

Material Science Institute Strategy 2021- 26

Background

Formed 2017, the Vision of the Lancaster University Material Science Institute (LU MSI) was to enhance the global reputation and visibility of material science and engineering at LU. The set objective was to achieve **scale** and **focus** in materials research. **Scale**, at 200 researchers active in the interdisciplinary research and education of new materials science and engineering; **Focus** provided through four themes (Appendix 1)¹, consolidating existing research expertise, specifically designed to populate important “gaps” in the national landscape.

The themes align with UKRI priorities of a productive and healthy nation; maximise the benefits of institutional investments and promote multi-disciplinary activities. The MSI further provided a vehicle to develop early career researchers and create a University-wide cohort of PhDs.



Image: ISOLab. Inside our world leading ISoLab that allows some of the highest spatial resolution images to be taken by SPM.

In 4 years, the MSI has:

- Connected ca. 175 researchers across the University
- Supported ca. 30 “new-start” interdisciplinary PhDs; building a 70+ PhD cohort
- Established internal structures necessary to promote greater interdisciplinary research
- Hosted a number of national and international conferences and workshops
- Established a unique centre for doctoral training, *Materials Social Futures* (CASE STUDY)
- Developed new models of industry engagement (GISMO, CASE STUDY)
- Enhanced grant income: MSI cumulative =£12.5M, £7.5M² (2019-2022)³

Despite clear progress, *significant internal and external challenges* remain and have prompted a review of MSI's direction at the four year point.

Most notably, the extraordinary investment made nationally (> £500M) into material science, that LU was not part of, casts a shadow over MSI's progress, creating a fiercely competition environment in materials science, making it difficult to gain traction to establish a “Lancaster niche”.

The MSI's forward-looking 2021 plan sets out to mitigate this challenge by identifying a “breakout strategy”, that leverages established and emerging capabilities at LU, recognising that visibility requires a still greater degree of differentiation. The 2021 plan creates a unique brand based upon transdisciplinary research, differentiating the MSI from traditional materials-discovery research centres; a transdisciplinary approach provides a big-picture perspective on materials in complex socio-technological relationships. *The 2021 plan: LU's world-class science and engineering providing solutions at the “materials-environment-health” nexus*

¹ E.g. Themes are complimentary, but do not map onto 8 core areas at the HR: Themes represent “arrowheads” as described by Sir Andrew Whitty: “Encouraging a British Innovation Revolution” (2015)

² Includes £4.5 ERDF project GISMO

³ increased from £15K in 2015

Material Social Futures

A Leverhulme Trust Doctoral Scholarship Programme at Lancaster University



Agbogbloshie (Accra, Ghana) electronic waste is burnt to recover the more valuable

We address the urgent and growing need to provide PhD training in which researchers look beyond their disciplinary boundaries and think about the material and social impact of their research.

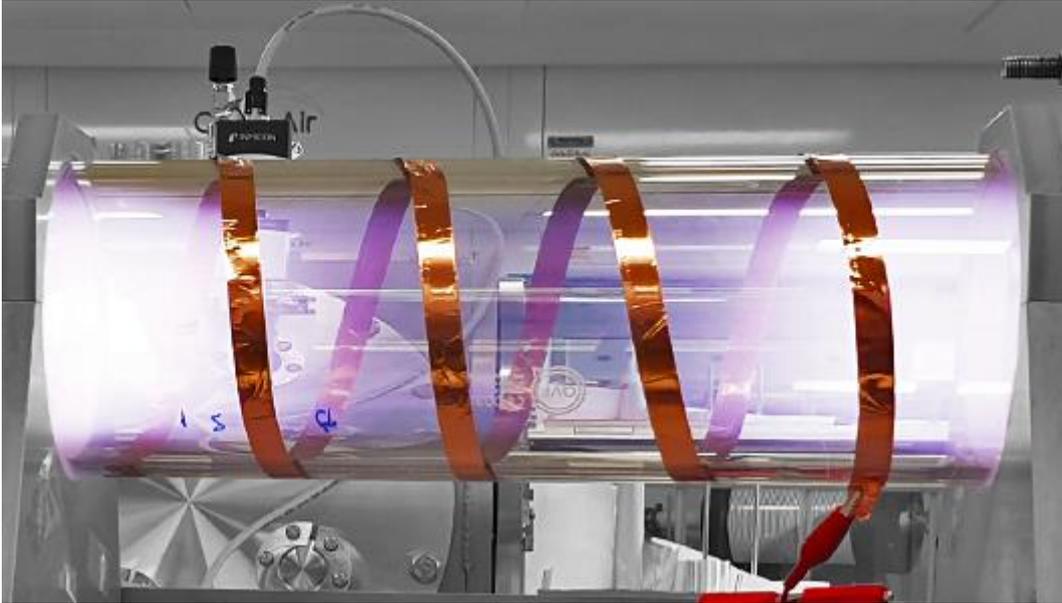
Materials have shaped human environment since pre-history and today they underpin our wealth, health and security. Each new material development offers possibilities, yet, there are potentially unexpected, unwanted social consequences (see photo). These social consequences can, in turn, drive new material problems and concerns. Today's researcher in material science, therefore needs to factor in the likely social consequences of new discoveries; likewise, social science and related research needs to look at how the social is shaping material uses.

If we want to influence the future, we have to make better-informed research choices. This requires big picture thinking to be part of PhD research; thinking that goes well beyond the confines of traditional PhDs and disciplinary boundaries.

Lancaster University's Material Social Futures research training programme is developing just this approach offering students new ways of researching a material and social future.

Critical dimensions often overlooked in materials development have included environmental impact, sustainability, future waste and particularly impacts on social behaviour and values. Critical dimensions overlooked in the social sciences include understanding of the material necessities and by-products of energy production and use. Material Social Futures brings together researchers in social futures and material science to explore the complex, multi-faceted relationship between technologically-enabled and socially-driven change.

Get Smart with GISMO



Caption: GISMO plasma polymerisation reactor provides ultra-thin coatings

As part of a £11.4M suite of ERDF projects, Greater Innovation for Smarter Materials Optimisation (GISMO) pioneers a new way for universities to work with industry.

GISMO provides cutting-edge material solutions to the North West: GISMO provides 120 SMEs fully funded access to experts in the Lancaster University Materials Science Institute, to provide real-world solutions to industrial materials and manufacturing challenges.

Companies use GISMO to:

- Develop new materials
- Trial new material technologies and processes
- Test and develop, ideas and products
- Develop and build prototypes
- Understand developments in materials science
- Improve the quality and effectiveness of products and processes

GISMO supports:

- 3 Innovation fellows
- 9 graduate researchers
- 18 academic researchers

GISMO builds new MSI capability and capacity in:

- Surfaces and coatings
- Additive manufacturing
- Chemical and hydrogen economy

Vision: *World-class materials science and engineering in the vanguard of environment and health applications; pioneering new ways of transdisciplinary collaboration; providing sustainable solutions*

MSF foreshadows and pioneers our transdisciplinary approach to responsible materials development based on a deep understanding of complex socio-technological relationships. MSF goes well beyond traditional research agendas. MSF is the beginning of a journey that, building on expertise in our institutes, & research centres, puts materials at the heart of long-term, sustainable solutions.

Objectives

a) Meet societal challenges in environment and health

Environment: The impact of materials consumption (production, use and waste) on air, land and water presents a global challenge. Publicised issues include CO₂ production (air) and micro-plastic pollution (water and soil); “under-the-radar” challenges include materials-promotion of anti-microbial resistance (AMR) (soil and water) and transport of viruses in pandemics (internationally and locally). “Environment” taps into e.g. the 2025 > \$8 trillion global market for low carbon services and goods.

Health: Ageing populations and the rise in non-communicable diseases create unsustainable, long-term health care costs. These health care costs are to exceed GDPs in developed countries within 30 years. There is an urgent, unmet need to develop practical solutions (e.g. low-cost asymptomatic diagnostics) and treatments that address local (the North West has some of the poorest UK health outcomes), national and international contexts. Yet, eg the required interventions are “Cinderella” research activities. UK research effort must pivot from late stage detection (= radical intervention) to asymptomatic & early intervention technologies.

In the past decade, communicable diseases have re-emerged: material science has much to offer to halt the spread of these; e.g. material to combat the rise in antibiotic resistant infections.

Materials-Environment-Health Nexi: Materials, environment and health cannot be disaggregated: materials impact on both; e.g. particulate matter impacts on air quality and health.

Understanding materials as “entangled” objects demands a transdisciplinary approach: The institute structure at LU provides a unique vehicle to harness the entire research power of a leading University to embrace complexity. **MSI involvement in the new £6.8M “Future Places Centre” foreshadows how we can engage, in novel ways, in larger teams to address these challenges.**

b) Couple technological innovation with big picture thinking

Electric vehicles, renewables and battery technologies are just the starting point for delivering a low carbon economy & green recovery and for the switch from fossil fuels. Understanding e.g. human behavior is central to success: recycling of plastics is not solely a technological problem.

Understanding the landscape in which technology is applied is crucial to developing the required solution. MSF provides a blueprint for how to develop big picture thinking to address complex problems.

c) Vehicle to enable Post Covid-19 recovery

It is vital for a post-Covid recovery that UK manufacturers add value to manufacturing, in new products and in manufacturing returning to the UK (e.g. PPE) in the light of the current pandemic. Objectives (a) and (b) and excellence in material science and engineering provide a truly competitive starting point. But, equally important to success, is to establish new modes of working with Industry. GISMO provides an exemplar of a model that will enable more effective engagement with manufacturers locally, nationally and globally.

d) Harness the power at LU

LU's research strengths have grown and matured significantly since the 2017 plan. Future success will be achieved by leveraging the research power of the other research institutes & centres and seizing the new opportunities opened up by the Health Innovation Campus.

e) Maximise new funding landscape

Rebuilding manufacturing in the north (Northern Power) is decade national priority. Further, government has highlighted the North West region as globally leading in environmental industries, technologies and services and clean energy solutions. Working with the Centre for Eco-Innovation and University Business Partnerships and Enterprise team, we will maximise new opportunities as they emerge, especially through the new 'levelling-up' agenda.

MSI 2021- 2026

Approach

"Where critical mass is required, Lancaster appears to be most successful when combining researchers in novel ways" VC consultation document 2020

To achieve these five objectives, we will leverage on the scale and focus built through themes. The number of themes is to be reduced to three; refocusing within each theme. Whilst MSF (theme 4) becomes an underpinning philosophy.

We are to strengthen each theme; at their core there will be ca. 6 professorial leads. Themes provide the necessary core research excellence, from which we assemble transdisciplinary teams from across LU, in order to provide big picture perspectives and long-term, sustainable solutions. In reshaping themes we will embrace new way of working with external partners (e.g. GISMO) and across all activities we will embed "MSF thinking" into MSI projects and solutions.

Principles

1. **Excellence in material science:** Excellence and domain specialism are at the core of what we are.
2. **Challenge-driven:** Our research addresses unmet needs; provide big picture solutions for complex problems
3. **Transdisciplinary:** Building on our core expertise, we form teams to develop solutions from across the whole of LU
4. **Agile, Responsive:** Respond quickly to rapidly changing landscape; retain flexibility; no "one size fits all" approach
5. **Respect and celebrate diverse expertise:** The MSI brings together academics across disciplines, professional services staff and practitioners. We value this diversity and recognize that we cannot succeed without it.

Priorities & KPIs

Five priorities and appropriate key performance indicators (KPIs) are identified to deliver against over the next 5 years:

1. Clear differentiation from other material science initiatives in UK

Achieved by building an LU niche, and providing leadership, in environment-health-materials:

- a. Locally, through ERDF activities e.g. GISMO
- b. Regionally, through the N8 and strategic partners, e.g. Eden North

- c. Nationally, by greater engagement with the Royce, e.g. achieving associate partner status
- d. Nationally in new partnerships, e.g. with Eden International, preparing for next round of CDTs

KPIs will be based upon measures of success towards a national niche at 5 years:

- i. invitations to contribute to research fora normally out of scope for “traditional materials” research
- ii. Invitations to contribute to regional and national policy fora
- iii. Invitations to lead/ participate in activities on behalf of the materials community that show expertise outside of our community
- iv. Leadership on transdisciplinary grants

2. Grow reputation and reach

This priority will be achieved by further developing our engagement & communication channels

- a. Increase circulation of MSI publications e.g. newsletter; broaden from internal to local SMEs and other organisations
- b. Continue to improve website and content
- c. Build on social media initiatives (Twitter, Facebook, LinkedIn)
- d. Institute attendance at key national events, to meet and inform a broad range of stakeholders

KPIs will be based upon:

- i. Press, social media coverage e.g. TV/radio, articles in broadsheets; impressions on social media
- ii. Breadth and number of engagement activities
- iii. Publications, quality and quantity

3. Increase diversity and amount of income

The MSI has enjoyed success in UKRC schemes, particularly EPSRC, we will maintain this. To achieve increased diversity in income we will:

- a. Broaden funding base to other research councils, e.g. NERC, BBSRC
- b. Increase the proportion of “higher quality” funding; i.e. of greater flexibility
- c. Leverage Northern Powerhouse opportunities
- d. Increase number/value of Industry projects
- e. Explore joint ventures with industry
- f. Access new sources, e.g. venture capital (British Investment Bank)
- g. Secure funding for training of PhDs, i.e. CDT; develop internal mechanisms to increase PGR

The KPI is a 50% growth in total over next five years from £3.5M (2020) to £5.25M⁴

4. Engage more of LU in the MSI

This priority is already covered; in addition to deepening engagement with LU institutes & centres, we will engage with LU's international campuses

KPIs will be based on the number/value of cross institute & centre grant applications

⁴ Excluding ERDF activities

5. Create a “can do” and entrepreneurial culture

In line with three, we are keen to see more spinout and joint ventures. In partnership with BPE:

- a. Internally, celebrate success. A number of institute members have been successful with spinouts etc. This success needs better advertising and celebrating, through targeted communications and stories about the MSI.
- b. Externally, develop relationships with funders and promote opportunities

KPIs will be based on formation of viable spinouts and joint ventures

6. Increase Diversity Of MSI

We recognise that there is substantial room for improvement on EDI; e.g., our current leadership is not reflective of the diversity at LU.

A younger generation of talented female research leaders emerging in our three major contributing departments (chemistry, engineering and physics) will be encouraged to take leadership roles within the MSI.

Appendix 1: LU MSI themes

Themes were formed in 2017.

Theme 1: Surfaces and interfaces unified existing research in Chemistry, Physics and Engineering with relevance to biological sciences and medicine. Surfaces underpin 85% of manufactured products (> £140bn pa of economic activity);

Theme 2: Health innovation materials is underpinned by surfaces and leverages on very high levels of productivity (compared to other sector) from a wide range of products including drugs, medical technology, diagnostics and digital tools within Health Life Sciences. HIM brings significant jobs and growth to virtually every region.⁵ Opportunities align with the objectives of the Health Innovation Campus (HIC) and populate under-served, but nationally important niches.⁶

Theme 3: Materials for advanced manufacturing (AM) focuses on innovative design and development of materials for AM. It has a singular focus of addressing a growing £5.5bn industry. This focus avoids fierce competition with national initiatives in mainstream AM, where LU trails by tens of millions in infrastructure investment.

Theme 4: Eco-sustainability (now Material Social Futures) reflects a growing concern about the social life of materials, addressing issues such as environmental impact, sustainability and ethical behaviour, offering an optimal opportunity to engage with researchers across the University.

Going Forward: Themes provide logical groups for our researchers, but will need aligning to the 5 new objectives and priorities. MSF (theme 4) underpins all activity and provides a vehicle to engage with LU in big, bold initiatives.

For the remaining three themes the plan is:

Build critical mass to be nationally-leading

- Each theme up to 6 professorial academic leads
 - Effective “hunt in packs” for funding
 - Provide strong case for University investment in significant equipment
 - (MSI must become more involved in University recruitment strategy)

Theme 2: Bioengineering and health materials. Revamp under Prof. Reham's leadership

- Focus on low affordable inventions (materials) and testing (poc)
- Greater interaction with local industry
- Build national partnership: QMC, Cambridge, Sheffield
- Focus on international activity through GCRF (IRC COMSATS as model)

Theme 3: relaunch as “material innovation for sustainable futures”

- Incorporate materials for additive, with focus on environmental impacts
- Joint leadership with LU Centre for Eco-Innovation
- Workshops to define in 2021

Equipment: leading edge material science requires state of the art equipment

- Themes provide nucleus of users
- Build “whole of LU” support for targeted equipment
- EM equipment is next target
- Microplastics lab is a further target

MSI Space: A physical space is needed to anchor MSI

- This is required to bring folk together
- “Prof XX” building/centre for material science
- Application for Wolfson Centre

⁵ Sir John Bell: “Life Science: Industrial Strategy Report” 2017

⁶ Sir Jim O'Neil: “Tackling Drug-Resistance Infections Globally”