

A New Institute for the "New" Economy :

The Institute for the Knowledge Economy

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– The Institute for the Knowledge Economy (IKE)

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§1. INTRODUCTION

Much has now been written about, and definitions abound for the Knowledge Economy. Unfortunately there is currently a predilection for writing about the ubiquitous 'e' and its 'dot com' counterpart, to the point that in some commentaries they almost become synonymous with the Knowledge Economy itself. In fact the Knowledge Economy, sometimes referred to variously as the Information Society, Digital Economy, the New Economy, the Weightless Economy, or even the Brainpower Industries, heralds a more comprehensive, swingeing, and ultimately more significant transformation of all aspects of society, than e-business alone.

Although economists still struggle with and engage in heated debate over how to measure the impact of the Knowledge Economy on productivity, there is little doubt that it will have a huge effect, and as a nation to not be an effective player and contributor is tantamount to economic suicide. While growth in America based on knowledge intensive industries, has moved ahead of other major economies in recent years, other nations realize the importance and are developing strategies to close the gap. Some analyses show that in this particular case being a second mover may actually be an advantage.

While there are many complex and interacting facets to the Knowledge Economy, any reasonable definition, such as:

“For countries in the vanguard of the world economy, the balance between knowledge and resources has shifted so far towards the former that knowledge has become perhaps the most important factor determining the standard of living – more than land, than tools and labour. Today’s most technologically advanced economies are truly knowledge-based.”

- World Development Report, 1999

clearly and obviously places **knowledge** at centre stage. It is therefore not surprising that a clarion call should go out to the education sector, with education, skills and the generation of new knowledge as its raison d’etre, to play a full role in assisting any nation achieve its potential in the migration from an industrial to a knowledge based economy.

However this intangible key resource poses a number of unique problems. Our inability to easily identify it and measure it prevents the development of sophisticated economic models to incorporate it. Furthermore unlike other resources, it does not exhibit the ‘scarcity’ feature on which Adam Smith’s economics is based, and in that sense does not lend itself to the normal processes of economic rivalry. A small amount of it is actually deemed to be ‘a dangerous thing’, but having it in abundance will bring considerable gains in the form of productivity improvements, if only they could be measured.

Fortunately to a degree, the effects of knowledge can be envisioned and made manifest through its facilitator, Information Technology (IT). In this sense IT amplifies brainpower in somewhat the same way as the technology of the industrial revolution amplified muscle power. Some of the latest economic thinking is able to consider and incorporate IT in its role as a tool for releasing the creative potential and knowledge embodied in people, and a such there is at least a beginning to the formulation of a framework that will enable this unique revolution to develop without a total abandonment of all the tenets of economic theory to-date.

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This paper looks briefly at these factors as a backdrop to the description of the development of a new collaborative Institute at the University of Strathclyde in Scotland, designed specifically to make a major contribution to the realization of the Knowledge Economy itself, and in addition to act as a catalyst and integrator for other initiatives in both the public and private sectors.

§2. THE REAL KNOWLEDGE ECONOMY

Perhaps in a few short paragraphs, some insight can be gained into the nature of the Knowledge Economy and its ramifications for economies worldwide, by identifying the key interacting aspects of change that are currently prevalent. This is not a linear sequence of events and as such there are complex interactions that economists are still struggling with. Furthermore in some respects the driver of these changes can be found in the proliferation of IT, which both demands change and also facilitates it. The schizophrenic and elusive nature of IT as regards its impact on economic growth will be explored in the next section.

While admittedly overly simplistic, it could be said that to-date a country's economic advantage has in the main been derived from being able to achieve high levels of productivity through the degree to which it has been endowed with natural resources, and the relative abundance of capital and labour. However as modern products use far fewer natural resources, they tend not to have the same prominence in the wealth equation. Capital availability has also dropped from the equation, with the attainment of a new found capital mobility where everyone is essentially able to borrow in a global capital market. Raw labour is also less important to the production process, and can in any case be obtained cheaply by relocating the manufacturing function to a low wage economy.

Today therefore technology, knowledge and skills have obtained a new prominence and importance as a source of comparative advantage. As a result the harnessing, enhancement and effective application of human intellectual capital is critical to an organisation's competitive position, and hence as a source for national GDP growth.

As a result the main comparative advantage an organization will enjoy in the future will be its ability to **innovate**: combining market and technology know-how, with the creative abilities of a knowledge-based workforce to create a continuous stream of new product and process options through which it can gain a new level of strategic agility; sensing and responding quickly to global market opportunities, by acting on the information and knowledge available.

Again as discussed in the next section, IT has played a crucial role in facilitating innovation.

As stated by Peter Drucker:

“Every organization – not just businesses- needs one core competence: innovation. And every organization needs a way to record and appraise its innovative performance.”

- Harvard Business Review, 1995

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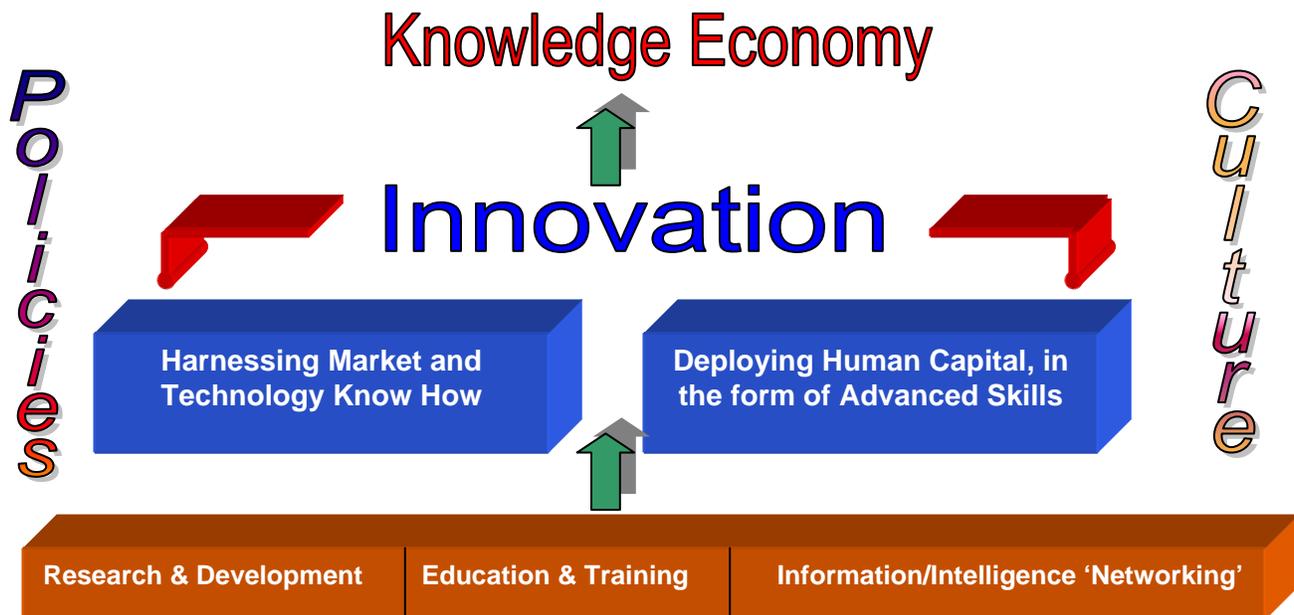
Although defined above as the productivity increasing combination of technology and creative brainpower, innovation has to be further examined. It is suggested that innovation should be considered to be an inclusive concept that permeates a seamless web of activity from invention, through design, production, marketing, sales, logistics and associated services, that together outpace the competition. It is the governing rubric under which organisations have to organise and better utilise their resources and processes.

Also to be effective at the process of innovation, there have to be methodologies and systems of innovation, which link together the key elements which are vital for the translation of science and technical knowledge into new products and services to benefit society.

For an organisation or indeed a nation to be innovative, and hence be successful in relation to a Knowledge Economy, requires a complex amalgam of ingredients:

- a strong research base, that covers both longer term knowledge creation and focused targeted strategic research;
- highly qualified staff resources, that represent the human capital required to power the innovative processes;
- a flexible, empowering culture that embraces and promotes entrepreneurship;
- a continuous flow of relevant information through local, national and international networks of stakeholders and partners that can be leveraged through data mining, knowledge management and other techniques;
- an overarching fertile business environment made possible through appropriate fiscal and monetary policies, government support mechanisms and regulatory frameworks, that ensure that the other key ingredients outlined above are realized and accessible, thereby producing deliverables that contribute to the attainment of the new opportunities.

This is summarized in the next diagram that shows all these elements. Clearly the implementation has to be inclusive, we should not be creating a generation of 'have and have nots', out of those who in relation to the use of advanced technology, 'can and cannot'!



Both SMEs and large multinationals (increasingly becoming 'non nationals') are important. The former if properly supported are less encumbered and hence can more easily exhibit the flexibility and innovation required. Whereas multinationals are key players in terms of their decisions on where to develop and maintain their technological leadership.

§3. IT COMES OF AGE

Robert Sollow the Nobel laureate in economics famously and somewhat controversially said:

"You can see computers everywhere but in the productivity statistics."

What was meant of course was that there was little if any evidence of investment in IT resulting in productivity growth. Given the proliferation of IT especially in the last 3 decades, this has become a paradox which commentators have only recently begun to understand. A number of explanatory factors have been identified:

- a technology only has a significant impact on productivity after it passes a penetration rate of around 50%. For IT this has only occurred recently in the States;
- there is a distinct dearth of appropriate statistics with which to measure the true economic impact of IT;
- organisations needed time to learn how to use IT effectively and efficiently;
- initially IT was used primarily for 'crunching' as opposed to the much more influential and potentially profitable process of 'communicating' (governments are only just recognizing the importance of telecommunications for the development of their economies) ;

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- because IT both facilitates and necessitates change, the structure of organisations ultimately needed to change before IT can have its transforming and beneficial impact.

This last point which is now widely accepted and understood came as an epiphany in the late 80's, and of course led to Michael Hammer and James Champy declaring that:

“no enterprise will gain anything from further automation through the use of IT unless they reengineer”

Although Business Process Reengineering was initially much maligned, in the main because the changes involved often clashed destructively with the extant culture, significant increases on return on investment in IT have now been realised where reorganisation takes place around new forms of communication made possible through the use of advanced IT systems. The recent advent of the Internet, e-business and e-commerce are providing further IT based potential for further innovation and growth, both in terms of the creation of new style businesses and also in terms of the efficiency gains that can be made by the reinvention of existing industries.

There is little doubt, that compared to other technological innovations that influenced other revolutions, IT is special.

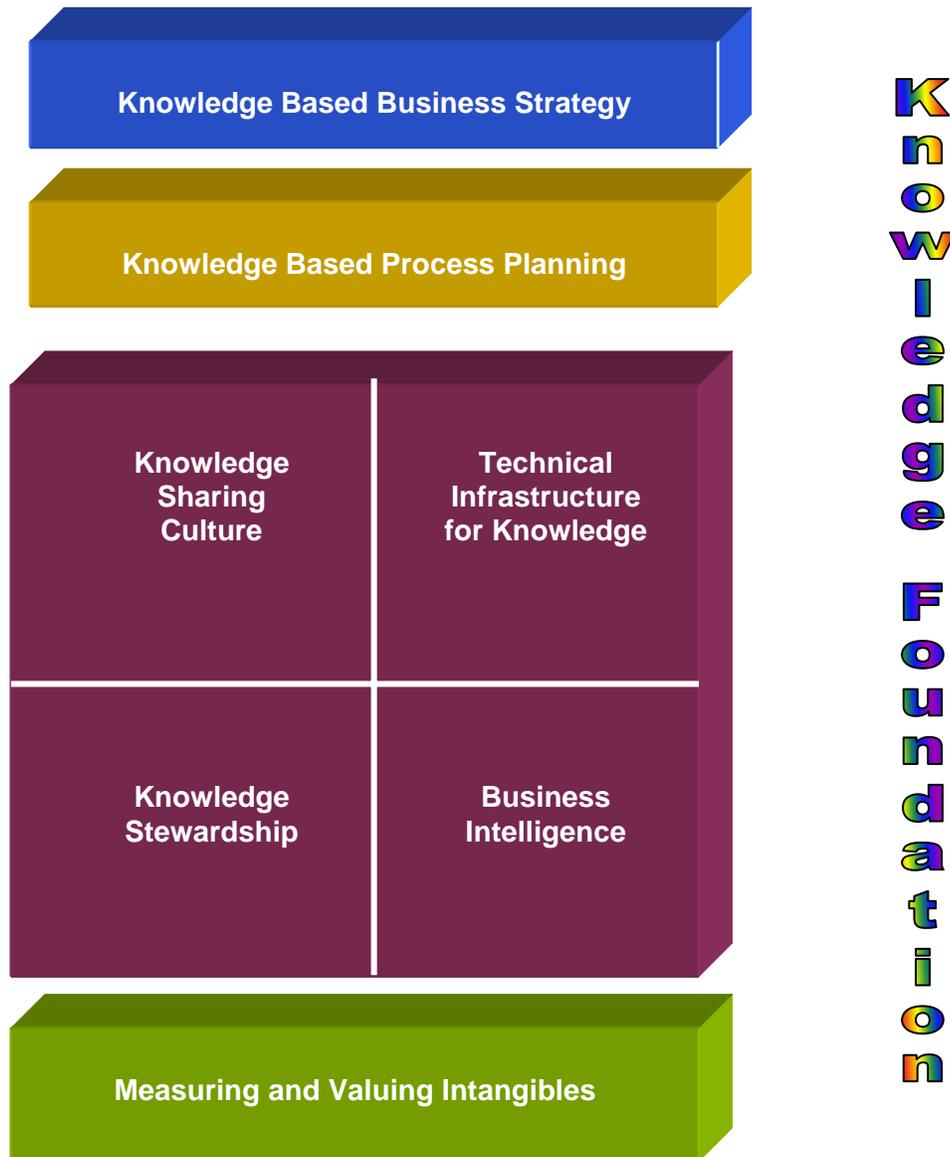
- IT is pervasive and as such affects every day life. In particular this has implications for the skills required by the entire population.
- IT has the potential to improve the efficiency of almost **everything** an organisation does from design to marketing to accounting and across **every** sector including services.
- IT is inextricably linked to globalisation through its innate ability to send knowledge anywhere at any time.
- IT is a powerful industry in its own right and in particular in the States the production of and investment in computers per se have greatly increased labour productivity growth.
- IT in particular the Internet could herald the death of taxes, because of the difficulties involved in tracking digital products, by allowing firms to operate efficiently from tax havens, and by allowing the middleman to be removed from the equation.

However the revolution has probably only just begun since IT's greatest impact will be through its ability to harness and put to use efficiently the creative aspects of a nation's intellectual capital. IT speeds up the innovation process itself, which as discussed in the previous section rates highly in an organisation's likelihood of becoming successful as a knowledge based enterprise, through providing access to and processing large amounts of information. In this regard new disciplines such as datamining are further fuelling the rate of innovation.

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In addition IT will play an enormously influential role in the entire process of **Knowledge Management**. Here again definition becomes important. It is suggested that Knowledge Management is a broad based policies, techniques and tools framework that needs to be developed and put in place for individual organisations and also for a nation as a whole. This is best summarised by Dr. Dale Neef's seven component model for an organisation's Knowledge Foundation.



§4. SCOTLAND OUT THINKING THE REST!

Little did Jim Telfer, Scotland's Director of Rugby know how apposite a mission statement he was creating for the nation as a whole in the context of the knowledge revolution when he said recently:

“The only way a country of Scotland's tiny resources can survive is by outthinking the rest.”

Of course the reference to our tiny resources, referred to the small number of rugby players that the nation can muster, and still relatively speaking the smaller physical stature of our players man for man. Nevertheless a creative innovative approach to our play as a team and as individual players can bring success.

§4.1 The Overall Position – Warts and All

Overall the Scottish economy has changed dramatically from the days of heavy engineering, and mining. There are many positive aspects and those both good and bad that are relevant to a burgeoning knowledge economy are explored in a bit more detail below.

As shown in the Royal Bank of Scotland report on The Scottish Economy, GDP is £55 billion and GDP per head sits at around £11,000. This shows an increase of 65% on total GDP and 67% on GDP per head over 1971 data. Nevertheless everything is relative, and while these figures on GDP per head are higher than Wales and Northern Ireland, we still lag behind England and the UK as a whole. Again relative to other European countries, America and Japan we lag behind most, with the exception of Portugal and Spain. It should be noted that the output from oil and gas from the UK Continental Shelf is treated separately, and that any attribution would be problematic although helpful.

Again comparing to 1971, the 1996 figures reveal that the subdivision of GDP between sectors has changed dramatically. Today 22% derives from manufacturing compared to 30% in 1971, while services has risen to 64%, with the Banking and Financial Services component tripling in size.

Of course in the context of a successful 'New Economy', the real issue is not only the growth of services, but whether the economy is making a successful transition from low wage, low skill industries to high skill high wage industries.

Another important and positive factor is the contribution made to Scotland's prosperity through international trade, including the rest of the UK. Clearly manufactured exports are dominated by whisky, computers and computer related products. The latter reflects the large number of US and Japanese companies in particular, locating their manufacturing in Scotland. This has led to Scotland enjoying a higher share of inward investment projects coming into the UK, than would be expected from its relative share of the UK GDP.

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However again it is a matter of considering for the longer term, the quality and security of the jobs that these opportunities bring. The industries concerned exist in a highly dynamic and competitive environment, with ever tightening margins. As such there is a risk that closures will affect stability or that there will be a pull to relocate in low wage economies elsewhere in the world, as a means of improving productivity.

In terms of our indigenous company birth-rate that is so important for the creation of dynamism and growth in the economy, we have a real problem.

As stated by Crawford Beveridge in his former role as Chief Executive of Scottish Enterprise:

“for some years, perhaps decades, we in Scotland have been aware that as a nation we seem to have lost some of the entrepreneurial drive for which Scots were once famed....it is apparent that we have a fundamental problem. That problem can be traced back to a simple lack of companies in Scotland”

An additional problem of significance is the low level of business related R&D compared to the rest of the UK. Here the figure in 1996 in Scotland was only 0.6% of the GDP, which was less than half of the UK rate.

§4.2 Digital Connected Scotland – ‘Necessary but not Sufficient?’

There is no doubt that Scotland through the Executive and its agencies, is well aware of the strategies and actions that must be pursued in order to deliver a viable Knowledge Economy, and for the country to be a major contributor to the development of the advanced technologies and strategic thinking that will be required for its advancement world-wide.

Much has been done at the strategic level and also on the ground, in other words both top down and bottom up, to secure a successful outcome. In addition there is a recognition that ongoing measurement and evaluation is necessary to ensure that the strategies and their deployment are realising the required outcomes, and that progress is being made timeously. In particular the ‘Tracking the Bigger Picture Project’ is being developed by Scottish Enterprise and partner organisations to track the performance of the Scottish economy, to help inform new policy development and monitor the progress of existing strategies.

The strategic initiatives comprise a wide range of activities such as :

- The development of learning initiatives such as ‘Learning Direct Scotland’ and ‘REAL: Glasgow the Learning Partnership’;
- ‘2000 by 2000’, the creation of 2000 new Glasgow based software jobs by 2000 under the aegis of the Glasgow Software City initiative; a target now surpassed and reset to ‘3000 by 2003’;
- ongoing support and development of the broadband educational networking infrastructure and associated educational content, under the aegis of ‘the National Grid for Learning and the Scottish HE Metropolitan Area Networks (MANS)’;

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- novel incubation and pre-incubation services involving partnerships between the financial and high-tech sectors;
- investment in the science base and the commercialisation of the resultant IP through successful participation in UK wide initiatives such as the Joint Infrastructure Fund and the University Challenge Fund;
- recognition of the 'Proof of Concept' gap in the exploitation of the IP from the science base, and the provision of resources to address it;
- the establishment of the Scottish Enterprise cluster approach, which is particularly relevant to the business intelligence ingredient within the innovation recipe, and the establishment of highly successful industry sector support mechanisms such as 'Services To Software' in Glasgow.

The above are orchestrated by forward looking strategies which are in turn informed by reports such as those produced by Digital Task Force Scotland, The Knowledge Economy Task Force, and 'Connecting Scotland – The First Wave', that all contribute to the pursuit of Scottish Enterprise's four key 'new economy' goals:

- the take-up of Electronic commerce;
- the development of Mobile commerce;
- the development of ICT infrastructure and services;
- the development of the requisite educational and skills programmes.

Through evaluation exercises such as 'e-Business benchmarking 2000', it is clear that considerable progress is being made in some of the key metrics such as:

- 79% of businesses are now connected;
- 8% of businesses are using email;
- 65% of businesses have a web site;
- 46% of businesses have an intranet;
- 32% of businesses allow customers to order on-line.

In comparison with other countries, Scotland is performing well in these and other measures of 'connectedness'. However before an overall measure of Knowledge Economy readiness can be made, additional factors will have to be taken into consideration including:

- R&D expenditure;
- number of employees in high tech/knowledge intensive sectors;

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- number of people undertaking education and training;
- number of University spin outs;
- number of patents registered by Universities and value of research grants awarded;
- number of households with a wage earner below median earnings.

Notwithstanding the progress made towards the adoption and integration of ICT into business processes, there are substantial weaknesses that have to be addressed such as the need to:

- improve the level of sophistication in the use of ICT;
- improve the broadband telecommunications infrastructure;
- create more innovative companies;
- greatly expand industrial R&D expenditure;
- get more students to consider careers in ICT;
- convince a significant number of currently non participating companies, that they can embrace and benefit from the Knowledge Economy;
- engender a desire and confidence within the venture capital community, backed by an efficient and robust process for new business opportunity development and assessment, to provide funds for high tech initiatives.

However the fundamental tenet of this paper is that while all of the above and more are necessary, they may not be sufficient to ensure that the aims outlined for Scotland above in relation to the attainment of the Knowledge Economy are attained.

The extra ingredient, described in the next section is the role of the '**Institute for the Knowledge Economy**' (IKE). As well as making a substantive contribution to some of the main areas of development required for the Knowledge Economy, IKE has to produce two key overarching results. First it has to integrate and catalyse other initiatives, creating a national outcome in which the whole is greater than the sum of the parts. Second it has to provide and be based on an in-depth fundamental level of understanding of what the Knowledge Economy and its implications are really all about. This has to pervade everything the Institute does and through a variety of transfer mechanisms be inculcated into every aspect of industry and society.

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§5. THE INSTITUTE FOR THE KNOWLEDGE ECONOMY (IKE)

With the advent of the Knowledge Economy never has there been a time when the Higher Education sector is more needed. Knowledge is both the key resource and the key output of the sector, and whether in the form of educated graduates, 'upskilled' professionals, or research outputs and the resultant IP, the outputs of the sector are vital.

In this regard Scotland is in a fortunate position. The HE sector already makes a major contribution to the Scottish Economy. Over 36,000 people are employed in a 'business' that turns over in excess of £1.6 billion. HE attracted nearly £400 million into Scotland from the rest of the UK in 1993/1994 only two thirds of which accrued to the sector, and generated over 68,000 full time equivalent jobs in Scotland, over half of which were outside the HE sector itself. As an exporter, tourism aside, HE is Scotland's leading exponent by value, recording £151.8 million in 1995.

All of the above is before any attempt is made to value the intellectual capital that is pumped into the economy in the form of new knowledge, and skilled graduates. The following extract from the report of the Scottish National Committee, anticipated the vital role that the sector has to and can play in the new economy:

“We are convinced that now, as in the future, one of the most important aspects of Scottish competitiveness will arise from our ability to innovate, and to develop and exploit knowledge. We believe that this can only be achieved through our capacity to conduct outstanding research.”

However it is fully recognised that to gain maximum impact such fundamental understanding and research output, complemented by the highest quality education and training programmes, have to be made relevant and have to be embedded in processes that efficiently and effectively transfer and exploit the outputs. The University of Strathclyde with its founder John Anderson's mission statement, that has survived for over 200 years, of “being a place of useful learning” has taken up this challenge in the full glare of the challenges posed by the new economy, and has inaugurated the Institute for the Knowledge Economy (IKE).

§5.1 Goals and Programmes of an Institute for the Knowledge Economy (IKE)

The Institute has been designed specifically to address the overarching objective of this paper, namely the successful transition of Scotland's present economy to a Knowledge Economy. It requires both an innovative internal restructuring and reorganisation of resources within participating institutions, and of equal importance, a new partnership with the private and public sectors, to ensure that the deliverables in the form of new knowledge and new skills find their way successfully into products and services, feeding and creating high quality jobs that will increase productivity.

In addition because the Knowledge Economy is still immature, the Institute will inculcate into society as whole a proper understanding of the issues, thereby raising confidence, and stimulating a need, and a desire for innovation and learning. It also will act as a catalyst and integrator for other initiatives that have to operate synergistically in a Scottish context.

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To achieve the above the Institute will conduct in parallel:

- top rated research and high quality degree based education and skills training, within a unique environment that is determined and dynamically evolved by industry's needs;
- commercialisation, consultancy, support for industry and standards work, that will create a novel technology supply chain;
- a novel range of complementary activities in the area of demonstration, information and intelligence gathering, knowledge management and analysis, enquiry handling, and dissemination, that will culminate in the ability to provide effective predictive planning for government and industry.

The above programmes will not be restricted to one aspect of the Knowledge Economy, either technology or business strategy, but will constitute a holistic approach, recognising the importance of the tight coupling and interplay between the push of technology and the pull of business reinvention in the context of the implications and opportunities of the 'new economy'. Technology will be used to support and facilitate the programmes as appropriate.

The universities of Strathclyde and Glasgow will bring together teams comprising the highest rated academics in a range of disciplines, covering computer science, information science, telecommunications and business management, complemented by staff with commercial expertise. This staff resource from academia will work with and through a wide range of partners and co-workers from industry and other academic institutions. These collaborations will be extended to international links which both universities can bring to bear, based on their global networking and partnership capabilities that have been developed over many years.

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§5.2 The Anatomy (Organs and Flows!) of An Institute for the Knowledge Economy

The following canonical diagram encapsulates and illustrates the main constituent parts (**'internal organs'**), and throughput and delivery mechanisms (**'fluid flows'**) of the Institute for the Knowledge Economy (IKE). How this entire piece interfaces with other initiatives, and indeed creates a situation in which the whole is greater than the sum of the parts will also be discussed.

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Research, Education and Training

The Institute will be grounded on a solid bedrock of inter-disciplinary world class research that is aimed at providing new insights, new results, and new technologies to support and grow the New Economy. The research programme will be distinctive in being primarily designed for and aimed at the exploitation of the intersection and powerful synergy between the areas of computing, communications and business. This will provide the necessary mechanisms for leading scholars from different faculties to tackle complex issues that could not be effectively resolved within any single discipline, or by 'one-off' project collaborations. As such the Institute will facilitate a comprehensive understanding of the current transformation of the economy from multiple

perspectives in a systematic manner, providing radical yet realistic visions on a series of fundamental issues about future society, driven by innovations in business and technology.

This will be complemented by a programme of post-graduate degree based education and professional development, designed to produce and update professionals with the requisite depth of understanding, coupled to practical up to-date skills in business and technology. There will be a tight coupling between degree based education and lifelong professional learning. It is important that the Institute imbues its learners with a culture of embarking on 'learning journeys' that last throughout professional life. Part of the solution is in incorporation of professional training materials to complement the fundamental principles gained through rigorous educational content. Also the use of technology to facilitate an anytime anywhere flexibility will be another important factor.

It should also be noted that students working within the Institute will have a first hand opportunity to witness and experience the research, through proof of concept, to product and spin out company pipeline in action, and as a result to pick up some of the entrepreneurial skills and mindset that is apparently in short supply in Scotland.

Demonstration

The 'Living Laboratory' which sits between the research programmes and the activities of the Institute that are nearer to market, will perform two vital roles through a series of 'Thematic Exemplars'. First it will provide laboratory test-beds to enable researchers to come together and integrate and advance their fundamental work in the context of real world thematic challenges (the chosen **themes** of E-Living, E-Business and E-Services are described in the Appendix 1), this is a critical part of the proof of concept stage. Second it provides a demonstration window into the future that will be available to all the stakeholders of the Institute. Again in the context of the Institute's role as a mechanism for informing, enthusing, and educating society in the large in the widest sense, through experiential approaches, this function of the Living Laboratory has a critical role to play. It is also planned to build a virtual version of this aspect of the Living Laboratory using the latest animation techniques to provide even wider access and experiences to as large an audience as possible.

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Consultancy and Standards

At the near to market end of the Institute's work, staff will conduct consultancy projects and through standards work ensure that the Knowledge Economy in Scotland is developed in an open fashion that will not be exclusive or proprietary. Standards developments related to the technology plus the work being undertaken in the area of policy and regulatory issues, both within the University and by a senior member of staff who is currently working with the Commission in Brussels on regulatory issues in telecommunications, have to be developed into a best practice framework.

As regards consultancy it is anticipated that the Institute will build up a programme that will assist organisations assess their 'net readiness'. This will be closely linked to and informed by the work on standards and by the work of the Strategy Planning Centre (see below). Discussions are underway with some of the major players such as Cisco and IBM, who have already made major gains in their own organisations by the successful adoption of a networked approach, and as a by-product have developed methodologies and tools to use in this process.

Commercial Exploitation

Pull through of the research results and exploitation of the associated IP, will be a priority, and commercial teams will be involved from the proof of concept stage within the Living Laboratory demonstrators to the creation of spin out companies or negotiation with commercial partners. It is a fundamental requirement that while Scotland may be sitting on a gold mine of intellectual capital, the processes involved in its exploitation must be efficient and effective to attract venture capital on an international level.

'Spin In' is perhaps a concept that has not had so much press. However it is a concept that has been commended to the University by both large and small companies. Here the Institute will make facilities and resources available to enable R&D teams from industry to work within the Institute enjoying a highly intellectually charged, innovative environment in which to develop new ideas of importance to their parent organisations.

As stated above it is a clear objective of the Institute to attract capital investment for the exploitation of the emerging IP, and to make this process easily accessible to the VCs. If successful, it is believed that the same sources of money would subsequently be prepared to invest in the entity, namely the Institute itself, that facilitates this flow of investment opportunities.

Intelligence Gathering and Strategic Planning

As with any organisation of the New Economy, the Institute has itself to be constantly innovating and evolving its offerings. To do this requires what Bill Gates in his book 'Business @ The Speed of Thought', describes as '**a digital nervous system**'. Like the biological nervous system it triggers reflexes enabling the organisation to react appropriately to changes and needs. It provides the all important information and intelligence to enable the organisation to ponder crucial issues and have the best chance of arriving at judicious decisions.

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As such the small 'organ' in the canonical diagram, entitled **Information and Knowledge Management**, will have a vital role in ensuring the well being of the Institute and its relevance to society on an ongoing basis. Without this function the Institute will atrophy and subsequently die.

The Institute will inaugurate an 'Intelligent Information Hub' and a 'Strategy Planning Centre' to fulfil this role. The 'Hub' will provide a range of mechanisms for collecting and collating information, including portal based facilities, that will facilitate networking with a wide range of partners, clients and general enquirers, throughout Scotland and further afield. It will in effect become the nerve centre of the Institute, receiving and processing enquiries, providing answers locally where possible, and making connections to other sources of solution when required.

While each of these enquiries is important in its own right, there is added value to be gained from an analysis of the traffic in the large. To this end backend systems in the 'Hub' will manage and process this traffic for the purposes of ongoing intelligent analysis and strategic planning within the 'Centre', where additional sources of intelligence and expertise from the Institute and elsewhere, can be brought to bear through the latest decision making and prediction techniques. These will be used to provide:

- insights and outcomes that will be used to ensure the ongoing relevance of the Institute, through a continuous tuning of its programmes and services;
- valuable forecasts and intelligence to partners, from the Scottish Executive to individual organisations, that can be used in planning future scenarios associated with their roles in the Knowledge Economy.

This ability to anticipate and in some respects control the future, based at least in part on predicting user behaviour and priorities, is central to the thinking of ntl's CEO and President Dr. Barclay Knapp, who in his lecture: 'Catalyst for Change – An Insider's View of the Communication Revolution', sees it as synonymous with 'necessity' in 'necessity being the mother of invention'. Ntl's generous financial support of the Institute will enable this role to be developed at an early stage.

The 'Hub' and 'Centre' will also be responsible for providing access to a number of additional resources and events such as:

- Discussion forums and online conferencing with local and international experts.
- Information about the projects and units that currently comprise the Institute.
- Publications created by the Institute or made available through its partnerships.
- Latest reports, case studies, and news items about developments that are pertinent to the work of the Institute and the Knowledge Economy in general.

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§5.3 The Whole must be Greater than the Sum of the Parts!

As emphasised throughout this paper, partnership, collaboration and synergistic connectivity, are at the centre of the Institute's philosophy. The Institute will only be successful in a Scottish context if there is no hint of elitism or parochialism and if it galvanises others into action. To this end the importance of the Intelligent Information Hub, and Strategy Planning Centre should again be stressed as the components that are not only at the heart of the Institute's own activity but which are also required to play a central role nationally in ensuring that the wider influence of the Institute and the activity generated elsewhere is not chaotic but 'joined up'.

There is clearly a range of types of partner that the Institute will seek to proactively work with and interface to, and as a result help bring to bear on the attainment of the Knowledge Economy:

- Other parts of our own University outside of the three main contributing areas of Computer and Information Science, Telecommunications and Business Management, are clearly also important. As a specific example, it is anticipated that the Institute will work closely with the new Hunter School of Entrepreneurship.
- Other HEIs will be involved according to their distinctive strengths. Already Glasgow University's Department of Computer Science is fully involved, and on the international arena a Memorandum of Understanding has been completed with the University of Southern California and discussions are underway with Carnegie Melon University.
- Industry, both public and private sector is a key partner and a number of ways of working together are envisaged that cover: endowment, contract research, the provision of consultancy and professional upskilling, collaborative research, secondments and so on. (Overall, as described below, it is anticipated that the Institute will be advised by an Industrial Board.) Partnership arrangements are being negotiated with key players such as IBM, Cisco, ntl and the National Australia Group.
- Innovative incubation and pre-incubation schemes are being developed such as BT's 'Brightstar' and Scotland's first 'dot com' incubator, 'Business Incubator.com/Scotland' launched in October 2000 as a partnership involving Sun, Cisco, IBM and the Royal Bank of Scotland. The Institute, in addition to its own incubation support for companies spinning out of the research programmes, will be able to act in support of these other initiatives, and for example add its imprimatur to that of the other prestigious organisations that are involved in the development and nurturing of the best business plans.
- The Institute through its Intelligent Information Hub can interface to community experiments such as the use of e-learning in the community and derive valuable information to add to its ability to provide useful forecasts and insights.
- Clearly the Scottish Enterprise Network has to be a major partner of the Institute. IKE has enjoyed the benefit of advice and support throughout its development from SEN and will continue to work with the Network to ensure that delivery is timely and well focused.

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In addition to the above, it should be noted that the University is also at the centre of a number of additional relevant and complementary activities that are central to a digital connected Scotland. In particular for example involvement in the discussions surrounding the creation of a national education network through the re-procurement of the Scottish MANs, in parallel with the rollout of SuperJanet IV; and playing a central role in the evolution of an e-learning strategy through seminal work on 'Glasgow the Learning City: the REAL Partnership', enable a wider integrated influence to be achieved from the outset.

§6. THE END OF THE BEGINNING

Plans are now well advanced for the establishment of the Institute this summer. The structure and management of the Institute are outlined in Appendix 2. Clearly not all aspects of the Institute will be available at the outset, with new degrees for example coming online in the future. However it is hoped that the Institute will move quickly to have a positive influence on the advancement of the Knowledge Economy in Scotland, through its own services and activities and through profitable relationships with other initiatives and partners in Scotland.

As identified by Grady Mearns and Mathew Faulkener, Price Waterhouse Coopers, Strategic change gurus:

“A process of continuous innovation isn't just nice to have, it's a must to have”

Equally the transforming role of IT has to be fully acknowledged and embraced. IT is the facilitator and necessitator of innovation. As stated in the Minister for Enterprise and Lifelong Learning's report: 'A Smart, Successful Scotland: Ambitions for the Enterprise Networks', echoing the call from Mearns and Faulkener:

“Embracing the Digital Age is not an option but a necessity for success. And it has already arrived.”

These are the sentiments and key characteristics, which the Institute will itself display in its own activities, and at the same time evince and promote to all stakeholders as the first vital steps to success in the Knowledge Economy in Scotland.

APPENDIX 1: THEMATIC EXEMPLARS

Theme One: E-Living - New Technology and Infrastructure for an E-Society

The rapid development of E-business and the underlying technological revolution are having profound implications for our lifestyles, creating an E-society that in many aspects is significantly different from the industrial society. Today, new technologies are being extensively used to modernise government, and to radically change the way that healthcare, education and other social services are managed and delivered. However, these changes will create new demands on computing and telecommunications, which in their current cannot be satisfied. These problems cannot be resolved simply by further increases in computer processing power and telecommunication bandwidth. A fundamental re-thinking of the basic models of computing and telecommunications may be necessary. The E-society will require technology to be pervasively available, essentially embedded in, and integral to the environment and the artefacts with which we interact as a natural part of our daily lives. These may in turn lead to a radical shift away from the desktop-computing paradigm. The systems will have to be highly dependable with high levels of interoperability, scalability, security and reliability, before an E-society can become fully committed to them. Developing effective systems to support an E-society raises serious technological challenges, which can only be effectively addressed in a multi-disciplinary environment. The mix of skills and research excellence constituted in the Institute places it in a unique position to achieve this.

Theme Two: E-Business - New Strategies, Models and Management Techniques

In the last few years we have witnessed radical changes in the strategies, business models and management decision-making techniques. In many cases, the basic business rules have been radically re-written. These changes are underpinned by the rapid development of computing and telecommunications, and in particular by the explosive growth of the Internet. The recent enthusiasm for mobile communications is creating a new dimension to these changes. Mapping, conceptualising and predicting the future evolution of these changes and identifying the technological support required are absolutely essential for the future development and survival of any company and for the economic well being of any country.

Rapid developments of computing and telecommunications systems have provided the essential tools for business to manage the most important resource of the economy (i.e. information) in ways impossible in the past. This powerful combination of new economy with new technology means that organisations have to adopt new strategies and business models, which need to be reflected in new organisational designs, new ways of working and new inter-organisational relations. Changes are also necessary in functional areas - new skill requirements, new marketing techniques, new production and logistical systems and new accounting systems, for example. These activities need to be supported by a whole set of new decision-making tools, and management science and information management models and techniques. The nature and characteristics of the new business environment needs to be identified and understood, and relevant policies developed; and E-business related activities measured in a timely fashion.

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Furthermore, the future direction of these business changes will depend critically on how the technology and infrastructure evolve and how the relevant services are then provided. The rapid development of E-business will demand radically different capabilities in computing applications, systems and architecture, but even some new E-business models are based on assumptions about the scalability of current Internet technology. To unleash the full potential of the enormous advances in technology may require the creation and implementation of a radically different model. The take-up of new technology has been happening at an unprecedented rate, and increasingly people are committing their entire business to the technology without understanding the full implications of their actions. The high technology industry and organisations using the technology are riding a wave where everything can change within twelve months. No organisation in this market, not even global corporations, can afford to be cautious and not invest in understanding the long-term models that can guard against catastrophic events. The Institute, as a source of leading academic knowledge, is in a strong position to tackle such leading-edge technological and business issues in an integrated manner.

Theme Three: E-Services

- Mobile Communications, Computing and M-Commerce

The evolution of telecommunications infrastructure and services in general and mobile communications in particular will have major implications for the way business is organised, conducted and the way we live. The Institute is strategically positioned to explore issues related to the development of electronic services in deregulated communications environments, with particular emphasis on the mobility of the service user. Mobility is not restricted to the concept of the mobile telephone user, rather it relates to the concept of delivering the service to the user wherever that user may be. The enormous interest in Mobile commerce (M-Commerce) has greatly complicated the environment for service delivery. Questions relating to user authentication, security of communication and provision of guaranteed quality of service have all been raised. Through the multi-disciplinary environment, the Institute is ideally placed to bring together leading scholars to address these and other related questions. As new technologies and paradigms take hold of society and industry, mobility will play an ever-greater role within the lives of individuals and organisations. By addressing this area, the Institute will seek to understand how changes within the fields of telecommunications, computing, and business are coming together and shaping developments within M-Commerce.

It is also recognised that a key feature of 4th generation mobile communications systems will be the emergence of multiple operators offering competing services to clients. The new strategy of the European Commission is to promote the sharing of spectrum and this will involve a major interaction of operators and their clients to ensure that spectrum is shared in a fair and efficient manner. As such work will be undertaken to investigate means of addressing the problem of **Dynamic Resource Allocation in a Multi-operator Communications Environment**. This will be based on dynamic resource allocation procedures, designed to ensure quality of service provision in a rapidly changing user environment. Such developments will have a primary influence on the way in which M-Commerce is carried out and therefore a close liaison with M-Commerce developers, within the E-Systems Institute will be an essential element in this project.

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CROSS CUTTING THEMES

Infrastructure for the emerging electronic world

Traditional models of networked computer applications consist of a number of computers running a distributed application, information being passed among instances of the application via a network of communications links. This picture embodies a traditional model of network computing, dating from the 1960's, and is rapidly becoming invalid.

In reality, communications and computing are fast becoming indistinguishable, for two reasons. The first is that networks are themselves composed of general-purpose computing devices, partly because of the sophistication of demands placed upon them, and partly because modern pricing makes it senseless to use any other technology. The second is that, as users and application developers increasingly assume their host machines are networked, the concept of a stand-alone computer no longer features among their expectations - computers are perceived to be a component within the network context, rather than as autonomous devices that occasionally communicate with others.

A further large class of use is device-to-device information flow, with the network and computers simply providing a central connection and computation service. In this case the physical embodiment of a computer can disappear from the concept space in exactly the same way that the communications network already has.

Merging of networks and computation

User demand, coupled with trends in price/performance ratio, will lead quickly to the situation where computers as entities become invisible to non-specialist users. This already happens to a degree. Users no longer need to own a computer to take part in activities such as email and web browsing - telephones and televisions have assumed the application interface role and the computation occurs remotely from the end user. The next generation of "thin clients" give users access to office-style software without the obligation to own and, critically, manage the software itself.

This is an enormous paradigm shift - computing facilities are being purchased, in perpetuity, along with devices. We are comfortable with an invisible communications infrastructure, and are moving rapidly towards an invisible computation infrastructure merging with it.

Wherever the required computing is not pertinent to the task in hand, it makes no sense for the user to have a manifest computer wasting space and resource between the devices and the network. The computing will thus be absorbed, partly into the network, and partly into the device, depending on the scenario in question. Most home users do not want to own computers, and currently do so simply to buy services that are better placed elsewhere.

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Scalability

There is a tendency to assume that current technical and pricing trends will continue indefinitely. However, the current Internet infrastructure has not been designed for scalability, but is a collection of autonomously and serendipitously developed standards and practices that happen to work with each other. Moving to a world where everyone uses the Internet is not a simple matter of adding more computers and connections. At some point this tactic will fail; currently we cannot even predict when this will happen.

It may even be that it is not feasible for everybody to enjoy the same level of Internet service that a minority currently experiences. For example, video-on-demand is a fashionable topic among telecom providers; however the harsh reality is that the network infrastructure is unable to support this service if there is any serious take-up. Bandwidth is always a precious commodity; up to now, the amount available has been ever-increasing, so fundamental questions about how to use it effectively have been largely ignored. Only a tiny proportion of the population currently rely upon the Internet for serious services - it is quite impossible for the whole population to successfully subscribe to current infrastructure technologies.

Take-up of the new technology is happening at an alarming rate - particularly alarming to engineers, and quite unprecedented in the history of engineering. People are committing whole businesses to technology that is (in engineering terms) untried, untested and largely not understood. Longer-term research into the technological and social issues is now essential to the continued well-being of the whole structure, to avoid the possibility of catastrophic failure.

Fundamental questions remain unanswered with respect to: quality of service; management; navigation and indexing; cost models, and information provenance.

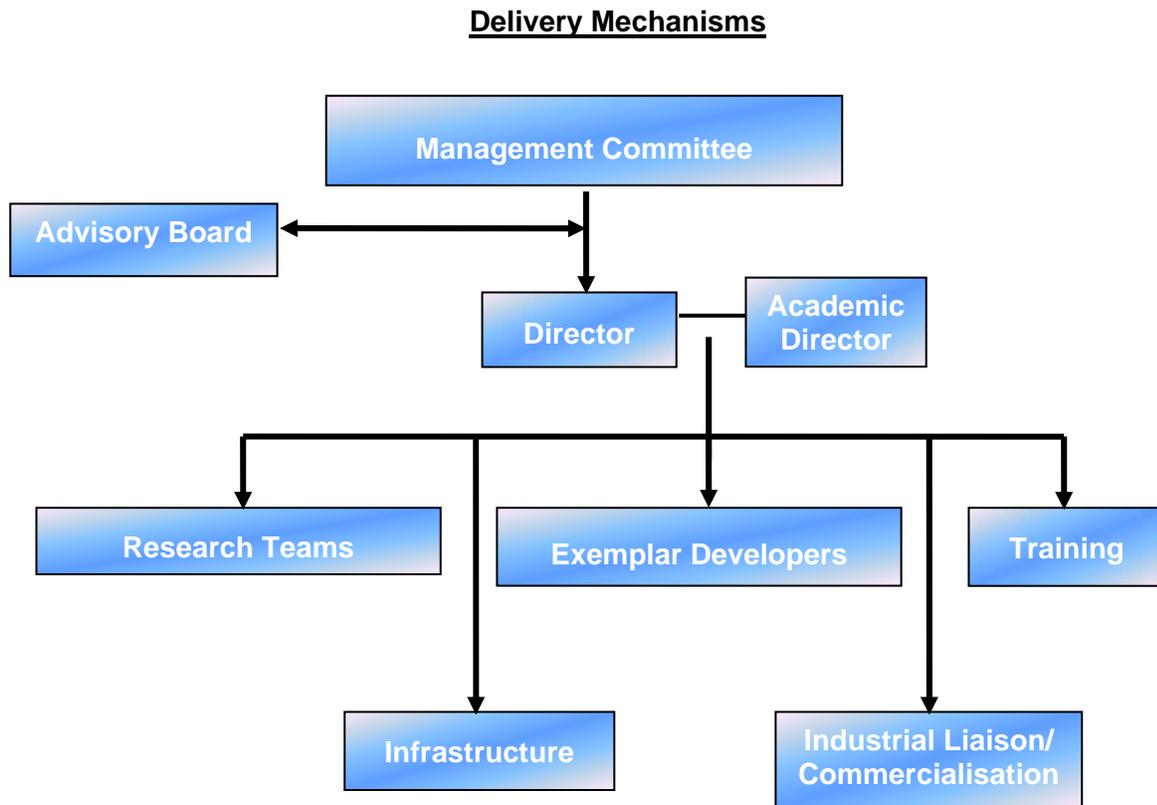
Searching and indexing

A rapidly emerging trend is for Internet information to be passed using semistructured data standards, such as XML, rather than document standards such as HTML. The value of this paradigm is that it separates the concepts of information and presentation, which makes feasible the automation of both maintenance and querying of the information. Outside this context, querying is an activity that occurs over databases, whose data is held according to the relational paradigm. While emerging standards such as XQL will allow fairly sophisticated querying of XML data, they fall far short of relational query paradigms in a number of areas, notably optimisation and generality. The research challenge here is to develop querying models and mechanisms to reach the same level of sophistication.

APPENDIX 2: STRUCTURE AND GOVERNANCE

Delivery Mechanisms

The Institute will have a distinctive identity, clearly recognisable by its stakeholders. It will be established outwith the normal Faculty structure (academic entities) of the Universities, but will work closely with the Faculties in developing programmes and modes of delivery. The Institute will have the flexibility to grow rapidly into a major academic and business unit, with the capacity to bring together the strengths of both Strathclyde and Glasgow Universities.



The workings of the Institute will be overseen by a Management Committee that will receive advice from an Advisory Board comprising representatives of all the stakeholders of the Institute. The day-to-day management of the Institute will reside in the hands of a Director, who will be supported by an Academic Director. The latter will provide leadership and direction for the research and knowledge generation activities of the Institute. An important requirement is to have resident inter-disciplinary research teams working on cutting-edge projects. These will be supported by teams who will conduct development work to establish Technology/Business Exemplars.

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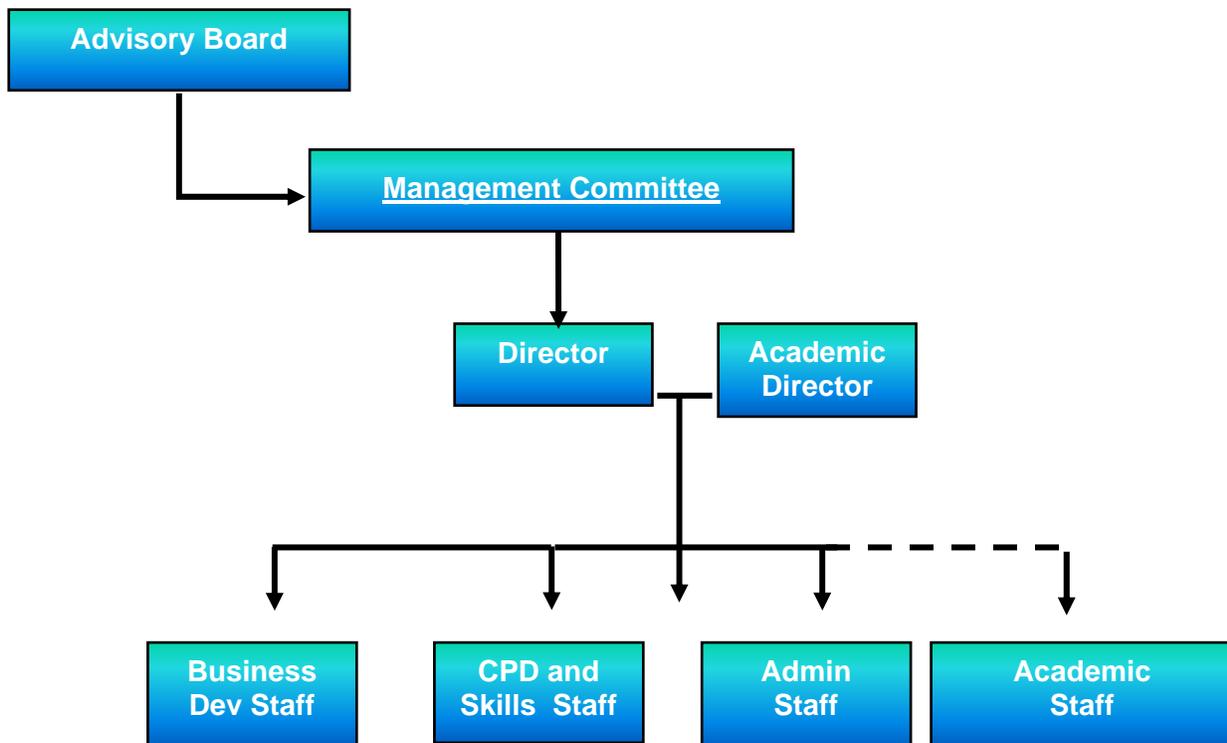
The Training Unit will carry out the complementary activity of delivering skills updating and continuing professional development programmes. A further Unit will focus on the commercial activities of the Institute, including commercialisation of the academic IOP generated in the Institute, supporting SMEs through advice and consultancy. Finally staff will be recruited to support the Infrastructure within the Institute.

The incorporation within the Institute of bespoke commercial programmes that both feed and feed from complementary academic programmes, when linked with business start-up, venture capital and continuous professional development, will empower the Institute in a way that has not been sought or delivered from traditional academic structures. The different interdisciplinary mix will offer the opportunity for the development of quite different types of research, training and education programmes. The outward looking ethos enshrined in the Institute's beginnings will provide the universities with a powerful vehicle through which to engage in partnership with outside Business, agencies of Government, Higher Education and individual investors.

Management Structure

The following diagram illustrates the proposed Management Structure for the Institute, and the staff to be associated with the Institute.

Management Structure



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The roles of the Director and the Academic Director have been outlined above. In addition to the Research and Exemplar building teams, the staff complement will include a Business Development Unit with responsibility to support the Director in establishing the business prospects of the Institute. The training activity of the Institute will be conducted by the CPD and Skills staff, who would be able to call upon the research specialists as and when required. The Administrative staff will support the management and clerical functions of the Institute. The relationship of the Institute with Universities will be facilitated through the Management Committee chaired by a Deputy Principal from Strathclyde appointed for this purpose. The Management Committee will provide strategic directions to the Institute, and oversee its formation and growth. In due course an Advisory Board will be established that will comprise representatives of stakeholder organisations from industry, government and the universities.

The Director and the Academic Director will be members of the Management Committee.

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