is expected to expand from the \$9 billion in 2017 to \$31 billion by 2025.

Demand for these key acoustics end-product markets is distributed throughout the Asia Pacific, North America and Europe regions. Indeed, the close association between these three application areas, materials, ultrasonic equipment and voice recognition, and major global trends in urbanisation, ageing, digitisation and mobility is driving demand for acoustics in all world markets.

UK acoustics is also active in building design, architecture and marine surveying, many of these yielding a vibrant acoustics service sector. Many of such services are delivered internationally, either by companies operating as independent acoustic consultancy firms or by units embedded within much larger buildings, construction and architecture practices.



Adapted from Dr Andrew Bullmore, Hoare Lea

SUMMARY



The contribution of the following experts to the apportionment processes used in sizing the industry is gratefully acknowledged:

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Authors:

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- Professor Richard Craster, Imperial College London
- Professor Kirill Horoshenkov, University of Sheffield

The input of many industry leaders and academics who, through the UK acoustics network, contributed their insights and knowledge into this report and the underpinning analysis of the UK acoustics industry is gratefully acknowledged.

Harnessing UK acoustics will grow the economy and improve lives

Sound and acoustics have always been ubiquitous, surrounding all of our everyday activities. In the 21st century, we are moving from a world of passive acoustics to an active world, where we harness sound in order to enhance our lives; from ultrasound scanners in a hospital, to sonar surveys conducted to monitor the marine environment, from active noise suppression, to managing the soundscape we experience in our cities. On top of which, voice control will become ever more pervasive, used in everything from cars to community care, with the general public increasingly coming to expect this functionality. Indeed, Digital Trends UK 2017 reported that 62% of British people were already using voice commands to control devices or would be happy to do so in the future (Mintel, 2017).

The UK is at the centre of this next generation of acoustics. Its world-renowned knowledge base spans the country, with a critical mass of research based in 47 different universities.

It is this expertise that feeds a thriving UK acoustics industry, comprising 750 companies, employing over 16,000 people who together generate a total of £4.6 billion worth of manufactured goods and services annually. Each one of these employees makes a

£65,000 gross value added (GVA) contribution to the economy annually. The leveraged economic benefit to wider industry, society and the environment is greater still and worthy of further quantification.

This vibrant UK industry supplies a global demand for acoustic goods and services in key application markets such as voice recognition, ultrasound and insulation, each worth over \$10 billion annually and growing strongly on the back of global trends such as urbanisation, ageing populations and digitisation.

Acoustics innovation and the expertise found in industry and academia will be a key part of any solution to the Grand Challenges identified in the UK's Industrial Strategy and will play an integral role in their success.

Acoustics is one of the fundamental enabling technologies where the UK has significant strength and depth. It supports and enables a vast range of applications which impact on us everyday. Fully harnessing the UK's acoustics capability will therefore be key to growing the economy and improving lives.



APPENDIX

Full methodology

To accurately quantify an enabling technology industry such as acoustics requires a rigorous process which leverages independent data on company size and, for differentiated businesses, the proportion of output that can be fairly considered acoustics.

Step 1: Define boundaries

A clear definition of 'acoustics company' is required in order to determine which companies should be admitted to the analysis. The following definition was adopted: companies involved in the generation, manipulation, control, transmission and detection of sound and vibration.

The above definition includes companies which offer acoustics within a wider product range as well as providers of acoustics services. It places no constraints on acoustic or vibration frequency and covers companies working with the human audible range as well as those catering for higher and lower frequencies, e.g. ultrasonics and vibration. Restrictions are not imposed on the medium of sound propagation, e.g. air or water, and thus companies dealing with sub-sea sonar are also included. However, companies providing public address system hire and services to the music industry, e.g. musical instrument services and sales, are excluded. Publicly-funded research bodies and organisations are also specifically excluded, since the aim of the present analysis is to quantify the economic contribution of the acoustics industry.

Step 2: Compile a comprehensive list of UK acoustics companies

A list of companies already known to the EPSRC UK Acoustics Network and Institute of Acoustics is supplemented with company names yielded by conducting a thorough search of all UK registered companies using common acoustics terms (i.e. sound, vibration, acoustic, noise, ultrasonic) as keywords. The entries generated using the search criteria are then filtered to ensure that only companies using Standard Industrial Classification (SIC) codes commonly employed by businesses within the UK Acoustics Network are included. The master list is then further reviewed and those companies with no clear link to the industry (e.g. 'sound financial planning' or 'acoustic record shops') are removed. Cross-referencing Companies House records then allows the exclusion of businesses no longer trading.

The final master list comprises 750 companies which contribute to the UK acoustics industry, either in their entirety or in part.

Step 3: Attach economic data

Obtain the output, profit and employment figures for companies in the master list from Dun and Bradstreet, based on matching the company name, registration number and location. Dun and Bradstreet figures are based on financial data reported to Companies House by individual organisations, or in the case of small companies, an estimate generated using Dun and Bradstreet's industry-accepted formula and informed by published figures.

The present analysis is based on the latest available financial data at the time of writing, i.e. the financial year ending 2017. Due to variation in the start/end date of companies' financial years, some inbuilt time averaging is necessary.

Where figures are not available for a company, or are divided between many separate operating organisations, data is sourced from the company's published annual reports.

Step 4: Apportionment

Many companies active in acoustics are highly diversified, with acoustics itself forming only a fraction of their business. Whilst this indicates the enabling nature of acoustics, enhancing capabilities within a wide range of other derivative technologies, including the entire output of such companies in this analysis would be to vastly over-estimate the size of the industry. In contrast, excluding them entirely would underestimate the scale of UK acoustics activity and fail to acknowledge the value that it adds to the products and services offered by many companies.

In order to present a fair representation of the UK acoustics industry landscape, this analysis is based on the proportion of a company's output agreed by an expert panel to be reliably attributable specifically to acoustics. The expert panel, comprised of 12 professionals involved in the production of acoustic devices or in the use of acoustics, estimated the acoustics proportion of companies by assigning them each to one of six percentage categories: 1%, 5%, 20%, 50%, 75% or 100%. These broad categories are used due to the difficulty, and possible commercial sensitivities, of assigning precise acoustics output fractions.

The process of apportionment focuses only on the top 97 largest companies in the master list (those with >£10m in revenue) since these are the most likely to be diversified. Industry sector categories are used to group diversified companies (e.g. automotive, defence and aerospace, construction, consumer) and the apportionment percentage applied across other companies within the same group, providing they are involved in manufacturing similar products (unless noted as an exception). Additional companies are also added to the master list at this stage on the recommendation of the expert panel during their review of the organisations within each category.

The percentage acoustics output is applied to the individual company's employment and profit figures, and summed with the data from companies trading in acoustics alone, to give the total acoustics output, employment and profit. No assumptions are made for potential differences in staffing and/or profit levels between acoustics and non-acoustic activities.

Step 5: Gross value added (GVA)

The gross value added contribution of acoustics is estimated based on the sum of the company's appropriately apportioned percentage acoustics profit and employee benefits paid. Total employee benefits are calculated using the number of acoustics employees (previously apportioned) and the average employee benefit paid, sourced from Companies House returns made by the top ten 'purely' (i.e. 100% of output attributed to acoustics) acoustics companies. As companies report total staff costs and total employee numbers, the average employee benefit (£46,000 per annum) considers all staff, from the chief executive to the apprentice, and does not therefore reflect the average salary of, for example, an expert acoustics engineer.

Notes on the methodology

Whilst every effort has been made to ensure the master list of acoustics companies includes all relevant organisations, some may yet be missing, e.g. companies not engaged in the UK Acoustics Network and without acoustics-related keywords in their names. Economic data on some 140 companies in the master list was also not available from Dun and Bradstreet. As a result, the present estimate places a conservative, lower limit on the size of the UK acoustics industry.

The apportionment process (Step 4) is also subjective. However, sensitivity analysis shows very little disparity from the final totals from varying the apportionment for any single company. Indeed, as the present analysis uses data from over 600 organisations, errors and/or variation in the numbers relating to any one single organisation do not make a material difference to the final figures. That said, these figures represent an economic estimate and should not be assumed precise to more than a few hundred million pounds.

This methodology is specifically designed to enable estimates of future growth. This includes comparing like-for-like growth and for the inclusion of new organisations, either missed in this initial scoping or newly entering the industry.

Data and methodology sources

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