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# FIRST REPORT OF MATRIX: THE NORTHERN IRELAND SCIENCE INDUSTRY PANEL



# PROFITING FROM SCIENCE

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IRELAND SCIENCE INDUSTRY PANEL

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## MATRIX PANEL



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## FOREWORD

*By the MATRIX Chair*

It has been an honour and a pleasure to have had the opportunity to serve as the first Chairman of 'MATRIX: The Northern Ireland Science Industry Panel'. In presenting this first comprehensive MATRIX' Report I would firstly like to thank all my MATRIX colleagues and all the Horizon panel members for their outstanding efforts and for their enthusiasm in developing the report's findings.

It has been a real privilege to work closely with such a distinguished and talented team over the past 18 months and I believe that our work, set out in the report, represents a significant and noteworthy step forward for the innovation agenda in Northern Ireland.

We were tasked in February 2007 to bring forward focused advice on the future policies necessary for Northern Ireland to ensure economic growth and wealth creation through greater commercial exploitation of its science and technology capabilities. In rising to this challenge my MATRIX colleagues and I embarked on an ambitious work-programme, supported by the Department of Enterprise Trade & Investment.

We engaged closely and in a sustained manner with Northern Ireland's leading high technology businesses and senior academics through our five Horizon Panels and we also consulted extensively across the wider stakeholder community.

Our eight volume report is the culmination of this detailed and intensive work programme and in it we have developed a suite of recommendations at both the macro and micro-economic levels which are entirely complementary and which we believe have the scope to break new ground in enhancing science and technology exploitation policy for Northern Ireland.

MATRIX believes that the overarching challenge for our region is to effect a permanent cultural change so that the responsibility for leading the innovation agenda lies not with government or academia but with business.

In order for Northern Ireland to compete effectively, market-led, cross-sectoral and multidisciplinary innovation must become at least as important over the coming decade as technology based or supply push innovation was in the last.

The report highlights the need to create and maintain a new working environment for business, government and academia where they can combine their resources in a market led approach to innovation. Within these innovation communities the risk and the tension between technology push and market pull can be better managed to achieve greater economic benefit.

Northern Ireland can compete and succeed internationally in key strategic technology based market opportunities. This comprehensive suite of MATRIX and Horizon reports sets out a blueprint to achieve this success.

Together with my MATRIX colleagues I strongly commend our recommendations for implementation.



*Damien McDonnell*

*Chairman Matrix*

## EXECUTIVE SUMMARY

### PREAMBLE

MATRIX was born out of the Regional Innovation Strategy (RIS) for Northern Ireland and it shares the RIS' objective of nurturing and sustaining a fertile innovation environment in which the region's knowledge economy can prosper and grow. This first phase of MATRIX' work has been strongly informed by the ongoing work of the UK Technology Strategy Board (with which MATRIX has developed strong and lasting linkages), and it aspires to play its part in achieving the EU's Lisbon Agenda objective of making Europe the most innovative economy in the world. It also takes into account the findings of a range of policy reports and documents including the 2003 Lambert Review of University-Business Links, the Gower review of Intellectual Property, and the 2007 Sainsbury Innovation Review - 'The Race to the Top'.

In essence this first MATRIX report is the culmination of more than 18 months of intensive engagement with a large and representative cross-section of Northern Ireland's leading high technology businesses and senior science academics. It has kept in mind the Northern Ireland Programme for Government view that:

***'WE NEED TO MEET THE CHALLENGES OF GLOBAL COMPETITION AND TAKE ADVANTAGE OF NEW OPPORTUNITIES TO MAKE OUR ECONOMY MORE COMPETITIVE, DELIVER INCREASED PROSPERITY AND TACKLE DISADVANTAGE AND POVERTY'.***

This report represents a distillation of the collective knowledge of some of the best and most experienced science and R&D based business people and researchers in this region, supported by national and international experts in key areas. Almost every major science based business and research institution in Northern Ireland has played some part in producing these findings and MATRIX' work has been grounded in the real world - it is evidence- based and placed in the context of the global economic challenges we face. It sets the vision, the objectives and the agenda on which MATRIX believes Northern Ireland should focus its future policy development for the commercialisation and economic exploitation of its science, technology, and R&D base.

The MATRIX Panel believes that this report, its key findings and its related recommendations, can make a major contribution to the development of Northern Ireland as a knowledge based economy - fit not only to keep pace with other regions, but to actually secure a genuine leadership position in the exploitation of specific technology areas in the global market over the medium to long term - a position this region has not held for a century.

## IMPERATIVES FOR THE FUTURE NORTHERN IRELAND KNOWLEDGE ECONOMY

MATRIX has identified 4 imperatives for Northern Ireland if it is to rise to the challenge of the 21st century:

- 1** To compete more effectively as a modern knowledge and technology based economy Northern Ireland must develop a more innovative culture of collaboration across industry, government, and academia. Within this new environment Business must take on an increased leadership role in the innovation agenda, with Government playing a support and facilitation role, and with academia working to inspire new heights of innovation through high-quality R&D, knowledge creation and workforce preparation.
- 2** Individual sectors have - through the MATRIX' Horizon Panels - identified that an exclusively single sector based approach of 'old economy' thinking will no longer suffice in the competitive Global Market. Interdisciplinary and cross- sectoral approaches need to be developed and adopted - it is evident that it will be in the spaces between sectors and technologies where the true added value, differentiated and unique to Northern Ireland technology-to-market opportunities will be found and exploited.
- 3** Skills are the bedrock of the modern innovation-based and knowledge economy, right through from the schools system, to Further and Higher Education and on into Life Long Learning. Increasingly a highly developed skills base will be a key source of competitive advantage in the Global Economy. Therefore Northern Ireland must set out to align the continuum of its skills and training regime to the future focused needs and requirements of Northern Ireland's higher value added goods, services and industries.
- 4** As a small region Northern Ireland will always be a net importer of knowledge, through research partnerships, globally connected firms and the attraction of the best talent. Northern Ireland must do more to look and work outward. A sustained means must therefore be found to assist Northern Ireland to become more connected within the UK, with the Irish Republic, across the EU and ultimately globally - especially with regard to its research base and its high technology and knowledge driven businesses, and with science and engineering based Intellectual Property. This includes attracting world class research and innovation leaders to Northern Ireland in key areas of R&D and science exploitation.

## MATRIX HORIZON PROGRAMME: NEAR TO MEDIUM TERM MARKET OPPORTUNITIES

A clear and evidence based overview of future Technology to Market possibilities has emerged from the MATRIX Horizon Technology and Market Foresight programme. This process identified an immediate series of specific near and medium term market focused opportunities for the 5 key technology sectors considered to be of highest economic significance in the Regional Innovation Strategy for Northern Ireland, taking account of the UK's Technology Strategy Board priorities, the EU Lisbon Agenda and in relation to the findings of previous Northern Ireland foresight exercises. The sectors identified are: Agrifood, Advanced Engineering (Transport), Advanced Materials, Information & Communication Technologies (ICT), and Life & Health Sciences.

Under the Horizon Programme MATRIX established an expert panel in each of these sectors and launched a series of time bound and focused technology and market foresight studies. These in turn led to the development of 5 MATRIX Horizon reports each of which contains a series of recommendations aimed at maximising the future science to market commercialisation opportunities within these sectors. This suite of Horizon Reports underpins all of the overarching MATRIX findings and it should be noted that these reports are the fundamental evidence base on which MATRIX top-level findings and recommendations have been built.

MATRIX strongly advocates that these reports - volumes 2-6 of the total MATRIX submission - should be implemented for the benefit of each key sector.

In summary the MATRIX Horizon reports have found as follows:

- In the Life and Health Sciences sector the MATRIX' Horizon Report has identified two major market opportunities for Northern Ireland in Personalised Medicine – diagnostics and medicines tailor-made for individuals - and Home-based Care.
- In the ICT sector the MATRIX Horizon Report has identified a need: for the balance of activity in Northern Ireland's indigenous software sector to move from bespoke application software to packaged product software; to devise a targeted programme of near-shoring aimed at large providers of Financial Services, telecommunications, human resources and ICT; and a long term grand challenge of fully exploiting our research into high performance embedded systems targeted initially at the financial services and telecommunications.
- In the Agri-food sector the MATRIX Horizon Report has found emerging market opportunities in leading differentiated / functional foods; innovative process and packaging; enhancing customer knowledge; leveraging computational science; multifunctional land usage and releasing embedded energy.

- In the Advanced Materials sector the MATRIX Horizon Report has identified market opportunities coming out of the application of biomaterials, nano-structured materials, and multifunctional materials (including catalysis), composites and computational science into the Advanced Engineering, Life & Health sciences and Agri-food sectors, with an overall emphasis on Cleantech.
- And in the Advanced Engineering (Transport) sector the MATRIX Horizon Report has identified market opportunities in: environmentally optimal products; design for passenger safety & security; use of lighter, stronger and more affordable materials; efficient supply of more complex, customised and innovative solutions combining products and services.

Distinct from the Horizon Programme MATRIX also conducted a separate study into the innovative use of Public Procurement by Northern Ireland Government. This has resulted in a recommendation that Government should launch a pilot scheme using pre-commercial procurement to explore new technologies as a way of improving service delivery and also provide a stimulus to the region's high technology companies.

## EMERGING LONG TERM MARKET THEMES

MATRIX through the work of its Horizon Panels and in developing its overarching recommendations has concluded that the real opportunities for the future knowledge economy lie not so much within key technology sectors as in the overlaps and spaces between them.

MATRIX therefore believes that Northern Ireland has the opportunity to secure strategic market advantage and to compete internationally in a range of future focused, multidisciplinary and cross-sectoral technology exploitation areas. In order to compete and win in strategic areas of the global market it will require an ongoing process of Foresight/Horizon Scanning to inform policy development and to assist the wider business and academic communities to seize specific market opportunities as they arise. By making the appropriate decisions now Northern Ireland can expect to secure a valuable share in key global markets of the future.

Based on global trends and drawing on the collective expertise of MATRIX' Horizon panel members and the recurrent themes drawn from the 5 MATRIX Horizon Reports, MATRIX has mapped out four distinct future world market opportunities in which Northern Ireland can realistically hope to secure a distinct role to play.

These future markets are:

### CLEAN & GREEN FUTURE WORLD MARKET

Characterised by environmental issues; total lifecycle manufacturing; challenge of (and opportunities presented by) climate change; and traceability.

#### Northern Ireland Opportunities

Here there is a real opportunity for Northern Ireland to develop a branded unique selling point as a 'Clean Region' across the full range of sectors (e.g. Clean Food, Clean Health, Clean Energy, Clean Manufacturing, and Clean Environment).

### HEALTH, WELL-BEING & VITALITY FUTURE WORLD MARKET

Characterised by an ageing population and increased prevalence of chronic illnesses, as well as a growing market for health promotion, disease prevention and 'beyond health' (i.e. improved fitness) based products and foods.

#### Northern Ireland Opportunities

Personalised Medicine; Home Based Care, including Connected Health (using ICT); Nutraceuticals and Functional Foods; and Management of Health systems. Northern Ireland already has a strong R&D infrastructure in key areas and maturing pilot programmes (diabetes care).

### JOINED UP & CONNECTED FUTURE WORLD MARKET

Characteristics include: Globalisation; increased uptake of ICT; expansion of wireless; growth of travel demand (with related carbon issues etc); increased need for security solutions; distance learning and learning technologies; new business models (including Hosted Systems); modern lifestyle expectations; financial services & insurance; and traceability - including supply chain and shelf-life management.

#### Northern Ireland Opportunities

There is potential for Northern Ireland to use the concept of the Connected Future as a means of differentiation in strategic sectors; to deploy connectivity to sell capabilities worldwide; also there is an opportunity for Northern Ireland to be a test bed for future Connected technologies, drawing in a variety of disciplines in key niche strategic areas which require multidisciplinary thinking (e.g. Connected Health).

### SAFE, PROTECTED & SECURE FUTURE WORLD MARKET

Characterised by the need to address issues such as: climate change; financial and data management concerns; public perception of insecurity and personal safety concerns; health security and traceability of health and food products (e.g. components, raw materials, storage conditions, drugs); environmental purity and security of resources (like water); and safe use of ICT, broadband etc).

### Northern Ireland Opportunities

Areas for Northern Ireland's future focus could include Secure Energy; Secure Environment; Secure Food Supply; and Personal Security.

## MATRIX PROCESS & KEY FINDINGS

The MATRIX process to date has been highly successful in establishing the potential within the Northern Ireland science and technology base, and identifying medium to long term market opportunities for exploiting that potential. The next challenge is in mobilising the key participants within the region's economy in a way that will accelerate and guide our capability to grasp these opportunities.

Within the above context MATRIX proposes a comprehensive approach to secure Northern Ireland's competitive future in the global, technology and knowledge based economy. The key aspects of the approach include:

- A market/business perspective of the strategic sectors identified by its Horizon Process;
- A 'now-sight' market/capability matrix- based assessment;
- Identification of growth opportunities for Northern Ireland's economy in each of 5 agreed strategic sectors;
- Identification of a range of conditions for success and economic sustainability for the region;
- A recognition that 'Technology Push' innovation in this region is working well - but to grow the Northern Ireland economy significantly faster we need to add an enhanced Market-led Innovation dimension.

The findings from this approach have led the MATRIX Panel to a core set of recommendations which address the key challenge of building on the existing innovation ecosystem to make a step change in our innovation capability.

## MATRIX KEY RECOMMENDATIONS

Within their deliberations the MATRIX Panel has developed a series of recommendations on key elements of the innovation ecosystem in Northern Ireland to address the challenge outlined above. The panel have arrived at an overarching recommendation to deliver growth in the Northern Ireland economy based on an enhanced capability to innovate. This can be summed up as follows: **Connect science to exploitation through market focussed technology innovation communities that are targeted at Northern Ireland specific roadmaps.**

This is shown in the model set out below as Figure 1 - a future innovation system for Northern Ireland. This model builds on the existing fundamental capabilities within the science and technology base in Northern Ireland but seeks to achieve a greater level of connectedness through multidisciplinary industry-led communities and enhanced routes to market for science and technology. To deliver this model MATRIX' full suite of recommendations are as follows:

1. **Industry led communities should be formed engaging business, academia and government to address global market opportunities by exploiting the science and technology capabilities in Northern Ireland.**

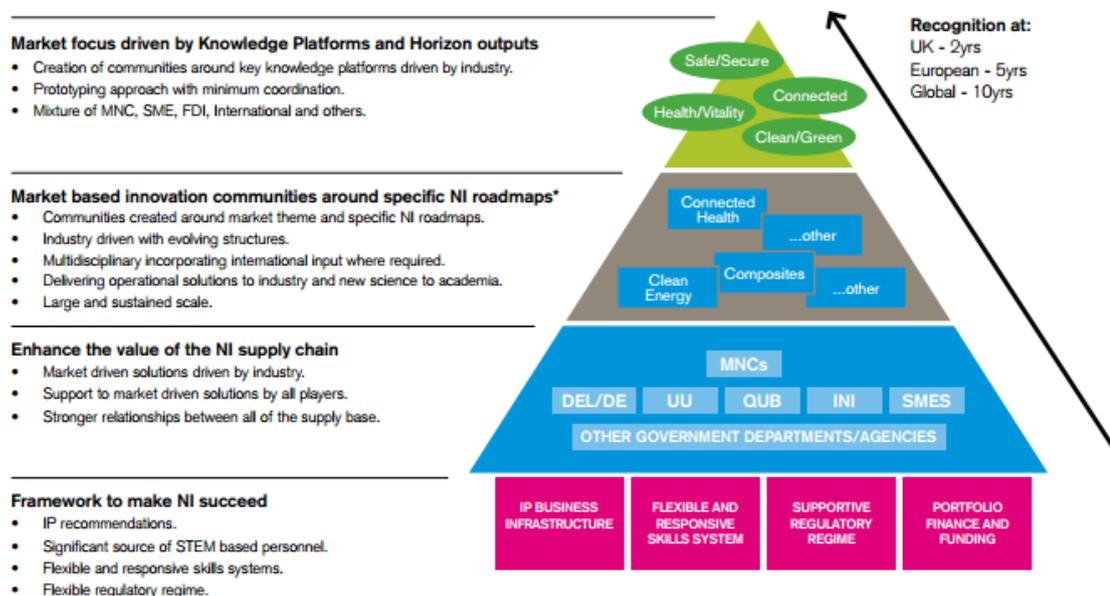
These communities should build on existing innovation activities by coordinating and aggregating their innovation resources and by bringing together existing Northern Ireland, UK and EU innovation support programmes to create sustained funding and 'flagship' projects. The communities should aim to attract international commitment and gain recognition nationally (within 2 year), continentally (5 years) and globally (ten years). Such 'flagship' projects must ultimately seek to attract resources from other markets if they are to succeed and will then enhance the development of the Northern Ireland knowledge economy still further;

2. **The Industry led Communities (above) should create Northern Ireland roadmaps (driven by industry). These should demonstrate and create outputs for all members of the Industry-led communities - thereby driving more effective knowledge and technology exchange among community partners.**

These roadmaps should aim to facilitate better exchange of information, assist with technology brokerage and allow members to aggregate existing resources and support programmes for maximum effect, especially to increase the absorptive

capacity of new ideas;

FIGURE 1: FUTURE FOCUSED INNOVATION SYSTEM FOR NORTHERN IRELAND



\*Those illustrated here are examples that have been proposed, but not exhaustive.

3. A world class Intellectual Property Business Infrastructure must be created in Northern Ireland. In this there must be a more comprehensive understanding among the business and academic community of the intrinsic value of IP and how to exploit it and Northern Ireland should also nurture more leading capability within the region's R&d and business community to develop fundamental IP.

There needs to be increased awareness in Northern Ireland of the potential to exploit the value of IP while avoiding any counter productive tendency towards over protection. Firms need improved capability to recognise the inherent value in their own business (in their people, processes, products, techniques, etc). It is evident that Northern Ireland needs to attract and retain top class researchers (international calibre) to develop deep IP capability which can be used to grow indigenous capability.

The ability to adapt or repurpose IP is also a critical ingredient of an effective IP Business Infrastructure.

4. Northern Ireland must have a Flexible and Responsive Skills System that leads Europe in terms of its ability to meet changing demands and is superior to all identified competitors.

Skills are the heartbeat of the economy and the quality and depth within the Northern Ireland skills base is key to the region becoming globally competitive. All key technology sectors in Northern Ireland recognise that the current skills balance in the workforce is not sufficient for the economy's needs. The entire supply chain of skills must be addressed from primary schools, secondary, third level and within the workforce. The review of STEM within Northern Ireland positions the science, technology, engineering and mathematics subjects as the foundation of the future skills system needed for a knowledge economy. However, it must be clearly recognised that as a small region, flexibility in education is essential for Northern Ireland to be able to align the skills supply chain to market need, a need that is changing fast. Such flexibility and responsiveness can then become a source of competitive advantage for a small region such as Northern Ireland.

5. The Regulatory Regime must be transformed to allow Northern Ireland to take and manage a higher level of risk within a broad innovation portfolio, and the model for this must be developed and shared across industry, government and academia.

Leaders must be empowered, through the recognition that Northern Ireland must operate in a different way to support innovation and to accept and manage higher levels of risk (with a focus on the resultant higher levels of return to the economy). Developing a more flexible approach to risk management for public sector funding support to R&D and Innovation based firms would mark a significant step towards a more creative incentive system.

Northern Ireland needs to increase the emphasis on private sector investment in R&D & Innovation and the portfolio of firms that are suitable for investment. Venture Capital, Banking, and other financial support services for high- technology firms and related projects have to be encouraged, including through mechanisms such as tax credits, vouchers etc. Funding for R&D and Innovation activities should reflect the medium to long term nature of securing returns from R&D and Innovation based investments (up to 10 years if necessary).

## THE SIZE OF THE PRIZE - INCREASING THE GROWTH OF THE NORTHERN IRELAND ECONOMY

Northern Ireland has had a positive economic growth rate in recent years and over the next decade it is projected that it will continue to rise. But when set against many other similar regions of the UK and EU it is also apparent that this rate of increase is comparatively modest. MATRIX believes that this report, if acted upon, will trigger a step change in the growth of the Northern Ireland economy.

The panel believe that MATRIX' suite of recommendations provides a platform to encourage a new approach by business, government and academia which will: considerably enhance the business contribution to regional GVA; accelerate sustained economic growth; significantly increase the number and quality of higher value added jobs; and make a major contribution towards raising productivity levels in Northern Ireland to at least the UK average.

These objectives - aimed at extending the wealth and success of the regional economy - mark the 'Size of the Prize' to which MATRIX believes Northern Ireland can aspire.

## CONCLUSIONS & NEXT STEPS

In summation, therefore, this MATRIX report sets out the steps that we should take if we are to secure Northern Ireland's competitive future in the global, technology & knowledge based economy over the coming decade. That future can only be realised if this region meets the challenges and opportunities ahead in a new and dynamic way - led by business, supported and facilitated by government, and inspired and informed by academic excellence.

MATRIX is placing a challenge before all key stakeholders - Business must step forward in this region and show real and constructive leadership on the innovation and R&D commercialisation agenda; Government must play a more effective support and facilitation role; and Academia must strive to inspire success through its research and development excellence and the critical qualities it brings to the economy through its skills training for the workforce. MATRIX believes that by working together in this new and redefined way, Northern Ireland has an opportunity to build a stronger and more sustainable economy than it has had for many years. In the current world economy this is a long term planning opportunity that we must not miss.

This first phase of MATRIX will be completed at the end of November 2008 as the panel steps down after 2 years of work. In that period MATRIX believes that it has arrived at a core proposition for enhancing and accelerating the development of Northern Ireland's knowledge and innovation based economy. Following the launch of this report and before

the formal end of this first reporting phase MATRIX will engage with key stakeholders across industry, academia and government to begin the process of agreeing a high-level implementation strategy for the MATRIX recommendations.

MATRIX will also initiate its preliminary Energy study and a full MATRIX Energy Panel will be assembled by the end of November. It will be tasked with reporting to the DETI Minister by the spring of 2009. Before the end of November MATRIX will also complete studies into the exploitation and management of Intellectual Property in Northern Ireland and the potential for private sector financial and mentoring support to high-technology start-up firms.

Ultimately by spring 2009 a renewed and refreshed MATRIX Panel will be established to continue the work which this report has begun.

## INTRODUCTION

**THIS FIRST MATRIX REPORT TO THE DETI MINISTER COMES AT A KEY POINT IN THE DEVELOPMENT OF NORTHERN IRELAND'S KNOWLEDGE ECONOMY. IT RECOGNISES THE NORTHERN IRELAND GOVERNMENT'S ASPIRATION IN THE PROGRAMME FOR GOVERNMENT THAT:**

***"WE NEED TO MEET THE CHALLENGES OF GLOBAL COMPETITION AND TAKE ADVANTAGE OF NEW OPPORTUNITIES TO MAKE OUR ECONOMY MORE COMPETITIVE, DELIVER INCREASED PROSPERITY AND TACKLE DISADVANTAGE AND POVERTY."***

MATRIX was born out of the Regional Innovation Strategy (RIS) for Northern Ireland and it shares the RIS' objective of nurturing and sustaining a fertile innovation environment in which the region's knowledge economy can prosper and grow. The work of the MATRIX panel is strongly informed by the ongoing work of the UK Technology Strategy Board (to which MATRIX is closely linked), and it aspires to play its part in achieving the EU's Lisbon Agenda objective of making Europe the most innovative economy in the world.

It was in light of these aspirations that - approximately 18 months ago - the Northern Ireland government handed business and academia a challenge to map out their preferred future for an innovation based economy capable of competing with the best in the world. MATRIX was established to rise to this challenge and in so doing it has broken new ground in informing economic policy for Northern Ireland. This report outlines a series of objectives and recommendations which have the potential to unlock a decade of opportunity for the region. It is the culmination of over a year's intensive engagement with Northern

Ireland's leading high technology businesses and senior science academics and it represents a distillation of the collective knowledge of the best and most experienced science and R&D based business people and researchers in the region.

The recommendations arising - if acted upon can make a real difference in a relatively short space of time. This report does not seek significant new Government funding to achieve its aims. While investment is required, that should be largely realised from the informed deployment of existing resources.

**The most important change that the MATRIX panel is calling for is in mindsets across the region and across all sectors. We advocate reaching consensus that innovation and the commercial application and exploitation of science - in a collective and coordinated strategic fashion - will be a key part of our future if we are truly to excel as a regional economy on an ever more competitive global stage.**

## THE MATRIX PROCESS

MATRIX is first and foremost a business led advisory panel which comprises: senior high-technology industrialists; the Pro-Vice Chancellors from Queen's University Belfast and University of Ulster; senior representation from the Association of Northern Ireland Colleges (ANIC); the Chairman of the Economic Development Forum Innovation Sub-Group; and representatives of the Invest NI Board.

MATRIX was tasked with producing evidence-based and targeted advice to help guide DETI and the DETI Minister in developing policies for maximising Northern Ireland's economic return from the exploitation of science, technology and R&D over the next 2-10 years.

MATRIX developed and implemented an unprecedented research and analysis programme to attain a thorough understanding of Northern Ireland's science and technology strengths and weaknesses, and to establish a clear set of future focused priorities for medium and long term economic success. The approach has been systematic and comprehensive:

- MATRIX' 'Technology Capabilities & Market Opportunities Study' was a challenging and detailed analysis of the strengths and weaknesses across the full range of science and technology based business sectors in Northern Ireland at this moment in time. An exercise of this comprehensiveness and scale has never been undertaken in this region before. In addition, the Northern Ireland Universities have been asked to submit detailed self-assessments of their scientific capabilities and capacities to MATRIX for association with the full suite of MATRIX reports. This complete body of work amounts to a new and very valuable 'mine' of evidence for assisting with informed policy decisions.
- Building on this foundation MATRIX established its flagship initiative - the Horizon Programme. Horizon was a focused and time-bound technology and market foresight initiative comprising a series of expert panels which represented the key technology sectors of the Northern Ireland economy as identified by the Regional Innovation Strategy: Advanced Engineering (Transport); Advanced Materials; Agrifood; Information and Communication Technologies (ICT); and Life & Health Sciences. More than 80 senior business people and academics engaged enthusiastically with the Horizon programme. The MATRIX process also enabled a focus to be placed on potential opportunities at inter-sectoral interfaces.
- MATRIX also conducted related studies into: the use of Public Procurement to lever Innovative Science & Technology Solutions in Northern Ireland; and innovative private sector funding mechanisms to support the commercialisation of Northern Ireland's science and technology excellence. These studies have primarily brought forward recommendations aimed at stimulating innovation and increasing the uptake of R&D by Northern Ireland's businesses.

- MATRIX was mindful of the STEM Review being conducted by DE and DEL in parallel with the Horizon programme and ensured cross-fertilisation through cross-membership, clearly recognising and acknowledging the future skills agenda in sustaining a knowledge driven economy; MATRIX has also considered how the protection, exploitation and retention of intellectual property might be optimized.

## CURRENT TECHNOLOGY & MARKET CAPABILITIES

MATRIX Technology Capabilities and Market Opportunities Study has shown that Northern Ireland industry currently has both strength and depth in several key areas of science, technology and R&D. In addition within our universities there are examples of world class research in several technology fields, and we have the added advantage of having a member of the Russell Group of universities in Queen's University Belfast.

In addition to the conduct of excellent research and dissemination of findings, the universities and the Regional Colleges place very significant emphasis on meeting the educational and training needs of the current and future workforce. Through Further and Higher education, sometimes in partnership with other public and private sector bodies,

Northern Ireland must aspire to harness the full talent potential of the indigenous community, while proactively seeking to attract world-class talent (for both academia and business) from elsewhere.

Importantly from the economic perspective Northern Ireland has some outstanding R&D intensive firms across all the key technology sectors. In Advanced Engineering (Transport) there are currently around 25,000 employees in more than 130 companies with a combined turnover in excess of £3.4 billion per annum; the Agrifood sector employs 12% of the private sector workforce, generates £2.4 billion in sales per annum and is responsible for 2.2% of the region's GVA; ICT employs some 11,000 people in 750 businesses of which most are indigenous SMEs; the Life & Health Sciences sector consists of around 60 companies which had a combined turnover of £400 million in 2005, and which currently employ approximately 4,000 staff; and in the comparatively newer Advanced Materials sector there are already more than 50 firms employing more than 7,000 people and turning over in excess of £850 million per annum.

## A FUTURE MARKET FOCUS: SUMMARIES OF MATRIX HORIZON PANEL REPORTS

The MATRIX approach has been to build on Northern Ireland's current science and technology capabilities and market opportunities - acknowledging where we have valuable ongoing research activity in some areas and world class quality research in others and to develop a market-focused technology foresight programme.

MATRIX' Horizon Programme has been a systematic process which sought to visualise the likely interactions between Science, Technology, Industry, Economy and Society over the medium to long term (up to a decade) with the purpose of identifying technologies and markets that could generate significant economic and social benefits for Northern Ireland. It was not about delivering probability- based predictions of future technologies nor was it about anticipating the possible impacts that future technologies might have on society in general.

Horizon was designed to both prepare for and affect the future in this region. It set out to identify the necessary overarching strategy and high-level actions which would allow Business and Academia - supported by Government to influence and adjust future events and developments for competitive economic advantage. The ultimate aim was to ensure that the Northern Ireland economy would be as well positioned as possible to compete internationally on the basis of its knowledge base and its science and technology capital.

As a result of the Horizon Programme a clear and evidence based overview of future Technology to Market possibilities has emerged. The process identified an immediate series of specific near and medium term market focused opportunities for the 5 key technology sectors considered to be of highest economic significance in the Regional Innovation Strategy for Northern Ireland, taking account of the UK's Technology Strategy Board priorities, the EU Lisbon Agenda and in relation to the findings of previous Northern Ireland foresight exercises. The sectors identified are: Agrifood, Advanced Engineering (Transport), Advanced Materials, Information & Communication Technologies (ICT), and Life & Health Sciences.

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Each of the 5 Horizon Reports comprises a chapter in the composite MATRIX report, and each report contains its own set of specific recommendations to be taken forward for the respective sectors.

[MATRIX strongly advocates that the recommendations within these reports should be implemented for the benefit of each key sector.](#)

## LIFE & HEALTH SCIENCES

The Life & Health Sciences Horizon Panel has identified 2 overarching opportunities for the Northern Ireland economy in that sector - Personalised Medicine and Home-Based care:

### Personalised Medicine

Personalised Medicine is the use of information about a person's genetic make-up to tailor strategies for the detection, treatment, or prevention of disease. It is expected to transform healthcare over the next decade and beyond.

Indicators are that Personalised Medicine will eventually grow to be about 25% of the whole pharmaceutical market worldwide - exceeding a value of \$250 billion. Northern Ireland can carve out a share of this growing market by becoming a centre for Integrated Research & Development in Personalised Medicine. Such an approach would help fuel the development of Personalised Medicine within the region, while also putting Northern Ireland's indigenous cluster of biotech companies firmly on the international map in this highly dynamic sector.

By harnessing the combined strengths of scientific businesses, clinical data and academic expertise there will be a series of benefits for the Northern Ireland economy:

- Development of existing firms, by accessing expertise and knowledge from the local and international scientific community;
- Attracting high quality FDI to Northern Ireland; and
- Generating new company spin-outs from the existing research base.

Realising the maximum real benefits from Personalised Medicine will require a multi-disciplinary approach, across business sectors and across academia.

### Home Based Care

Also known as telehealth or e-health, Home Based Care refers to the remote exchange of a patient's details and data from his/her own home to a response centre (e.g. a GP's surgery, clinic, hospital or third party service provider). The Home Based Care Market in the United States will be worth \$4.5 billion by 2010, and the UK market share will be \$286 million by the same time.

There are 2 emerging areas of immediate priority for Northern Ireland - the management of chronic disease (e.g. diabetes, cardiovascular etc) and extending the independence and quality of life for an ageing population and the disabled.

Northern Ireland now has a major opportunity to become the first UK region committed to the early adoption of a telehealth system in a region-wide Health & Social Care platform. Such an initiative would create an attractive 'Whole System Integration Test Bed' for local and international technology providers who would choose to use Northern Ireland as the

key gateway to the UK, island of Ireland and European home care export markets. Northern Ireland government would also benefit from savings achieved by the delivery of health in this innovative, highly efficient new manner.

## ICT

It is undeniably true that the ICT sector forms the 'backbone' of several industries in Northern Ireland - such as the financial services industry - and it is an important value adding component of many consumer products and services across all sectors. In Northern Ireland - as across the globe - the ICT sector is a dominant force in enabling companies to create new products, open new distribution channels, and deliver differentiated services to customers. It is worth noting that ICT is constantly changing based on customer and market demands as the sector is part of a Global supply chain that constantly seeks new markets and innovative solutions in order to sustain existing markets.

Given the pace of change in the ICT sector world-wide and the corresponding developments in Northern Ireland over the past decade, the potential for exploiting the collaboration between industry and academia, supported by government, is huge and has significant potential to make a major economic impact over the next 10 years.

The ICT Horizon Panel set out to achieve a step-change in thinking within and about the sector in this region. It is evident that if the sector adopts the correct strategic approach and draws together all of its strengths in new and innovative ways, then it can offer significantly more in terms of developing a global leadership position and contributing more to economic growth in Northern Ireland. To this end it developed 3 focus areas for future development:

### Packaged Application Software

Northern Ireland should transition from the existing bespoke software application capability to packaged software which uses new and innovative delivery mechanisms.

This initiative should focus Northern Ireland technological capabilities in the sector towards the major markets of Global Financial Services, Telecommunications, Healthcare and Security Solutions.

### Nearshoring

Northern Ireland should transition its existing 'Nearshoring' operations from transaction based service to decision making based services interacting with the customer directly. The core business opportunities for this initiative will again be within key markets such as Financial Services and Healthcare, with an emphasis on Human Resource and IT functions.

### High Performance Embedded Systems

High Performance Computing and High Performance Embedded Systems present Northern Ireland with the opportunity to further the development of science and technology in the region and also to attract high quality international partnerships and potential FDI from numerous sectors in the Global marketplace. This cutting edge computational field plays a key role in other large industries such as Automotive, Aerospace, Telecommunications, Security Solutions (identity authentication etc), and smart construction for energy management and healthcare provision.

### AGRI-FOOD

Northern Ireland is synonymous with the Agrifood sector. It is characterised not only by food and traditional agricultural industries, but increasingly it comprises multifunctional businesses and research based opportunities. The Agrifood sector has the potential to achieve a step change in its fortunes by exploiting new science and technology. The future of Agrifood is dependent not only on its own existing capabilities, but also those developed and used within Life Sciences, ICT, Advanced Materials, and Advanced Engineering.

For a region the size of Northern Ireland, the Agrifood Horizon Panel has concluded that the key to success in this sector is to focus on areas where there is potential for international leadership. Five such potential leadership areas have been identified and are set out below:

#### Leading differentiated/Functional Food

The development of world leading differentiated/ functional foods (i.e. food with a health benefit) using pharmaceutical techniques;

#### Innovative Process & Packaging

The development of existing processing and materials skills to produce innovative food processing and packaging mechanisms to improve food safety, product shelf-life, reduced preservation and storage costs, and also to enhance consumer confidence;

#### Enhancing Consumer Knowledge

The development of knowledge based toolsets that enhance and communicate the safety, security and purity aspects of products and provide assurance of quality to the consumer;

#### Leveraging Computational Science

Further the development of the existing use of computational science capability to advance the Agrifood sector in terms of food and process modelling and to master change and alleviate risks associated with food security, food quality and overall industry risk;

Exploiting the multifunctional nature of Agri-food and finding mechanisms to release the Embedded Energy in the Sector

The creation of a complete supply chain throughout the Northern Ireland Agrifood sector that focuses on the multifunctional usage of the sector to increase productivity and to release the embedded energy resources within food products. This will create an energy supply source, and reduce waste and costs.

It is recommended that agrifood businesses, academia and government work together to develop these leadership areas.

### ADVANCED MATERIALS

The Advanced Materials sector is a key technology driver in all market sectors and is of the utmost importance to the Northern Ireland economy over the medium to long term. Indeed, success in this sector is arguably a prerequisite for success in other sectors and throughout the Northern Ireland economy as a whole, particularly in relation to the role of materials in the overall innovation process.

The analysis of the industrial and academic strengths shows that a rich focus area for Northern Ireland is the convergence area between traditional material sectors and a focus on the interdisciplinary and multidisciplinary areas of advanced materials. Specifically these areas are:

- Biomaterials;
- Nanostructured Materials;
- Multifunctional Materials (including catalysis);
- Composites (Intelligent and Structural); and
- Computational Science.

In these areas Northern Ireland has demonstrated significant competency, across industry and academia and is capable of establishing a niche leadership focus within the UK, Europe and the rest of the world.

Advanced Materials have risen to dominate science and technology exploitation on the global level, drawing in all sectors and all scientific disciplines. Current innovations in Advanced Materials are the driving forces for new product developments. Industries such as aerospace, automotive, chemicals, data storage, electronics, medical devices, food and agriculture and ICT, among others, have and will continue to benefit greatly from underpinning technology developments in the Advanced Materials sector.

Northern Ireland is fortunate in that it has already developed international quality strengths in this area and can build on its Advanced Materials capability to underpin all other key sectors in the knowledge economy. These strengths not only include centres of academic

excellence and highly innovative SME's but also world class companies such as Dupont, Seagate and Bombardier. In many respects this region is 'punching above its weight' in this area.

The panel concluded that Northern Ireland should develop a sustained funding mechanism that allows for the establishment of an industry led R&D capability of international standing.

The funding mechanism will specialise in the cradle-to-grave evaluation of advanced materials with a focus on the globally emerging Cleantech market. Also, Northern Ireland should create industrially led expert networks in specific focus areas of Advanced Materials.

### ADVANCED ENGINEERING (TRANSPORT)

Northern Ireland has a strong tradition of engineering, particularly in the transport sector. The challenge if this sector is to strengthen and sustain its position in world markets is

to continue to move up the value chain by integrating design, development, in-service support and manufacture (including robotics and automation) with the exploitation of genuine science and technology expertise in Northern Ireland.

There are four key market opportunities emerging from the Advanced Engineering (Transport) sector: Environmentally optimal products; Design for passenger safety & security; Use of lighter, stronger and more affordable materials; and, Efficient supply of more complex, customised and innovative solutions combining products and services.

There is no single 'big bet' technology on which to focus within this sector - rather a number of core science/technology areas are evident which will form the basis of the future for world class Advanced Engineering in Northern Ireland. These include the application of technologies and approaches to support a cleaner, safer environment; the increased use of Advanced Materials (including biomaterials, nano-structured materials & composites); the increasing importance of microsystems, embedded sensors and computational science; and the use of robotics/automation in the manufacturing process.

An area which is important to ensuring that this sector remains competitive at a global level into the future is in creating and supporting the development of new business models in particular with reference to business models which encourage shared participation in R&D activities.

## PROCUREMENT

Related to but distinct from the Horizon Programme, MATRIX also conducted a study into the use of public procurement as an instrument to find and implement innovative solutions to issues faced by the public sector, and to fund early-stage companies and SMEs with ideas for such solutions. As a result MATRIX has concluded that Northern Ireland Government should establish a pilot scheme using pre-commercial procurement to explore new technologies as a way of improving service delivery and also provide a stimulus to the region’s high technology companies.

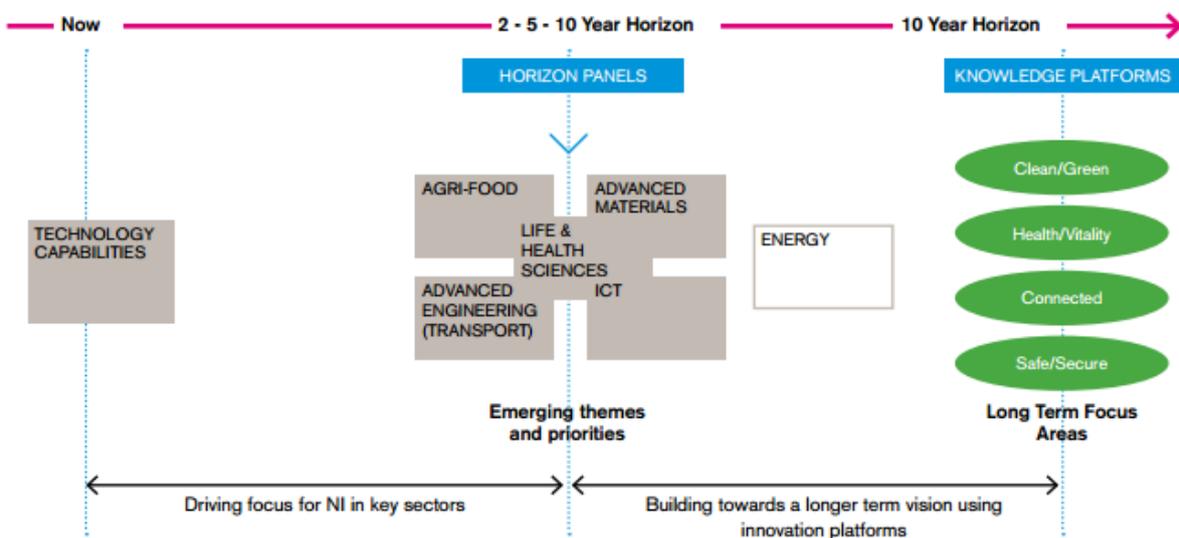
## CROSS-SECTORAL & MULTIDISPLINARY OPPORTUNITIES - EMERGING HORIZON CROSS-PANEL ISSUES

While the Horizon Programme brought together expertise from within the five most visible and important technology-based sectors in Northern Ireland, the wider MATRIX objective was to seek the added value of moving beyond the solely sectoral focus.

It is abundantly clear that many of the most interesting new business and emerging market opportunities are to be found not so much within the specific technology sectors, but rather in the overlapping spaces between them. Northern Ireland can already point to clear examples of where technology sectors have collaborated to produce world class business focused products or services which would not have been possible without proactive collaboration between forward thinking businesses and science and technology expertise.

This cross-sectoral and interdisciplinary approach is the model on which the region’s future economic success must be developed. (See Figure 2 below).

FIGURE 2: TECHNOLOGIES CAPABILITIES TO FUTURE MARKET OPPORTUNITIES



## GLOBAL MARKET THEMES & OPPORTUNITIES OF TOMORROW

Through the work of MATRIX and the Horizon Programme - transcending traditional business sectors and technology disciplines - it is now possible to anticipate the emergence of major future global opportunities and begin mapping how Northern Ireland might best place itself to access these opportunities.

Based on the global trends outlined above and the agreed recurrent themes coming out of the 5 Horizon Reports, MATRIX has identified four distinct, high-level future world markets in which Northern Ireland can realistically hope to secure unique specific and distinct areas to make its own. More work needs to be conducted on the specifics of each of these strategic niche markets, but the overarching evidence makes it clear that it will be in these areas that we should start to focus attention if Northern Ireland is to make the most of the opportunities arising.

The high level future global markets are:

### CLEAN & GREEN FUTURE WORLD MARKET:

- Captures: environmental; total lifecycle (incl. cost reduction); challenge of (and opportunities presented by) climate change; traceability.
- Northern Ireland has a real opportunity to develop a Unique Selling Point as a 'Clean Region' across the full range of sectors (e.g. Northern Ireland Clean Food, Northern Ireland Clean Health, Northern Ireland Clean Energy, Northern Ireland Clean Manufacturing, Northern Ireland Clean Environment);
- Northern Ireland resources such as grass, ocean, fresh-water could be exploited;
- Focus on addressing climate change and health issues can also play into financial services - e.g. insurance.

### HEALTH, WELL-BEING & VITALITY FUTURE WORLD MARKET:

- Characterised by an aging population and increased numbers of chronic illnesses, as well as growing market for health based products and foods;
- Major opportunities for Northern Ireland in: Personalised Medicine; Home Based Care; Nutraceuticals and Functional Foods; Connected Health (using ICT); Management of Health systems;
- Northern Ireland already has strong R&D and infrastructure in key areas (e.g. cancer care, bio-engineering);
- There are opportunities for companies/ researchers from across the food and health sectors to work together more directly in areas such as functional foods etc.

### JOINED UP & CONNECTED FUTURE WORLD MARKET:

- Characteristics include: Globalisation; increased uptake of ICT; expansion of wireless; growth of travel demand (with related carbon issues etc); increased need for security solutions; distance learning and learning technologies; new business models (including Hosted Systems); modern lifestyle expectations; financial services & insurance.
- The increased level of 'Connected-ness' in the future brings identifiable challenges, including:
  - managing national boundaries;
  - emotional/social disconnectedness;
  - cultural dilution;
  - adverse health impacts (e.g. obesity, mental health etc);
  - criminal abuse and misuse of connected technologies.
- Areas of overlap across sectors likely to yield best solutions - Personalised Food; Financial data and services; niche product differentiation (production, process, traceability); use of connected-ness in education and skills development.
- There is potential for Northern Ireland to use Connected Future as a means of differentiation in niche strategic sectors; can use 'Connected-ness' to sell capabilities world wide; possible opportunity for Northern Ireland to be a test bed for future Connected technologies, drawing in a variety of disciplines in key niche strategic areas which require multidisciplinary thinking.

### SAFE, PROTECTED & SECURE FUTURE WORLD MARKET:

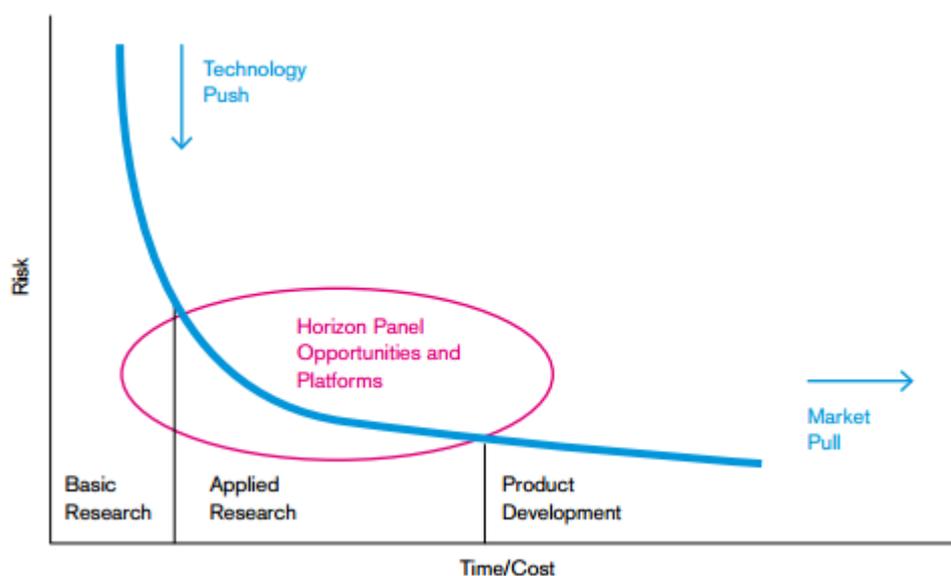
- The drive towards a Secure World is characterised by the need to address issues such as: climate change; financial and data management concerns; public perception of insecurity and personal safety concerns; health security and traceability of health products (e.g. drugs); environmental purity and security of resources (like water); safe use of ICT, broadband etc.
- Additional challenges exist in the context of: the regulatory & legislative environments (both a driver and a disruptive force); uncertain but developing business models (new technological applications need tested and proved);
- Niche strategic areas of this field for Northern Ireland's future focus are: Secure Energy; Secure Environment; Secure Food Supply; Personal Security.

## SECURING THE INNOVATION OPPORTUNITY FOR NORTHERN IRELAND

MATRIX believes that there is a real opportunity for Northern Ireland to assume a leadership position in key strategic areas of science and technology exploitation. But to ensure that this happen the panel is of the view that a key gap in the exploitation infrastructure and in the alignment of the region's skills needs to be addressed.

### THE INNOVATION GAP & FRAGMENTATION

FIGURE 3: NORTHERN IRELAND'S FRAGMENTED INNOVATION SYSTEM



MATRIX work to date has shown clear evidence that Northern Ireland's Innovation System has evolved considerably in the past decade. Concerted action, led by Government and supported by key businesses and the academic sector, has delivered a gradual and sustained upturn in the levels of business innovation and R&D exploitation in the region. This commitment is maintained in the vision of the NI Executive's Programme for Government which seeks to create a 'dynamic, innovative economy' and which sets the specific task of cutting in half the productivity gap with the UK average (excluding the Greater South East of England) by 2015.

Recent figures speak for themselves. In 2006, General Expenditure on R&D amounted to £319.2 million, an increase of 5.5% on the previous year, which itself had experienced a 9% increase on 2004. Business Expenditure on R&D in 2006 was £155.4 million, the highest figure recorded since the record high of £173.5million in 2002. And small and medium sized firms accounted for 53% of the regional R&D spend - indicating increased SME engagement in innovation and R&D.

However, Business Expenditure on R&D (BERD) was only very fractionally more than Higher Education Expenditure, and in regions where knowledge is being exploited successfully, the gap in favour of private sector investment is typically much wider. That is not, of course, to suggest that investment in Higher Education based R&D (HERD) is less important - merely that private sector-led investment is much too low at current levels and this under-investment is stunting the growth of the Northern Ireland knowledge economy.

What this tells us is that Government policy, working through Northern Ireland's universities and the publicly funded support mechanisms provided by Invest NI and others, has succeeded in the past decade in establishing a strong and vibrant R&D base and in creating some genuinely world-class research strengths in key technology areas. However, the Innovation System that has been developed tends towards a reliance on the dynamics of 'Technology Push'.

Additionally, because of the average small size of Northern Irish businesses there has been a real lack of awareness of, and absorptive capacity for, R&D and technology transfer opportunities in the Northern Ireland business community. While smaller firms may very well want to become more involved in innovation and R&D related activities, the scale of the challenge is often too great. Northern Ireland's SMEs, with their emphasis on survival, often struggle to engage with research institutions in a meaningful way, and many are even unable - or unwilling - to enter into partnerships with larger companies.

MATRIX concludes that many of the component parts of a successful knowledge based economy are either in place or could be developed out of the existing infrastructure and actual or planned skills base in this region.

However, the core message emerging from the work of MATRIX and its foresight focused Horizon panels is that there is an ongoing disconnection between our science and technology capabilities and the demands of the market place. Consequently, the missing segment in the Northern Ireland innovation eco-system is a strong 'Market Pull' dimension (see Figure 3).

MATRIX would note that the Technology Push dynamic will remain important and should therefore continue to be supported to encourage disruptive technology development. Indeed, MATRIX fully accepts that excellent basic research in academic and other research institutions should be seen as an important source of future inspiration and the deep

IP essential for the future development of commercially successful science and technology opportunities. In no respect does MATRIX suggest that the basic research agenda should be re-oriented to serve the exclusive needs of the economy.

However over the longer term if Northern Ireland's economy is to close the gap on leading innovative regions it must do more to embrace Market and Challenge led innovation. In essence it is critical to the success of the future knowledge economy of Northern Ireland that the imbalance between Technology

Push and Market Pull is addressed and that businesses - particularly indigenous SMEs and R&D intensive FDI companies - become more focused on drawing through and exploiting the R&D which is being generated by the region's science and technology base.

## DELIVERING THE SKILLS FOR A KNOWLEDGE ECONOMY

Underpinning this vision for the future economy there must be a focused and responsive education and skills regime which is dynamically matched to the needs of Northern Ireland's high technology industry.

MATRIX has developed a close working relationship with the Department for Employment & Learning (DEL) during the preparation of its Horizon reports and the overarching MATRIX report. DEL has indicated that it will take the findings of the MATRIX work into account when planning its future approach to skills development for Northern Ireland. MATRIX welcomes the opportunity to work more closely with DEL on this crucial matter - it is the MATRIX' view that the single most important underpinning fundamental for a knowledge economy is the quality of its skills and training provision. This must include the development of a full spectrum of skills and knowledge including increasing the quality and quantity through to PhD level.

In parallel with MATRIX, the Northern Ireland Review of Science, Technology, Engineering and Mathematics (STEM) is developing recommendations which will help shape the delivery of STEM knowledge and skills from our education system into our economy. This review, which is jointly sponsored by the Department of Education and the Department for Employment and Learning, has been informed by its close working relationship with the Department of Enterprise, Trade and Investment (DETI) and with MATRIX.

The STEM Review has actively engaged with MATRIX and has welcomed the opportunity to help shape the recommendations arising from the MATRIX review. There has been crossover of membership and the relationship between the two reviews has ensured that the recommendations arising from each are well targeted and aligned to the needs of the region's future economy.

Indeed, the two Reviews are mutually dependent; the vision of the economy will not be achieved without the supply of STEM skills and knowledge while the attraction of young people into STEM education will require a communicated vision of future career opportunities within a growing and prosperous knowledge economy.

## MATRIX IMPERATIVES FOR THE FUTURE NORTHERN IRELAND KNOWLEDGE ECONOMY

Based on findings that have emerged from across all of the research and analysis conducted for the Horizon Panel reports and drawing on the other relevant MATRIX studies, four Top Level 'Imperatives' for the future Northern Ireland Knowledge Economy have been identified. These are set out below - with supporting rationales for their inclusion:

1. To compete more effectively as a modern knowledge and technology based economy Northern Ireland must develop a more innovative culture of collaboration across industry, government, and academia. within this new environment Business must take on an increased leadership role in the innovation agenda, with Government playing a support and facilitation role, and with academia working to inspire new heights of innovation through high-quality R&d, knowledge creation and workforce preparation.

Imperative 1 reflects the reality that Northern Ireland must re-establish itself as a world- class innovating region able to exploit the science and technology at its disposal - from whatever source it is available. This requires a significant cultural shift with regard to moving away from the low wage and low cost 'old economy' thinking of the past few decades and towards: new approaches to business innovation; improved commercial risk taking; better methods of investment in R&D and Innovation (from both the public and the private sectors but with a strong emphasis on business investment in R&D in particular); and more effective management and exploitation of Intellectual Property to ensure maximum economic return.

International best practice also shows that such significant cultural change and the development of a strong science, technology and knowledge-led economy can only be built around the integration of business, government and academia in new and dynamic partnership arrangements. Key to such an arrangement must be a clear and consistent focus on the needs of the market and leadership from industry.

2. Individual sectors have - through the MATRIX' Horizon Panels - identified that an exclusively single sector based approach of 'old economy' thinking will no longer suffice in the competitive Global Market. Interdisciplinary and cross-sectoral approaches need to be developed and adopted - it is evident that it will be in the spaces between sectors and technologies where the true added value, differentiated and unique to Northern Ireland technology-to-market opportunities will be found and exploited

Imperative 2 points out that narrow and sectorally specific thinking belongs to the low cost and low wage economy of the past. Northern Ireland can no longer hope to compete on the basis of low wages and costs, but must do so on the unique nature of its knowledge, skills and technological excellence. In essence we must identify what we do better than anyone else and become recognised internationally for a leadership position in key strategic niche areas of commercial science, technology and innovation. And the uniquely Northern Irish technology-to-market opportunities in this highly competitive world lie across a variety of business sectors as well as across a range of scientific disciplines.

In this regard our small size can be treated as a considerable advantage. By putting in place appropriate cross-sectoral and interdisciplinary mechanisms across this region, high-technology business and academia can be encouraged to collaborate in new and more dynamic ways, thus ensuring a better connected and joined up innovation system for Northern Ireland.

3. Skills are the bedrock of the modern innovation-based and knowledge economy, right through from the schools system, to Further and Higher Education and on into Life Long Learning. Increasingly a highly developed skills base will be a key source of competitive advantage in the Global Economy. Therefore Northern Ireland must set out to align the continuum of its skills and training regime to the future focused needs and requirements of Northern Ireland's higher value added goods, services and industries;

In terms of skills Northern Ireland's small size can also be turned to its advantage. This region has the opportunity to ensure that the needs of high-tech business are identified and built into the strategy for future skills provision in both higher and further education policy planning.

In addition there is a need to promote an enhanced and enduring culture of innovation across the region and this must be driven through the whole education system - from primary, through secondary education and beyond. Not only should more emphasis be placed on the creation and training of scientists and engineers, but more general efforts should be directed through the education system at creating a science literate population who are aware of and open to the opportunities emerging from the commercialisation of science, technology and innovation. There is an opportunity - by bringing these various strands of the education continuum together - that Northern Ireland could attain one of the most adaptive and responsive workforces in western Europe.

With regard to Imperative 3, the DE & DEL-led STEM review and the MATRIX report have been coordinated throughout to ensure that they are joined up effectively.

4. As a small region Northern Ireland will always be a net importer of knowledge, through research partnerships, globally connected firms and the attraction of the best talent. Northern Ireland must do more to look and work outward. A sustained means must therefore be found to assist Northern Ireland to become more connected within the UK, with the Irish Republic, across the EU and ultimately globally - especially with regard to its research base and its high technology and knowledge driven businesses, and with science and engineering based Intellectual Property. This includes attracting world class innovation leaders to Northern Ireland in key areas of R&D and science exploitation.

Imperative 4 acknowledges that an inward looking region is not an innovative region. The most commercially successful knowledge intensive regions thrive in the global marketplace by ensuring that they are prominent players internationally and have secured unique status in key technology areas. Northern Ireland has had significant and growing success in becoming an outward looking region in recent years, but there is more to be done. Northern Ireland's high- technology businesses must be more proactive in setting the agenda for the future economy by monitoring opportunities on a global basis, anticipating future market opportunities, and preparing to compete with the best in the world in key selected sectors. Northern Ireland's universities and research institutions should also continue to develop their collaborations and linkages at the global level - drawing in world class researchers and developing high quality international partnerships with both businesses and other academic institutions. And the policy focus for Northern Ireland should be on developing and maintaining fundamental Intellectual Property from which future world-class business opportunities can be developed.

## THE SIZE OF THE PRIZE - INCREASING THE GROWTH OF THE NORTHERN IRELAND ECONOMY

Northern Ireland has had a positive economic growth rate in recent years and over the next decade it is projected that it will continue to rise. But when set against many other similar regions of the UK and EU it is also apparent that this rate of increase is comparatively modest. MATRIX believes that this report, if acted upon, will trigger a step change in the growth of the Northern Ireland economy.

The panel believe that MATRIX' suite of recommendations provides a platform to encourage a new approach by business, government and academia which will: considerably enhance the business contribution to regional GVA; accelerate sustained economic growth; significantly increase the number and quality of higher value added jobs; and make a major contribution towards raising productivity levels in Northern Ireland to at least the UK average.

These objectives - aimed at extending the wealth and success of the regional economy mark the 'Size of the Prize' to which MATRIX believes Northern Ireland can aspire.

## CONCLUSIONS & NEXT STEPS

With the completion of this report, therefore, MATRIX' work has just begun. Although the first phase of MATRIX will conclude at the end of November 2008, a renewed and refreshed MATRIX panel is planned to be in place by spring 2009. In this way MATRIX will continue to provide a rolling programme of advice and guidance on the development and enhancement of Northern Ireland's technology and knowledge based economy in the months and years ahead. MATRIX will stand ready to advise and guide on key science and technology exploitation policy matters to Northern Ireland Government as and when called upon to do so.

Already new areas for consideration are emerging. MATRIX is preparing to commence a major foresight focused study into Energy related issues as a matter of priority. MATRIX also feels that there is a key role for the private sector to help fund and mentor high technology start up companies. Plans are under development to look at options to provide ongoing industry support to such businesses based on a study of the Northern Ireland Science Park's CONNECT Programme in the first instance. A study into the management and exploitation of Intellectual Property is also planned.

But at the end of the first key phase of MATRIX' work, this report sets out the steps that we believe should be taken if we are to secure Northern Ireland's competitive future in the global, technology & knowledge based economy. That future can be realised if this region

meets the challenges and opportunities ahead in a new and dynamic way - led by business, inspired & informed by academic excellence, and supported & facilitated by government.

MATRIX main proposal, therefore, is that a select number of market focused innovation communities should be developed – led by business, facilitated and supported by government, and inspired and informed by academic excellence. These communities would be tasked with ensuring that emerging market opportunities are matched to the region's R&D and technological capabilities to be exploited for maximum commercial and economic advantage. The scale and nature of these communities should be determined by industry and tailored to the specific markets or sectors with which they are associated - and as agreed by all key stakeholders - but their governance would be commensurate with their function and they would be regulated effectively within the parameters of public sector requirements.

In this way MATRIX is placing a challenge before all key stakeholders - Business must step forward in this region and show real and constructive leadership on the innovation and R&D commercialisation agenda; Government must play a more effective support and facilitation role; and Academia must strive to inspire success through its research and development excellence and the critical qualities it brings to the economy through its skills training for the workforce. MATRIX believes that by working together in this new and redefined way, Northern Ireland has an opportunity to build a stronger and more sustainable economy than it has had for many years. In the current world economy this is a long term planning opportunity that we must not miss.

In its first 2 years of work MATRIX believes that it has arrived at a core proposition for enhancing and accelerating the development of Northern Ireland's knowledge and innovation based economy. Following the launch of this report and before the formal end of its first reporting phase in November MATRIX will engage with key stakeholders across industry, academia and government to begin the process of drawing up a high-level implementation strategy for delivering this suite of MATRIX recommendations.

MATRIX first series of overarching recommendations follow.

## MATRIX OVERARCHING RECOMMENDATIONS

### CONCLUSIONS & NEXT STEPS

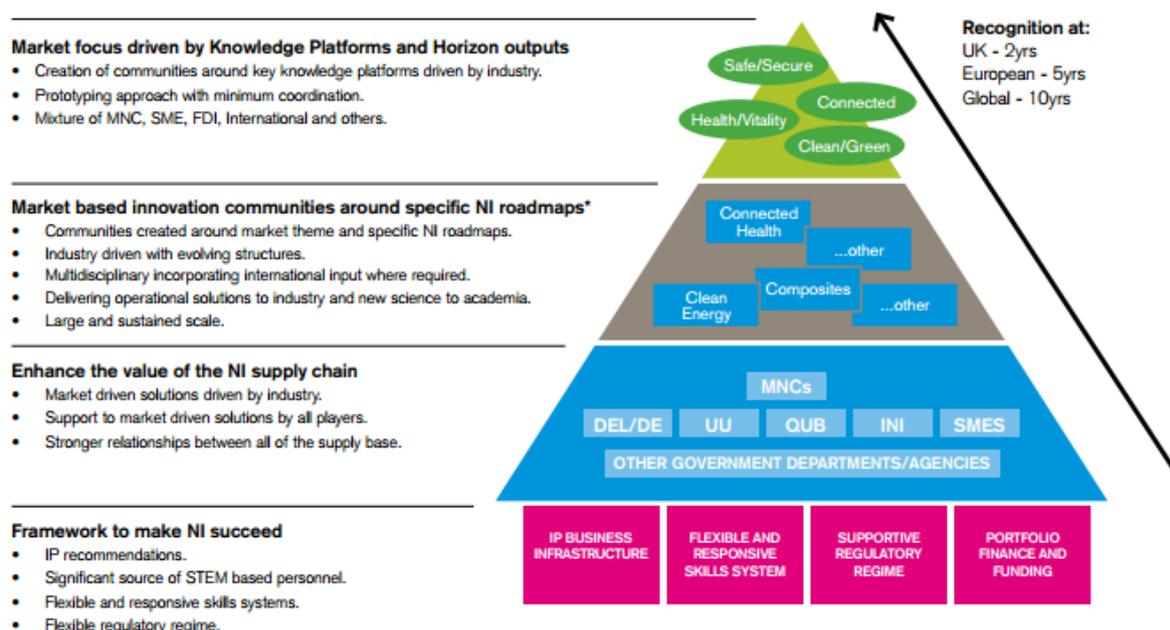
Within their deliberations the MATRIX panel has developed a series of recommendations on key elements of the innovation ecosystem in Northern Ireland to address the challenge outlined above. The panel have arrived at an overarching recommendation to deliver growth in the NI economy based on an enhanced capability to innovate. This can be summed up as follows:

Connect science to exploitation through market focused technology innovation communities that are targeted at Northern Ireland specific roadmaps.

This is shown in the model set out below as Figure 4 - a future innovation system for Northern Ireland. This model builds on the existing fundamental capabilities within the science and technology base in Northern

Ireland but seeks to achieve a greater level of connectedness through multidisciplinary communities and enhanced routes to market for science and technology. It is based on an assumption that there will be greater leadership from business within the innovation agenda and that SMEs, which play a key role in the NI economy, are fully represented within the business dimension and across all recommendations.

FIGURE 4: FUTURE FOCUSED INNOVATION SYSTEM FOR NORTHERN IRELAND



\*Those illustrated here are examples that have been proposed, but not exhaustive.

To deliver this model MATRIX full suite of recommendations are as follows:

1. Industry led communities should be formed engaging business, academia and government to address global market opportunities by exploiting the science and technology capabilities in Northern Ireland.

These communities must be focused on the knowledge and technology platforms<sup>1</sup> which are key to the Northern Ireland economy.

These knowledge platforms were derived from a broad section of the industry/academic communities in NI through the MATRIX Horizon Panels and ultimately a plenary session in Belfast in February 2008.

#### **Rationale**

These communities should build on existing innovation activities by coordinating and aligning their resources and by bringing together existing Northern Ireland, UK and EU innovation support programmes to create sustained funding and ‘flagship’ projects. The communities should aim to attract international commitment and gain recognition nationally (within 2 year), continentally (5 years) and globally (ten years). Such flagship projects must attract resources from other markets and this will enhance the development of the Northern Ireland knowledge economy still further.

2. Knowledge and Technology Platforms are a global societal challenge that brings together a range of technologies, people and policy levers to deliver innovative new products and services for which there are real customers in a potentially large global market. These challenges bring together stakeholders and funders, are driven by business and insights from the research community, identify appropriate levers to use and links research to market through technological innovations for all companies in NI.

The Industry led Communities (above) should create Northern Ireland roadmaps (driven by industry) for the specific knowledge platforms within Northern Ireland. These should demonstrate and create outputs for all members of the Industry-led communities - thereby driving more effective Knowledge and Technology Exchange (KATE) among community partners.

#### **Rationale**

These knowledge platform based roadmaps should aim to facilitate better exchange of information, assist with technology brokerage and allow members to aggregate

existing resources and support programmes for maximum effect, especially to increase the absorptive capacity of new ideas;

This implies Knowledge Transfer not just Technology Transfer and in both directions, i.e. it is important to see both the technology and the related codified knowledge being exchanged. Additionally, innovation is a non-linear process in which many actors are working together. The starting point does not have to be academia but rather the impulses and ideas tend to come from existing production or the specific markets with no specific interaction amongst players and ideas being refined and generated at all stages of the overall process. This implies that basic research and development is not always the sole initiator and in fact value is not maximised until the commercialisation stage. It also introduces the concept of repurposing whereby developments in some sectors are used in others.

These communities build on the activity that is already underway by aligning their resources to create sustained funding 'flagship' projects that attract international commitment and gain recognition nationally (within 2 year), continentally (5 years) and globally (ten years). Such flagship projects may attract resources from other markets to accelerate the NI potential;

3. A world class Intellectual Property (IP) Business Infrastructure must be created in Northern Ireland. In this there must be a more comprehensive understanding among the business and academic community of the intrinsic value of IP and how to exploit it and Northern Ireland should also develop stronger capability to develop fundamental IP. This means that:

- Firms need improved capability to recognise the inherent value in their own business (in their people, processes, products, techniques, etc). It is evident that Northern Ireland needs top class researchers (international calibre) to develop deep IP capability which can be used to grow indigenous capability. The ability to adapt or repurpose IP is also a critical ingredient of an effective IP Business Infrastructure;
- NI needs to modify existing UK structures and create clear guidelines on the ownership and management of IP that are needed to foster innovation and build confidence in the exploitation process between and across Business, Academic and Public Sector partners;
- The creation of deep IP in NI should be fostered where there is a clear route to market and based on the NI Horizon Panel sectors and the future 'worlds';

- A strong and clearly defined protection systems will help stimulate more investment in innovation;
- The infrastructure is lightweight but defines all necessary IP structures at the onset.

### Rationale

IP is not well understood with firms lacking a complete understanding of the IP supply chain in terms of creation, repurposing, management, protection etc. In particular firms do not recognise the inherent value in their own business (in their people, processes, products, techniques, etc). A small percentage of the IP that exists in NI firms is understood, valued and exploited effectively.

#### 4. Northern Ireland must have a Flexible and Responsive Skills System that leads Europe in terms of its ability to meet changing demands and is superior to all identified competitors. This requires that NI:

- Re-enforce the significance of STEM as the bedrock of the economy, including an emphasis right back into the schools system;
- Incentivise the key focus areas of importance to the economy to improve numbers and quality of outputs - with specific rewards for study in areas of high priority - e.g. awarding bursaries for areas of demand that are relevant to the economy, attracting the best talent from home or overseas etc;
- Develop the most flexible, responsive skills system in Europe that is not purely 'demand led' (where students often chase points) but more 'demand managed' in relation to economic needs of NI;
- Request that all skills bodies take an end-to-end view of skills from schooling to readapting the workforce and integrate key departmental responsibilities to create a more coherent approach to skills.
- This could be achieved through a single ministerial responsibility for innovation covering education skills and careers advice across a number of existing departments;
- A NI Plc approach is developed for areas such as apprenticeships where programmes are supported in individual companies but candidates are made available to the broader economy upon completion - could be central

coordination of a NI pool based on the sector needs and across existing SMEs;

- Develop sustained/certified conversion courses (including Sales/Marketing, Law, technology) as a strategic and core element of the skills infrastructure in NI to deal with the rapid changes an ongoing responsiveness needed in a knowledge based economy

### Rationale

Skills are the heartbeat of the economy and the quality and depth within the Northern Ireland skills base is key to the region becoming globally competitive. All key technology sectors in Northern Ireland recognise that the current skills balance in the workforce is not sufficient for the economy's needs. The entire supply chain of skills must be addressed from primary schools, secondary, third level and within the workforce. The review of STEM within Northern Ireland positions the science, technology, engineering and mathematics subjects as the foundation of the future skills system needed for a knowledge economy.

However, it must be clearly recognised that as a small region, flexibility in education is essential for Northern Ireland to be able to align the skills supply chain to market need, a need that is changing fast. Such flexibility and responsiveness can then become a source of competitive advantage.

5. [The Regulatory Regime must be transformed to allow Northern Ireland to take and manage a higher level of risk within a broad innovation portfolio, and the model for this must be developed and shared across industry, government and academia. This requires that:](#)
  - Leaders must be empowered, through the recognition that we must operate in a different way to support innovation, to accept and manage higher levels of risk.
  - We develop a portfolio approach to risk management for public sector support to R&D and Innovation based firms marking a significant step towards a more creative incentive system. This could be tested as a pilot in a discrete area of support for R&D and science and technology exploitation in the first instance;
  - Funding for R&D and Innovation activities should reflect the medium to long term nature of securing returns from R&D and Innovation based investments.

Up to 10 years - in some circumstances – ought to be possible given the nature – and importance - of high-tech industry.

- Current governance and approval mechanisms can be improved through:
  - Increased transparency across governing bodies
  - Collective approach to constraints
  - Portfolio approach to finance and support mechanisms
  - Reviewing current procurement practices.
- NI Inc needs to take a well informed and managed approach to risk providing confidence gained through knowledge and experience.

### **Rationale**

The mechanisms to support R&D and innovation at present were considered as extending only as far as medium-term and do not facilitate emergent research that may be up to 10 years from market. Support is also considered excessively risk averse and not truly appreciating the success-failure rate of R&D. There remains limited support for near to market activity, e.g. where industry are seeking new processes with clear applications in industry context and the delay and excessive bureaucracy is most often cited with respect to funding support. These delays apply to the entire system within NI and not to specific aspects of this system.

Northern Ireland needs to increase the emphasis on private sector investment in R&D & Innovation and the portfolio of firms that are suitable for investment. Venture Capital, Banking, and other financial support services for high-technology firms and related projects have to be encouraged, including through mechanisms such as tax credits, vouchers etc. Funding for R&D and Innovation activities should reflect the medium to long term nature of securing returns from R&D and Innovation based investments. (up to 10 years if necessary).

## APPENDIX

### MATRIX PANEL MEMBERS

Alan Blair

Albert Sherrard

Bryan Keating

Clare Passmore

Colin Elliott

Damien McDonnell (Chair)

Ed Vernon

Frank Bryan

Gerry McCormac

Bernie Hannigan

Jim McLaughlin

### ADVANCED ENGINEERING HORIZON PANEL MEMBERS

Colin Elliott (Chair)

Catherine Jones (Michelin)

David Beatty (Thales ADL)

Graeme Thompson (Schrader)

Julian Hine (UU)

Mark Nodder (Wrightbus)

Michael Maguire (Datum Design)

Patrick Hurst (Munster Simms)

Tim Brundle (UU) Tom Edgar

(QUB) Tom Millar

(QUB) Gavin Campbell (Bombardier)

## ADVANCED MATERIALS HORIZON PANEL MEMBERS

Jim McLaughlin (Chair)

Brian Meenan (UU)

David Andrews (Centre for Competitiveness)

Donald Fitzmaurice (ePlanet Ventures)

Fahed Fallaha (Du Pont)

Gavin Campbell (Bombardier)

Ian McAuley (Alpha Environmental)

Norman Apsley (NISIP)

Rob Hardeman (Seagate Technologies)

Robert Bowman (QUB)

Stephen Bell (QUB)

Vyvyan Howard (UU)

## AGRI-FOOD HORIZON PANEL MEMBERS

Clare Passmore (Chair)

Chris Gibson (Foyle Food Group)

John Gilliland (Farmer)

John McLenaghan (Just Farm Energy)

John Woolven (IDG)

Ken Baird (Moy Park)

Maurice Johnston (Dale Farm)

Mike Mills (Jigsaw Tree)

Colin Coffey (FSIP)

Sydney Neill (AFBI)

Frank Kee (QUB)

## ICT HORIZON PANEL MEMBERS

Ed Vernon (Chair)

Bryan Keating (Deputy Chair)

Bikash Mathur (Polaris)

Brian Baird (Meridio)

Bro McFerran (Northbrook Technologies)

Denis Murphy (Mobile Cohesion)

Elizabeth Hull (UU)

Gary Burnett (ANIC)

Kevin Donaghy (F5 Networks)

Padraig Canavan (Singularity)

Pat McKillen (Citigroup)

Patrick Corr (QUB)

Ponsailapathi Viswanathan (Polaris)

Steve Brankin (Asidua Ltd)

Sylvia Alexander (UU)

Ian Graham (Momentum)

## LIFE & HEALTH SCIENCES HORIZON PANEL MEMBERS

Bernie Hannigan (Co Chair)

Albert Sherrard (Co Chair)

Alan Stitt (QUB)

Bert Rima (QUB)

John Lamont (Randox)

Michael Neely (HSC R&D Office)

David Brownlee (HSC Innovations)

Neville McClenaghan (UU & Diabetica Ltd)

Peter Donnelly (BioBusiness NI)

Stephen Barr (Almac)

Tony Bjourson (UU)

Werner Dubitzky (UU)

# MATRIX

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