Developing Mathematical Innovators to Bridge Research and Impact in Data-Driven Applications

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Abstract
The effective deployment of mathematical sciences in interdisciplinary, data-driven research remains a challenge for universities. Despite underpinning the UK's digital research capability, mathematics often fails to translate into real-world impact, in part due to the lack of structured roles for researchers working at the interface of academia, industry, and government.

This paper presents the Mathematical Innovation Research Associate (MIRA) model, developed at the Institute for Mathematical Innovation, University of Bath. The model formalises the role of PhD qualified mathematical scientists as embedded research professionals. MIRAs apply techniques from applied mathematics, statistics and machine learning to projects spanning health, engineering, social sciences and public policy. Their time is allocated across externally funded work, with flexible deployment and cost recovery mechanisms ensuring sustainability.

We describe the model's operational, financial and professional development structures. Since 2018, the MIRA team has supported over 60 projects and contributed to £27 million in research income. The model is now being adopted nationally via the MInDS programme, which supports institutions to establish similar roles.

The MIRA model offers a scalable, transferable framework for embedding mathematical capability into research ecosystems, bridging the gap between academic expertise and applied, interdisciplinary impact.

Keywords
Mathematical innovators, data-driven applications, research impact, knowledge exchange, research technical professionals, interdisciplinary collaboration

1 Introduction

Mathematics brings an unmatched degree of rigour and depth to computational challenges. It underpins much of today's digital technology and can be applied across disciplines and sectors wherever there is data to analyse or systems to model (National Research Council, 2013; Bughin et al., 2018). Yet, despite its foundational role, mathematics often struggles to translate research insight into real-world impact. This challenge stems in part from the communication gap between mathematical scientists and those in other fields: non-specialists may hesitate to engage with mathematically complex

ideas, while mathematicians may lack experience in conveying their expertise in interdisciplinary, practical terms (Bond, 2018; Nightingale and Scott, 2007).

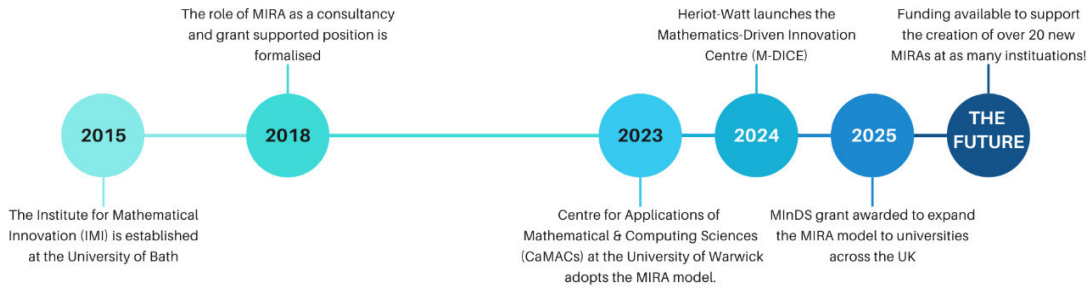

Figure 1: Timeline of the emergence of the MIRA role and related national initiatives.

A visual timeline showing the development of the Mathematical Innovation Research Associate role at IMI (2018), followed by adoption of these positions at the University of Warwick (CAMaCS) in 2023 and Heriot-Watt University (M-DICE) in 2024. The MInDS project started in 2025 to facilitate the growth of 20 new MIRA-type positions at institutions across the UK.

In response to this gap, the Institute for Mathematical Innovation (IMI) at the University of Bath developed the Mathematical Innovation Research Associate (MIRA) role. MIRAs are PhD-qualified mathematical scientists who apply advanced mathematical expertise to data-driven challenges across disciplines and sectors. Their time is funded through externally supported projects, ranging from weeks to years, allowing for delivery in full-time or flexible part-time arrangements. This flexibility supports a more diverse workforce by accommodating part-time work and career breaks, addressing cultural concerns raised by researchers about career sustainability and inclusivity in academia (Learning, 2020). Since its inception, the MIRA model has been adopted and adapted at other UK institutions (Fig 1), reflecting a growing national interest in professionalising applied mathematical roles in line with emerging definitions of research technical professionals (UKRI, 2024).

The emergence of the MIRA role echoes the trajectory of the Research Software Engineer (RSE) role, which arose in the early 2010s to meet the software development needs of modern research (Baxter, 2012; Hettrick, 2016). Both MIRAs and RSEs belong to a broader class of digital research technical professionals, as recently defined by UK Research and Innovation (UKRI, 2023), whose work is vital to computationally intensive, data-rich research. While the two roles are distinct, they are complementary: MIRAs typically draw on techniques from applied mathematics and statistics, such as machine learning, scientific computing, and numerical modelling, to generate insight and innovation.

Like RSEs, MIRAs face the challenge of occupying a non-traditional but increasingly essential position without a clearly defined career structure. National surveys of RSEs have shown widespread concerns about job security, recognition and institutional support

(Brett et al., 2017). Universities struggle to retain mathematical scientists in these roles due to the higher salaries available in industry. However, academia offers comparative advantages in research freedom, long-term security and intellectual exploration. Retention and growth of this talent pool depends on the creation of sustainable career pathways, including opportunities for progression, an issue raised across the research workforce more broadly (Learning, 2020).

This paper presents the IMI MIRA model as a framework for bridging the research-impact divide in the mathematical sciences. We detail the development of the role, outline operational strategies, and highlight lessons learned in growing the UK's largest MIRA team. In doing so, we provide a blueprint for other institutions looking to harness mathematics to deliver impact across sectors. The paper is structured as follows: Section 2 sets the context and rationale for the model, including a comparison with the RSE pathway. Section 3 describes the implementation of the model at IMI. Section 4 presents quantitative results and practical outcomes. Section 5 discusses challenges and the potential for national scaling. Section 6 concludes with reflections and recommendations for institutional adoption.

2 Background and Rationale

The accelerating digitalisation of research has brought mathematics to the forefront of national discussions around research capability and innovation policy (Bond, 2018; National Research Council, 2013). From machine learning to uncertainty quantification, mathematical tools are indispensable in delivering high-quality, reproducible research across the sciences, engineering and social sciences. Yet, the pathways through which this mathematical expertise is embedded in collaborative, interdisciplinary work remain underdeveloped (Perkmann et al., 2013). Universities have struggled to sustain research roles that are neither conventional academic positions nor purely technical support (UKRI, 2024).

This gap presents a barrier to the UK's ambitions in digital research. While institutions increasingly recognise the importance of knowledge exchange (KE) and research impact, the mechanisms for delivering this in the mathematical sciences are still maturing (Johnson, 2022). One-off engagements or superficial involvement of postdoctoral researchers often fail to deliver continuity or capacity building. Moreover, this approach risks diluting the training and development of early-career researchers, who are not supported to operate effectively at the academic–industry interface (Learning, 2020).

The MIRA model was developed at the IMI at the University of Bath to address these limitations. The model provides institutions with a structured mechanism for embedding advanced mathematical expertise into interdisciplinary collaborations through flexible, project-based engagement of PhD-qualified mathematical scientists. The role is designed to be pedagogically valuable, exposing MIRAs to real-world problem-solving contexts

while supporting their professional development; and financially sustainable, through salary recovery mechanisms tied to external funding.

From a policy perspective, the MIRA model aligns with several recent UK national initiatives aimed at supporting digital research capacity. The role reflects the broader definition of Research Technical Professionals (RTPs) set out by UKRI (2024), which highlights the importance of specialist expertise in enabling cutting-edge, data-driven science. It also complements the UK's Digital Research Infrastructure agenda by ensuring that mathematical capability is not only present but fully integrated into national research priorities (Hainsworth et al., 2023).

The pedagogical philosophy underpinning the model is based on experiential learning: MIRAs gain deep technical experience while navigating diverse problem domains and stakeholder cultures. This builds a skill set rarely developed in traditional academic pathways - namely, the ability to scope, communicate and lead applied mathematical work in collaborative, multidisciplinary environments. MIRAs are mentored within a team, and their contributions often feed into future academic research or larger-scale proposals, reinforcing the academic value of externally engaged work (REF, 2019; Nightingale and Scott, 2007).

The model is also designed to be financially robust. MIRAs are employed by the university, with their salaries recouped, either fully or partially, through externally funded projects. A flexible cost model allows their time to be allocated across multiple initiatives, enabling institutions to respond nimbly to funding calls and emerging opportunities. This cost-recovery mechanism not only supports sustainability but also incentivises strategic alignment with institutional KE and research income goals (Johnson, 2022).

The MIRA model builds on the precedent set by the RSE career path, which has successfully gained institutional and national recognition since its emergence in the early 2010s (Hettrick, 2016; Brett et al., 2017). Just as RSEs brought visibility and structure to software expertise in academia, MIRAs bring the same to mathematical modelling and data science. The success of the RSE movement, marked by the creation of a dedicated professional society, formal promotion routes, and professorial-level roles, provides a valuable roadmap for embedding the MIRA role more deeply into the UK's research infrastructure.

3 Implementation of the MIRA Model at the Institute for Mathematical Innovation

The MIRA model at the IMI, University of Bath, was developed iteratively between 2015 and 2022, informed by early experimentation with consultancy-based mathematical engagement and by the growing national appetite for data-savvy, impact-focused research professionals. Over time, the model has evolved into a robust, institutionalised mechanism for deploying mathematical expertise across a wide range of externally engaged projects.

3.1 Role Definition and Team Expertise

MIRAs are post-PhD researchers in applied mathematics, statistics, or related quantitative disciplines. Their work involves mathematical modelling, computational analysis and data-driven insight in collaboration with external partners. While grounded in the mathematical sciences, the scope of their work can extend into areas such as engineering, health, environment and public policy. MIRAs must be able to communicate technical ideas across disciplinary boundaries, co-design methods with non-specialists and work with agility across multiple short-, and medium-term projects.

3.2 Funding Model and Cost Recovery

MIRAs are employed by the University of Bath, with IMI responsible for recovering their costs through externally-funded projects. These include research grants, consultancy contracts, impact acceleration funds and underspend from existing projects. Some MIRAs hold permanent contracts, while others are on fixed-term roles of one to three years. The funding model is flexible by design: it enables fractional allocations of MIRA time (e.g. 0.25 Full-Time Equivalent for discrete phases of a long-term project) and allows this time to be spread across projects and funding sources.

The current internal target is 100% salary recovery for fixed-term MIRAs and at least 85% for those on permanent contracts. These targets have been met consistently since 2018. Where appropriate, MIRAs are named as co-investigators or researchers at the proposal stage, enabling IMI to build a future pipeline of funded work. MIRA inclusion often strengthens applications by providing methodological detail and demonstrating credible capacity in digital research.

The in-house MIRA model also allows the university to offer high-quality mathematical expertise without the administrative burden and uncertainty associated with short-term hiring. For example, IMI was able to allocate a MIRA for six months at 0.25 FTE to a Psychology-led EPSRC project, a scale and structure that would have been difficult to support through traditional recruitment routes.

3.3 Operational Infrastructure

The IMI maintains a lightweight but effective infrastructure to support MIRA operations. Projects are tracked internally through a live database and MIRA time is scheduled via a centralised coordination process that balances research, consultancy and business development activities. Approximately 80% of each MIRA's time is devoted to externally funded work with immediate deliverables; the remainder supports proposal development, strategic initiatives and longer-term institutional research (Fig 2).

Figure 2: Example of MIRA time deployment across project types.

Case study example of time distribution as a percentage for one member of IMI's MIRA team across research projects (externally funded by government grants, charities, foundations or trusts), consultancy projects (commissioned work funded by companies, governmental bodies, and other organisations), and career development activities. Up to 20% of MIRA time can be spent on career development, which includes acquiring new mathematical skills, establishing and growing new research collaborations, proposal development, and longer-term institutional research. The remaining 80% of MIRA time is spent on externally-funded research and consultancy project work, which varies in proportion depending on demand.

Work is scoped collaboratively, with IMI's management team playing an active role in identifying and triaging new opportunities, matching MIRAs to projects, and supporting quality assurance. The Institute promotes Responsible Research and Innovation (RRI) by ensuring that modelling assumptions are transparent and context-sensitive, and by embedding Equality, Diversity and Inclusion (EDI) throughout hiring, project selection, and training.

3.4 Training and Development

Professional development is a core pillar of the MIRA model. MIRAs benefit from mentoring, peer review and project leadership experience. They are encouraged to participate in grant writing, client engagement and dissemination activities, with a view to building a distinctive, impact-oriented academic profile. In some cases, they serve as primary investigators on smaller projects. Career progression is possible through the University's research-focused promotion pathway (University of Bath, 2024) and IMI has successfully supported one promotion from Research Associate to Research Fellow, with further advancement under development.

4 Results and Outcomes

From 2018, when the current MIRA work model was established, to 2025, IMI's MIRAs have contributed to over 60 projects across academic, industrial and governmental domains.

4.1 Financial Outcomes

The MIRA team has contributed to substantial externally-funded income for the University of Bath. Between 2018 and 2025, MIRA-supported projects represent over £27 million in total project value to the University, distributed as follows (Fig 3):

- £25M from government research funding (primarily UKRI)
- £1M from charities, trusts and foundations
- £1M from consultancy and commissioned work

These figures reflect the growing demand for embedded mathematical expertise across sectors and validate the MIRA role as a financially sustainable mechanism for knowledge mobilisation. Importantly, this income includes both lead and partner roles on collaborative grants and spans research, impact, and Knowledge Exchange-focused funding streams.

Cost recovery targets have been consistently met, with 100% recovery of salaries for fixed-term MIRAs and at least 85% for permanent staff. This is achieved through proactive engagement in proposal development, flexible costing structures and continuous pipeline development. Underspend on existing research projects accounts for an estimated 25% of MIRA-supported funding, offering a low-risk mechanism for initiating or extending collaborations.

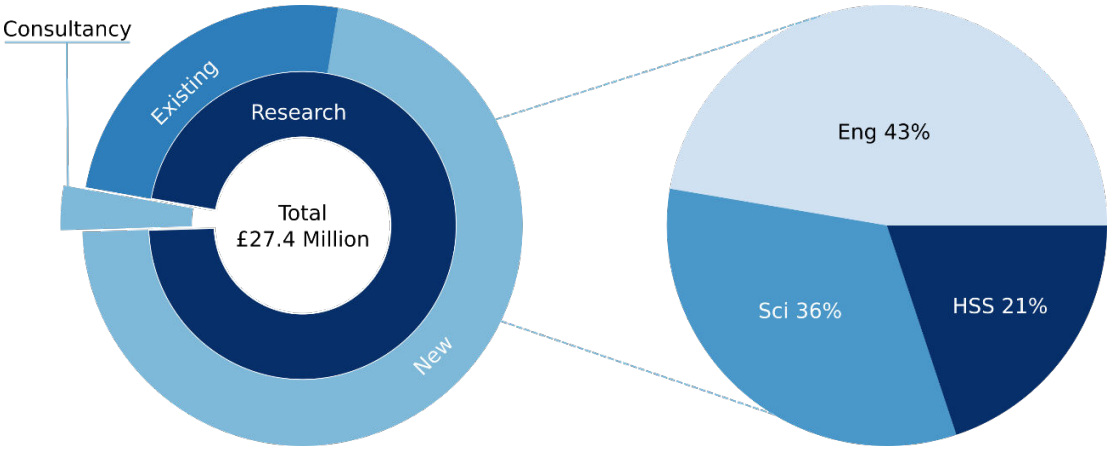

Figure 3: Funding sources of projects with MIRA involvement since 2018

Breakdown of funding income for projects that MIRAs have contributed to from 2018 worth a total value of £27.4M to the University of Bath. New projects where MIRA time is costed into the grant account for approximately 75% of total funding income. The remaining 25% of total income represents ongoing projects where underspent funds are redeployed to support MIRA work, for example to explore modelling or data analysis. Consultancy and commissioned work represent approximately 4% of New funding income. New funding income comes from all three University of Bath faculties (Eng – Engineering and Design, Sci – Science, HSS – Humanities and Social Science) illustrating the breadth and versatility of mathematical applications across disciplines.

4.2 Strategic Deployment of Expertise

The flexible deployment model has enabled MIRAs to contribute to projects with highly specific, time-bound needs. MIRAs regularly work across different disciplines and funding models, with time allocations ranging from 0.1 to 1.0 FTE depending on project scale and stage. As illustrated in Figure 4, over the course of a year, a MIRA may work on multiple research and consultancy projects of varying duration and proportion, in addition to having time to develop new skills, collaborations, and proposals. In-house mathematicians who can work responsively and flexibly circumvents the difficult challenge of trying to recruit skilled researchers at short notice for brief periods.

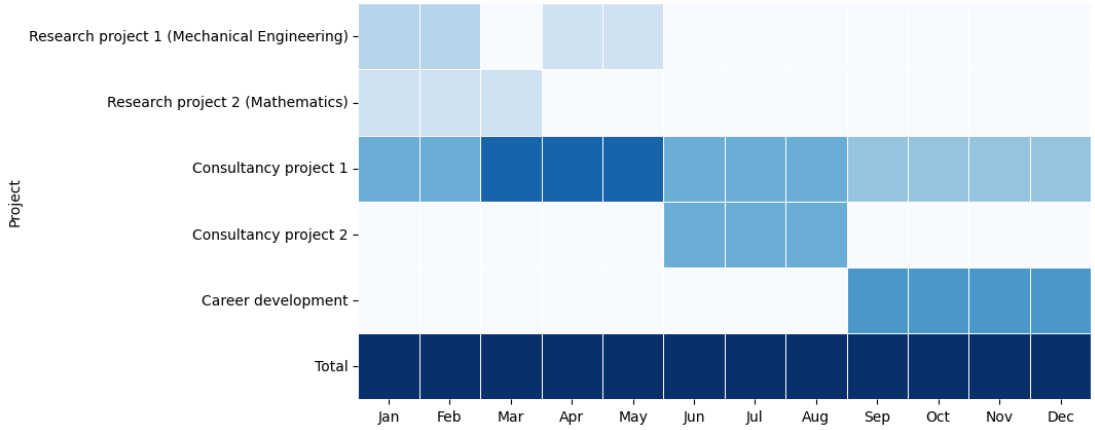

Figure 4: Work scheduling case study for an IMI MIRA in 2024

Proportion and scheduling of work over 2024 for the same member of IMI's MIRA team as in Figure 2. Proportion of time worked per month on a particular activity is represented by lighter (lower proportion) to darker (higher proportion) blocks, with the darkest colour representing 100% of total time worked. The amount of time spent on a project, and when the work takes place can vary depending on project requirements. This flexibility allows MIRAs to work on multiple projects, thus contributing to a multidisciplinary range of research. MIRAs can spend up to 20% of their time on career development activities, which include learning new skills, contributing to proposals for future funding to cover their time, and growing new research collaborations.

4.3 Institutional Reach and Interdisciplinarity

Engagement with the MIRA team extends across all three University of Bath faculties (Fig 3) with MIRAs collaborating with non-mathematical disciplines as diverse as life sciences, economics, mechanical engineering, and politics. More than 50% of projects originate outside the Department of Mathematical Sciences representing £19.5M in external research and consultancy income, underscoring the value of mathematics as a cross-cutting enabler of interdisciplinary work across the University's research portfolio.

4.4 Team Growth and Diversity

The IMI MIRA team expanded from three members in 2018 to twelve by 2025. The team reflects a diverse demographic and disciplinary profile. As of this writing:

- 42% of MIRAs are women
- 75% are international
- Two members work part-time
- Five periods of parental leave have been supported

IMI's project focus shifted in 2020 from primarily industrial consultancy to include also externally-funded academic research. The resulting increase in demand for MIRA expertise has driven rapid growth of the team and allowed retention of all team members since 2020. The inclusive and flexible design of the role has contributed to strong retention and recruitment, enabling the IMI to attract talent that might otherwise be lost to industry or diverted into less impact-oriented roles.

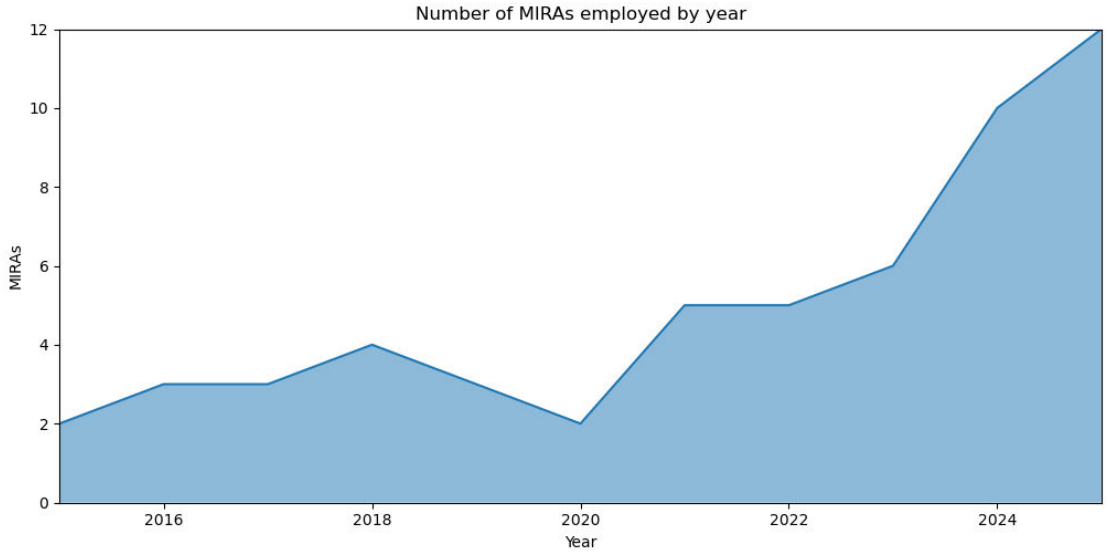

Figure 5: Growth of the MIRA team

The number of MIRAs employed at IMI has grown from an initial two posts in 2015 to twelve members in 2025. The increase in team size observed from 2020 onwards is due primarily to increased demand resulting from expanding IMI's partnerships to include externally-funded academic research projects. Pre-2020, IMI worked primarily on industrial consultancy projects.

5 Towards a National Model

The success of the MIRA model at the IMI has demonstrated that targeted investment in mathematical research professionals can yield high-impact outcomes across disciplines.

IMI has inspired other institutions, including the University of Warwick (CAMaCS), Heriot-Watt University (M-DICE), and the University of Oxford to establish their own MIRA groups. Collectively, these institutions form the early core of a national MIRA network.

To benefit the wider UK research ecosystem, we must expand beyond early adopters and embed MIRAs more broadly across institutions. This is the central ambition of the Mathematical Innovators in the Digital Space (MInDS) programme, a 4-year UKRI-funded national initiative (UKRI, 2024) launched in 2025. MInDS will grow and support the MIRA model at scale.

MInDS is designed to catalyse the development of a UK-wide network of MIRAs (termed Innovation Research Associates (InRAs) in MInDS), providing institutions with the resources, structure and community necessary to adopt and sustain similar roles. Coordinated jointly by the University of Bath and the University of Warwick, MInDS builds on the operational experience of IMI and CAMaCS and leverages partnerships with the UK Knowledge Exchange Hub for Mathematical Sciences, the Academy for Mathematical Sciences, the Isaac Newton Institute, and the International Centre for Mathematical Sciences.

5.1 Flexible Funding to Support Institutional Adoption

At the heart of MInDS is a Flexible Fund (FF), which provides seed support to institutions seeking to launch new MIRA roles or embed existing ones. Institutions may apply for 6-12 months of salary support for a new MIRA post, matched at least 1:1 by host commitment, with an expectation of a minimum 24-month contract. This structure is designed to reduce the perceived financial risk of initiating these positions, while encouraging long-term sustainability through cost recovery, similar to the IMI model.

In addition to direct post support, the FF covers training, networking, stakeholder engagement and career development activities (Fig 6). These include an annual congress, national training programme, stakeholder engagement, and sandpit proposal development workshops – each designed to enhance visibility, recruit new individuals and organisations to the role, and foster interdisciplinary collaboration.

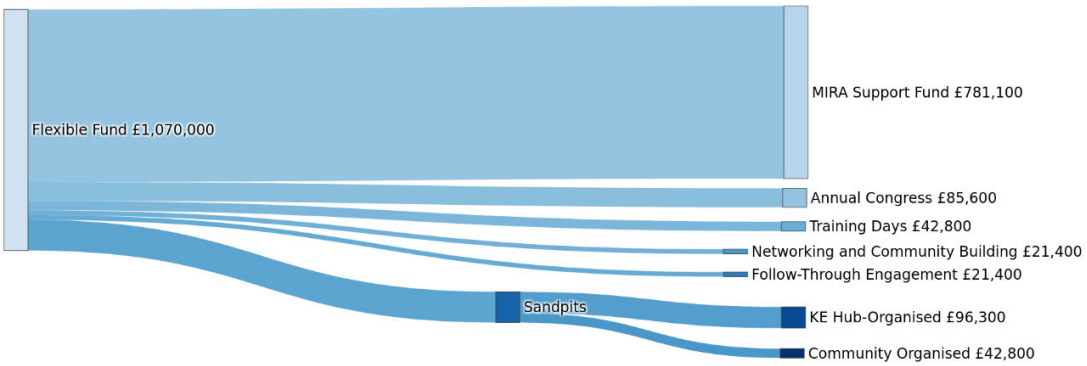

Figure 6: Breakdown of MInDS Flexible Fund activities

The MInDS project will distribute over £1M via competitive process to underwrite up to 20 new MIRA-type roles at eligible UK research organisations, and support UK-wide training, community building, and stakeholder engagement activities. The Support Fund is intended to minimise any perceived institutional financial risk associated with the creation of these new digital research technical professional positions.

5.2 Shared Challenges and National Coordination

Institutions establishing MIRA posts face a set of common challenges, including:

- Justifying the initial underwriting of positions
- Embedding the role within institutional structures
- Creating promotion pathways aligned with university frameworks
- Ensuring access to training and professional development
- Building external partnerships that yield sustainable funding

MInDS addresses these challenges through a national community of practice. A Career Advisory Group, chaired by Prof Simon Hettrick (Southampton) will define best practice for MIRA promotion and recognition drawing on the successful precedent of the Research Software Engineer (RSE) movement. MInDs will provide a structured mentorship and peer-support programme to new individuals and institutions joining the network.

5.3 Community Building and EDI Integration

MInDS places strong emphasis on community cohesion and inclusivity. Networking events, training sessions and thematic workshops will be hosted across the UK, with hybrid options to ensure geographic accessibility. Dedicated EDI leads from the MIRA community will oversee inclusive recruitment strategies, monitor engagement and share best practices across institutions. The flexible, modular work structure of the MIRA role makes it particularly well-suited to diverse working arrangements, and MInDS will promote these design features as standard for all participating institutions.

5.4 Long-Term Vision

The MIRA model offers a scalable blueprint for professionalising mathematical expertise within the UK's Digital Research Infrastructure. MInDS aims not only to grow the number of MIRA-type posts, but to change how institutions think about mathematical sciences as a strategic, deployable capability rather than a purely academic discipline. By 2028, MInDS anticipates the establishment of a self-sustaining UK-wide MIRA network embedded across research institutions, capable of driving mathematical innovation and impact at scale.

6 Conclusions and Recommendations

The MIRA model developed at the IMI has proven to be an effective mechanism for translating mathematical research into real-world impact. Embedding PhD-qualified mathematical scientists into externally engaged research projects has enabled the University of Bath to respond flexibly to interdisciplinary challenges, enhancing its research income and strengthening its institutional reputation in knowledge exchange and innovation (Johnson, 2022; REF, 2019).

The success of the model rests on a combination of operational flexibility, financial sustainability and a strong emphasis on professional development. MIRAs are not only effective consultants and data scientists, they are strategic enablers of impactful, responsible research (Owen et al., 2020). Their work has improved diagnostic tools, guided public policy, optimised engineering processes and catalysed new collaborations across academia and industry.

With the emergence of similar roles at other institutions and the national-scale ambitions of the MInDS programme, the MIRA model is now entering a phase of wider adoption. The establishment of a UK-wide MIRA community provides an opportunity to embed this approach as a recognised part of the research ecosystem.

However, challenges remain. New institutions must be supported in taking on the initial investment risk. Career structures must evolve to support promotion and retention. And national coordination will be essential to avoid fragmentation, ensure inclusive access, and maintain consistent standards of excellence and rigour.

We recommend that:

- Institutions interested in a MIRA-type programme engage early with national initiatives such as MInDS to access funding, templates and peer support.
- Research funders continue to recognise and support roles that operate at the interface of academic research and impact delivery.
- Universities develop dedicated pathways for mathematical research technical professionals, ensuring clear routes for advancement and recognition.

In an era defined by digital transformation, the ability to deploy mathematical expertise where it is most needed is not a luxury, it is a strategic imperative. The MIRA model offers a tested, transferable framework for making that expertise accessible, impactful, and sustainable. Embedding mathematical scientists in digital research infrastructure is critical not only for research excellence, but for societal benefit and economic resilience (Zhang et al., 2022).

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