Knowledge Economy and Science Policy Link-up: What Wales *Really* Needs

Edward C. Conley, Alex R. Hardisty and David R. Owens, CBE

A new type of 'knowledge export' drive

The Welsh Assembly Government's Economic Development and Transport Committee requires a science policy for Wales which more effectively supports the development of a 'knowledge-based economy'. However, a draft consultation document entitled *A Science Policy for Wales?* has recently elicited a high-profile critique—led by Professor Sir John Cadogan and signed by 12 other distinguished Fellows of the Royal Society.

The focus of the critique (see picture) is WAG's 'confusion of economic and science policy' - essentially a failure to understand the business of 'hard' sciences that are 'based on experiment and calculation' - extending to excellence of engineering and medical disciplines (as defined by Professor Cadogan). We understand this critique but wish to offer additional perspectives to heal this apparent schism between economic and scientific world views. We hold dear the internationalized values and practice of 'hard science' but have also thought deeply about its effective *translation* into export opportunities to raise Welsh GDP. It is these future opportunities—real multi-billion pound earnings potential—that have profound implications for sustainability of fundamental 'curiosity-driven' science and the economic prosperity of every person in Wales.

A resolution to the 'schism' needs everyone to grasp the scale and intractability of the country's problems that are driving its ambitions: Wales has significant economic inactivity, a massive public services transformation agenda, relatively low cash resources and is not sufficiently exploiting its advanced intellectual capacity. In order to take its own 'main chance' through knowledge translation it has to prioritize its activities, excel in chosen areas, and earn substantial national income from them. These areas must communicate their needs to underpinnings of 'hard' interdisciplinary science through collaborations. In our opinion, advanced computing infrastructures need to be *vigorously* exploited to bring about this coherence. Many other countries have modernization agendas similar to Wales: all desperately seek solutions. Solving national problems by harmonized translation can therefore be only a first step. Genuine growth in the knowledge economy will only come when home-grown intellectual products across all strategic sectors are translated into sustainable export propositions.

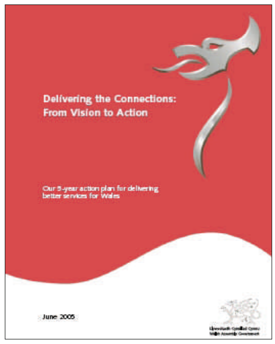
Cover of the Institute of Welsh Affairs Journal *Agenda* from Spring 2006 that contained John Cadogan's Critique of *A Science Policy for Wales?*

SUMMARY — This opinion paper focuses on some radical innovations in *production capacity* needed to make more realistic the vision of a 'joined-up' knowledge-based economy for 21st Century Wales. As a contribution to the science policy debate, the paper proposes a practicable 'pipeline' model for harmonizing outputs in the form of advanced computational applications. However, since Wales has to simultaneously bridge multiple 'implementation gaps' across its strategic landscape, similar thinking has been applied to creation of a range of innovative knowledge-based services in diverse fields. We argue that *interoperating families* of applications in advanced scientific, health/social care, government and other strategic sectors (aerospace, automotive and energy) can bring 'fabric and focus' to the Wales knowledge economy ambition. *Serial production* of focused applications evokes a 'collaborative export industry' model where specialist contributors can be in any geographical location. We show how a common underlying *translational process* can articulate national policy drivers creating 'joined up' solutions that (through global standards) are exportable. A recent Wales policy-driven interdisciplinary ICT project that has potential global reach (integrated telehealth technology services for people with diabetes) is used to exemplify the proposals.

Inside

'Silo mentality' is history—an exploitable advantage for Wales

We all live by dreams of future prosperity—it's a very 'human thing' and often gives strength to carry on 'when the chips are down'. But serial unfulfilled dreams turn people to cynicism before too long. This is happening in Wales. As Professor Cadogan points out, Wales has become rather prone to the use of 'wish lists' (and serial strategies) to capture idealized and perhaps unachievable 'future states' without sufficient consideration of their resourcing, priority or interdependence. And yet in Wales we do have remarkable political alignment and will to permit growth of an integrated knowledge-based economy. In the context of advanced service delivery, for example, the Assembly Government's *Making the Connections (MTC)* and the follow-up *Delivering the Connections (DTC, see figure)* have described principles by which separate policies in many different service areas should converge. MTC thus sets a comprehensive agenda for advanced service delivery in health, social care, education, training, housing/communities, business, transport, environment, planning rural services, culture, language and sport—for all citizens including children, older and disabled people. With such a flagship policy driver in place, it is unsurprising that the WAG wants to see some 'science' in its support, e.g. under the policy theme of 'Health'. To the dispassionate observer, however, advanced service delivery and science policy activity are proverbial 'chalk and cheese' - culturally, in scope, in breadth, in depth. From our experience however, the overwhelming need for sustainability of national growth supports a case for harmonization of purpose in both agendas.



***Delivering the Connections* set out a collaborative framework for advanced 'citizen-centred' services**

Knowledge applications: radical innovations in a box

We think the current debate on policy 'convergence' is of significance for the *economic survival* of Wales in the 21st Century. Other countries are not standing still in their 'knowledge economy' ambitions. In the case of far east countries, they are backed up with massive inward investments from global companies and large, well-trained, ICT-competent workforces. Clearly, without *substantial* focus on globally competitive products originating from Wales not much of anyone's vision will be sustainable. So how can Wales really 'get its act together' to satisfy its basic science / technology sectors, service transformation needs and economic development ambitions? As the First Minister has written, a distinction *within* Wales should be 'collaboration' - the indubitable corollary being that *outside* of Wales, ruthless 'competition' will rule. But *where* is the model to converge different collaborative inputs into globally-competitive outputs? *Where* are the science proposals that are relevant to solving Wales's *endemic* problems? — at first sight they seem a world away from 'laboratories and libraries': Wales still has large segments of the *working age* population who are economically inactive, and much of the active workforce are in low added-value jobs. Policy convergence must attack these real-world problems 'full on'.

At the other end of the 'skills scale' is an endemic problem of poor career choice and low mobility for highly qualified people such as specialised scientists in Wales. Within the UK's urban centres, these people do not find it difficult to efficiently 'migrate' between projects to build essential *interdisciplinary* skill portfolios. Any science policy should innovate to benefit these highly-qualified specialist post-graduate and post-doctoral workers: they are the 'engine room' of any future Wales Knowledge Economy. They *generate* much of the 'knowledge' destined to appear in first-rate journals, patent literature—and innovative products and services from dynamic companies. In our opinion, computing infrastructure needs to be employed—in creative ways—for these people to acquire critical interdisciplinary experience *irrespective of their geographical location in Wales*. They need to gain confidence and flourish by participating in (and sometimes leading) international collaborations that include world-leading CoE. There are parallel needs with respect to *advanced services production*, where we see a critical requirement for the dedicated 'pipeline' creating flexible services supporting inter-disciplinary or inter-agency collaborations. As for basic science applications, these can be based on integrative capabilities of advanced computing architectures - the Grid, the Service Oriented Architecture (SOA), Event-Driven Architecture (EDA) - each with particular strengths in delivering advanced functions to end-users. We believe building serial applications will give 'fabric and focus' to the Knowledge Economy aspiration (a still lofty ambition that is figuratively like 'putting a man on the moon' for Wales). For the dream not to fall apart, it needs a determined, harmonised 'catalytic' process to continuously converge required inputs to give desired outputs. Essential cultural and organisational changes need addressing to take advantage of new capabilities. Innovative Welsh companies can use applications as paths to satisfy demand in larger markets. For the WAG, they can help build a range of citizen-centred, need-driven applications to communicate across the integrated service economy. For scientists, engineers, entrepreneurs—they are a global platform for sharing resources, innovations and results (see next page).

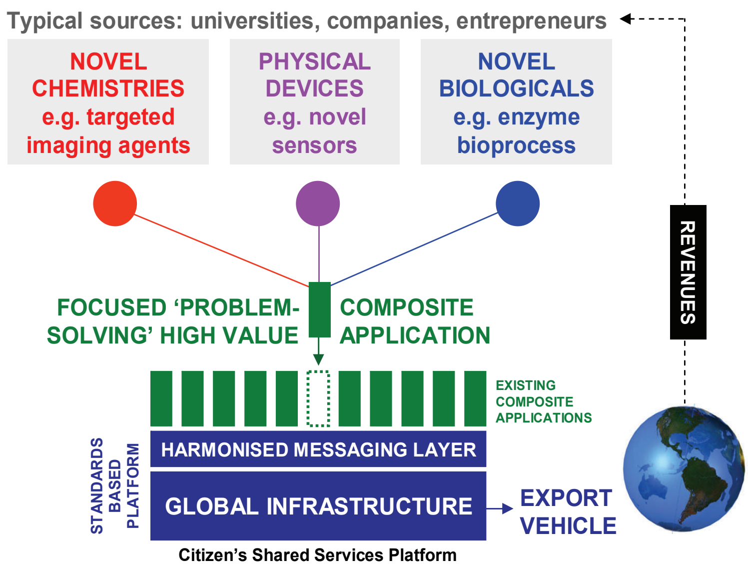
The changing dynamics of 21st Century science

It is worth saying at this point that 'knowledge products' are not bounded by a restrictive commercial definition. For example, a piece of well-executed research that achieves its objectives is a 'product' that may have a cultural value transcending its economic value. Effective translation, in any context, is really about the most efficient, routine *way* to form 'agile supply chains' bringing collaborative partners—and the resources they need—together for working towards a series of defined outputs. This process will take them from 'where they are now' to 'where they need to be'. For scientific applications, the translational 'pipeline' model would build on significant Grid, SOA, EDA and broadband computing infrastructure investments in Wales/ UK. Favourable impacts include enhanced capabilities for Welsh scientists to join global collaborations enabled by the next-generation Internet. Fundamental science increasingly needs to use very large data collections, 'colossal' computing resources and high performance data visualization techniques. Computation now ranks alongside theory and experiment as a method of advancing scientific knowledge. A well-designed application can change the dynamics of the way science is conducted, putting greater emphasis on collaborations between geographically-separated people and the sharing of information and resources. Typical work components in these interdisciplinary projects might involve handling mass data feeds from specialised (remote) scientific instruments, knowledge management systems, the design and creation of innovative problem-solving environments, or the invention of advanced 3D visualization methods. A translational process 'pipeline' might put any or all of these to work in 'hard science' applications on demand. Such applications might also use advanced computational models to help researchers understand physical, biological, chemical (or other domain) system complexities. For group communications, meetings and seminars can be run from any location with participants 'tuning-in' on their own PC's or in dedicated *AccessGrid* rooms (see figure, below). This saves much unnecessary travelling whilst maintaining the camaraderie of project-based collaborative communities.

Helping inventions 'get out of the lab'

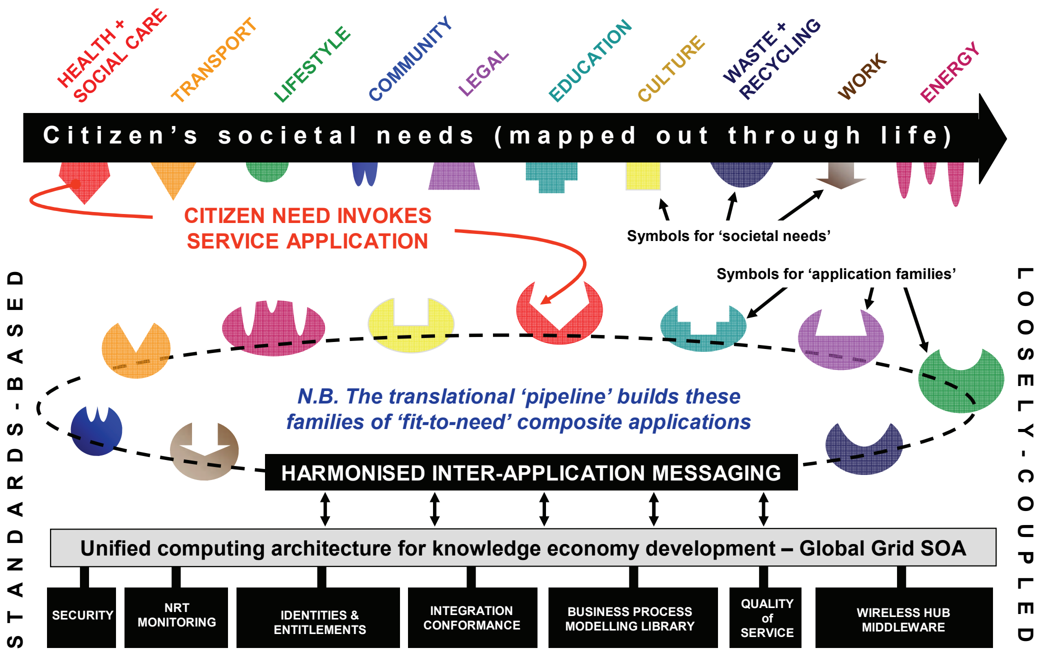
For an isolated piece of new technology, many barriers exist to its translation (e.g. technical immaturity, interdependence, financial constraint, system incompatibilities, end-user acceptance). These barriers may be so high that innovators (entrepreneurs, inventors in companies, universities and independents) eventually 'stop trying' — i.e. they are put off by the struggle to bring their idea / innovation / niche product to market. It just doesn't 'get out of the lab' - the patent that took so much hard work and money to obtain may go unlicensed! Acknowledging the difficulty of this path, we tried to think how many of these 'small-but-perfectly formed' innovations could be given much greater access to *end-user business processes* - by embedding them in targeted translational applications that work on global computing infrastructures. This is crucial for key emerging areas like telecare technologies (see next page)

The concept is best described by an example. Suppose a university researcher discovers a highly-innovative physical principle with potential to be employed as a real-time sensor of low-concentration blood analytes like hormones. The ideal application might be an implantable probe to read out continuous physiological data—creating a high value 'exportable' diagnostic service. In this example, the translational 'pipeline' generates options for process-based collaboration. In this case, platform *delivery* of the end-to-end 'diagnostic' solution—is embedded in a specially written 'composite application': this is a piece of focused, problem solving software of restricted but independent function 'sitting' on a unified computing infrastructure (see figure below). A point of convergence is compatibility of this application delivery platform with the Citizen's Shared Services Platform (for significance, see next page).



Predicting 'citizen-centred' service dependencies

Thus far we have emphasised the significance of 'pipeline' production methods for 'inter-disciplinary' working—creating high-value science and exports from Wales. Similarly, 'inter-agency' working within innovative 'citizen-centred' government services can benefit from this integrative 'production pipeline' approach. A major coordination issue involves 'interweaving' different strands of services so the *Making the Connections* criteria are satisfied—i.e. are 'inclusive' (for vulnerable and disadvantaged people); are 'citizen-accessible and participatory in nature'; have 'interfaces that are simple, coherent and transparent' - producing services that are efficient and effective, that maximise safety and *achieve sustainable solutions by tackling and preventing Wales's endemic problems*. It is possible to model this *future state* of 'joined-up' modernised, citizen-centred services in Wales (see figure). When built with care, this 'end-stage' model can be queried to predict *functional dependencies*, which set priorities for application interoperations (e.g. the need for a shared scheduling timeline between an elderly person's healthcare appointment and provision of his/her minibus transport). Through responsive infrastructure and well-designed end-user applications, citizen's (patient's, client's) needs drive *all* integration of information. For the model's credibility, it is important to show how example 'problems' can be 'attacked and prevented' by building an *exemplar family* of composite applications. An exemplar in our area of interest—diabetes—is introduced below. In all areas, application design require detailed data interoperability research to take into account data sharing policies (under the constraints of the Data Protection Act) and ethical permissions by embedded informed consent.



Exemplar problem—A family of applications for tackling & preventing diabetes

Diabetes is a massive global health problem. By the year 2025 it is projected that approx. 5% of the worlds population (c.300 m people) will have diabetes (and hence be at elevated risk of complications such as diabetic retinopathy). Currently about 3% of the Welsh population (c.100,000 people) have diabetes, accounting for approx. 10% of NHS Wales' resources. In Wales, twelve Diabetes National Service Framework (NSF) standards set out an uncompromising response to the scale of this problem. They call for improved ways to identify pre-symptomatic and otherwise undiagnosed diabetes (termed 'the missing million' by Diabetes UK). Much greater emphasis is given over to self-directed disease prevention by attacking a root cause: unhealthy lifestyles (see later). An essential principle is that patients are empowered through shared decision making about care plans. The standards call for systematic support to optimise and control blood sugar, blood pressure and other individualised risk factors such as cholesterol levels. Holistic care for the young and special risk management is required for acute hospital admissions and during pregnancy to optimise outcomes. Surveillance and management of long-term complications, with timely, appropriate and effective interventions (where needed) are provided in the context of multi-agency support (i.e. integrated health and social care). As a *raison d'être* for innovation, the diabetes exemplar provides a series of key symbolic targets for Wales—disease prevention, patient empowerment, individualised care, evidence-based risk management, surveillance, monitoring and outcome analysis across agencies. Within our research demonstrator, these watchwords set priorities for application designs, and defined inventive steps. Through the 'patient-centred' care of the Diabetes NSF, one must look to how future national health service operations might evolve, not just in Wales, but in other home nations, EMEA (Europe, Middle East and Asia) and ultimately across the world.

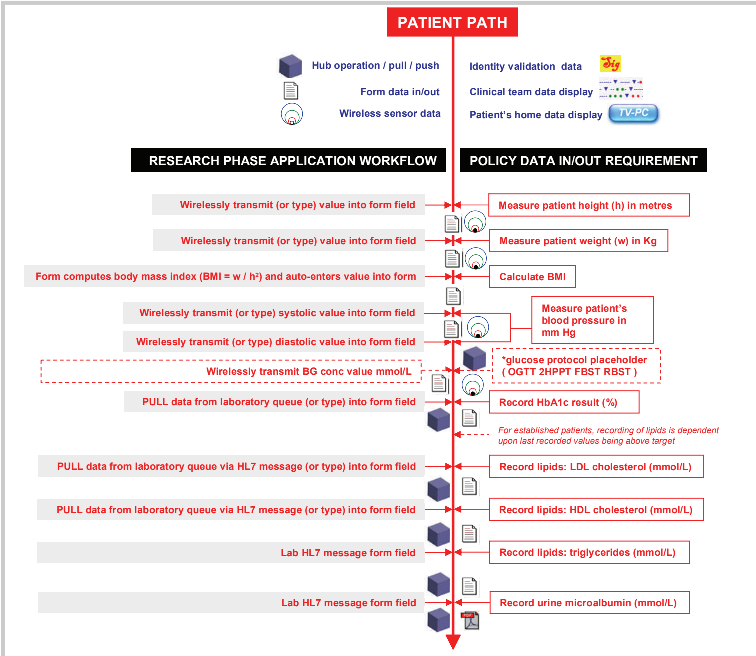
NOTE: Detailed descriptions of the telehealth applications described here will be published in due course.

A 'policy-driven' approach to service & technology innovation

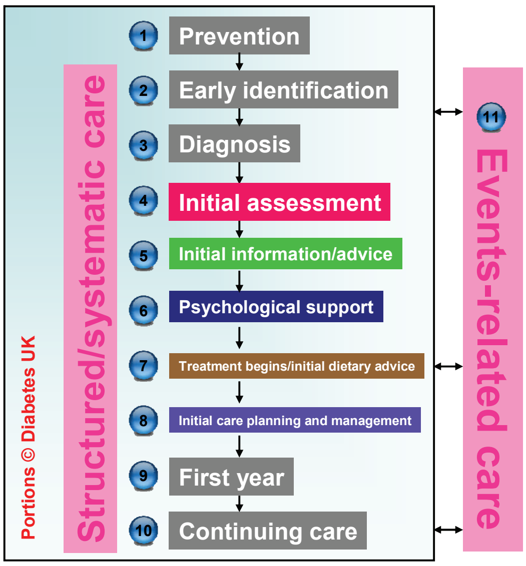
When we think about a health problem as challenging as diabetes, what does the 'catalytic path' enabled by composite applications look like? How can we translate both service and technology innovations to best benefit end-users? Can its repeated practice in a 'pipeline' of similar application developments directly benefit the economy? These questions set the agenda for translational research in Wales. As described earlier, we think concentrating on 'application building' can break down barriers in science and technology translation, while 'taking on board' relevant national policy drivers. In this case, the detailed policy focus would be the All-Wales Diabetes NSF (see previous page). This type of approach was encouraged by the UK Department of Trade and Industry (DTI) who (in 2004) funded a £1.4 million flagship programme in which we participated—in conjunction with IBM (UK), two medium-sized technology companies, one based in Wales (Zarlink Semiconductor) and one based in Cambridge (Smart Holograms). The demonstrator proposal was successful in the 2004 Inter-enterprise Computing call of the UK DTI Technology Programme Competition and is due to complete in 2007. The project ranks highly amongst its peers within the DTI and has taught us many valuable lessons pertinent to development of the 'Wales Knowledge Economy'.

The set of demonstrator applications are focused on addressing requirements of the Diabetes NSF standards (the 'policy' component) into 'at home' diabetes management services. These use a variety of novel 'sensor net' technologies (the 'translational' components). In doing this we have to face important challenges of individualized data management, security and scalability. We aimed to create the solutions as models for regional and national 'near real time' data management services—again not just for Wales but (through global standards) for the rest of the UK, EMEA and other countries across the world (the 'export' component). A dissemination and exploitation plan will sustain these translational activities beyond the end of the project.

In the research phase leading up to the creation of applications, 'knowledge inputs' to prioritise a 'problems-to-be-solved' list were provided by clinicians who were a formal part of the application design team. Ongoing national integration work by the one of the authors (DRO) and his senior colleagues (in particular, Dr. Dean Jenkins) involved drawing up 'consensus' standards supporting the Wales NSF for Diabetes which were critical to incorporate in building 'bottom-up' applications. Within a research context, the aim was to *evolve* the 'embryonic' applications, *testing* different approaches while preserving those tools or technologies that had evidence for high level end-user engagement—and which solved the defined problems set by the policy framework. All application design centred on detailed 'fit-to-need' - e.g. providing specific application support for each and every *data-producing or consuming step* in the 'patient journey' - workflows thus reflected the NSF standards' data requirements—*see figure, above*. A strong strategic component involved developing technology platforms that would support health-promoting self-interventions such as lifestyle changes and comprehensive tools for management of long-term conditions at home.



Application workflows designed in the 'pipeline' are determined by *policy* data requirements in a 'bottom-up' manner with strong clinician and patient end-user (design team) engagement. We rejected 'top-down' IT approaches as composite solutions are assembled 'fit-to-need' when the 'problem' is understood by research.



The Integrated Care Pathway (ICP) embraced by the Diabetes NSF exemplifies 'patient-centred' care.

Thought-out policy + collaborative consortia + standards = pilot solutions

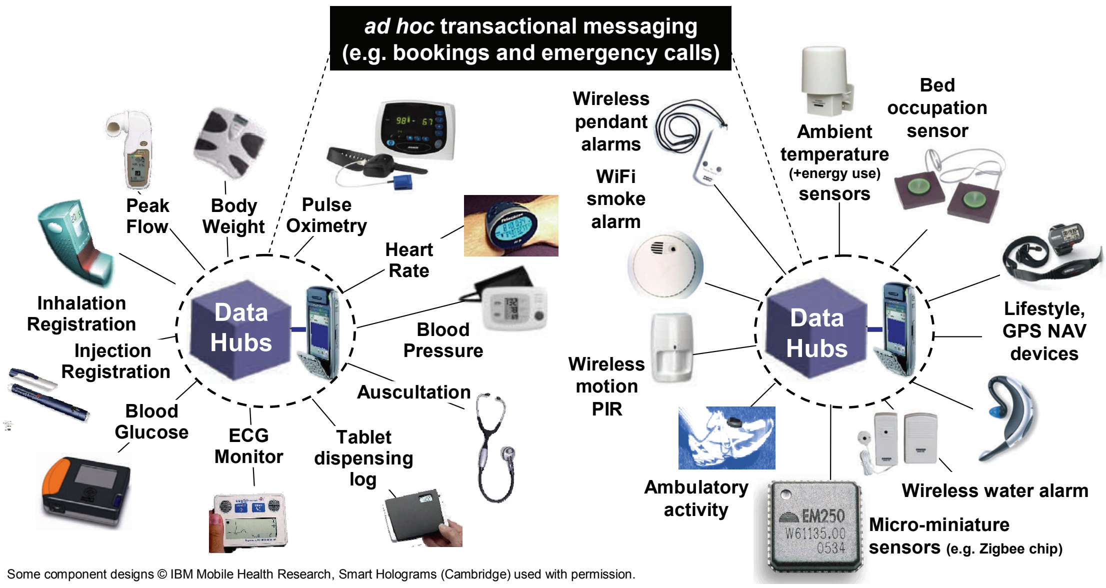
Creation of 'composite applications' by collaboration (as described) needs to be a growth industry in Wales. Their 'catalytic' properties—integrating a range of defined information inputs to give specified policy-aligned outputs—can be incorporated in a continuous 'pipeline design and production' process (that takes into account 'fit' to other applications serving different parts of the economy). If properly designed, a composite application (by definition) will be 're-usable across domains' and work seamlessly with applications in its immediate family and other designated families. For example, an application focused on 'at-home blood pressure monitoring' should be expected to work 'seamlessly' across different care pathways (e.g. not only diabetes services, but also in cancer, cardiovascular, child health services etc. on a 'do it well once' principle). This does *not* mean the user interfaces look identical, but it does mean the internal semantics and standards that underpin the service definitions are rigorous and consistent. Ensuring this 'consistency to standards' is a partnership role for major (global) IT companies, the normal business of which is data interoperability across the world by means of standards. Interoperability standards is a major unsolved problem when messages need to pass between many new and legacy systems from different ICT vendors. For this aspect, there is an overwhelming need to create a unified logical design *by research* before mapping to HL7 or any other interoperability language.

Specialist technologies (e.g. *via* hardware) can radically increase value of a service 'package'. In the context of the diabetes NSF applications, our recent focus has been wireless 'sensor net' technologies. In this case the 'adaptor' capabilities of applications—integrating 'hard' (non-software) elements—can be exploited to integrate these isolated devices into high-value services. Applications allow diverse device data inputs to contribute to the problem's solution. In principle this can 'plant' any innovative niche product within an advanced service framework — in a so-called 'Service Creation Factory'.

As illustrated earlier, innovative individuals with entrepreneurial drive—from universities, companies, government departments etc.—should be able to collaborate to create real applications. Of benefit to inventors of technology components that lose value when licensed as a 'standalone' - the same inventions can gain value as part of an integrated application *platform*. In the exemplar, novel sensor device designs (e.g. wireless hologram-based glucose sensors) combined with cutting-edge mathematical techniques to analyse 'real time' data streams. This can be a real strength of 'hand-picked' consortium-based interdisciplinary research—free choice of component solutions to achieve target solutions for well-defined, policy-relevant, end-user problems.

Global standards for real-time data flow across multiple applications

The application platforms we propose can interface thousands of 'niche' medical and lifestyle-ambient sensors (e.g. specialised measurement devices or alarms — see figure at right) to *supply data* into multiple advanced service applications. In this scheme, wireless data hubs can 'join-up' device inputs in any part of the patient's path - in the clinic, at home, or when mobile. Hard-wired high bandwidth 'legacy' data sources like medical imaging machines (e.g. MRI) or transactional messages can also be 'pulled' into applications via data hubs in clinical environments.



Platform standardisation—wireless sensor device 'ecosystems' for home/mobile/clinical data hubs. Wireless devices have profound advantages in creating flexible data flows into telehealth applications. Examples are specialised clinical measurement devices (left) and/or lifestyle-ambient alarm sensors (right). *Integrated supply* of these devices, serving demands of citizen- (patient- client-) centred applications is a major opportunity for Welsh instrumentation companies— i.e. within advanced translational services adhering to globally-interoperable device standards—see www.continuaalliance.org. Interfaces need to meet *Making the Connections* criteria of being 'simple, transparent and cohesive'.

Our proposal for sustaining implementation effort across Wales

The Diabetes NSF knowledge translation exemplar has (by design) many outputs that support national policy drivers to 'attack and prevent endemic problems'. What's emerged are templates and know-how for large-scale science/technology translation, advanced service application developments and a fledgling 'process' for export-ready knowledge economy development. Current examples include capabilities for 'lean clinic' infrastructures, evidence-based service remodelling, sophisticated intervention/outcome analyses, quantitative individualised risk analysis for disease prevention, continuous 'anywhere to anywhere' patient pathway data support and aggregation of national research datasets in near real time—these and other outputs will find significant applications in *any* modern healthcare economy. Crucially, the demonstrators have exemplified the power of 'translational computing' to analyse national priorities and catalyse the development of tools to *provide evidence for re-engineering* to improve information flows between interdependent parts of the economy.

We want to find how benefits of these 'export-driven' approaches can be spread across *all* of Wales. Given that there are no closed markets in an e-economy, defining how 'export' will happen is critical. The 'pipeline' process we currently propose for sustaining this type of effort in Wales (using what we know works) is illustrated in the figure below. To be worthwhile this needs to *significantly* increase high economic value outputs, coordinated by University-led training initiatives *across* the skills spectrum. Innovative 'inclusivity' paths (exploiting investments in national computing infrastructure) still need to be devised by key organisations like e-Wales to encourage wide social participation - especially to counter patterns of 'entrenched' economic inactivity. Self-directed, step-wise paths to improve an individual's prospects to participate in building the new economy—no matter where they live in Wales—is a prerequisite.

This is all a huge challenge, but capturing contributions that help the country pay its way in the world is perhaps a new social leveller. The first step will always be to *evolve* high quality working applications using advanced service infrastructures which 'get straight to the point of problem solving' applying innovative thinking in 'bottom-up' designs, most often from the 'end-users' themselves. These *research demonstrators* would then be candidates for a formalised development process, in partnership with major ICT companies (see figure, below). The 'application maturation' (evolution) process creates an excellent learning model for team members involved in their construc-

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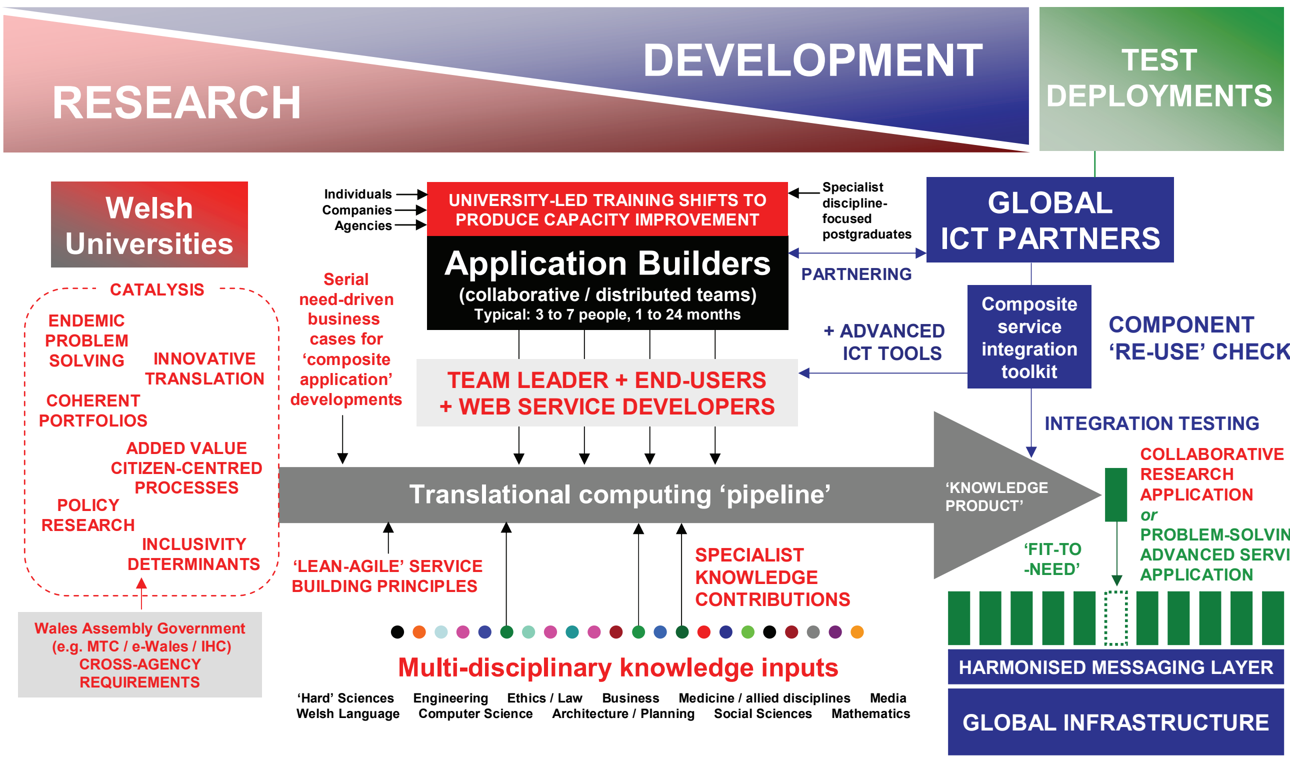

'Attacking and Preventing' key problems by application focus. The figure summarises a sustainable 'pipeline' process to the *serial* creation and development of advanced service applications. These will not be 'all things to all men' but concentrate on problem areas of national and global need. They are a strident bid to focus productivity and international competitiveness based on solid foundations of 'hard' sciences, engineering, ethics/law, business and other knowledge 'domains' as shown.

Sustaining implementation effort across Wales *continued*

tion. The pipeline would 'flow' in response to application demand — sponsors requiring a particular 'composition' could be given pricing options (using analogous examples) in relation to application performance and 'maturation'. The pipeline can create links between diverse areas of the economy—e.g. waste recycling and community-based applications, or build 'first contact points' between strategically-linked areas e.g. integrated transport and work. Understanding 'cross-agency' information flows and their interdependencies (see figure earlier) is critical for bringing about the *Making the Connections* vision and requires significant informatics research to ensure semantic consistency throughout.

Universities across Wales have a fundamental role to play in creating and sustaining a national Knowledge Economy development programme. We have argued that development of 'problem-solving' applications are a good way to 'prioritise and target' skills—clearly the Universities could engage with the 'demand stream' to supply appropriately-trained graduates and postgraduates. We have also argued that any *Science Policy for Wales* should ensure supply of 'discipline-oriented' graduates that are *also* highly skilled in application of advanced information sciences. We see the introduction of a translational applications 'pipeline' as an ideal vehicle to introduce graduates from the 'hard' sciences (and other disciplines, see previous figure) to the advanced capabilities of 'next-generation' ICT *in their field*. We predict many 'specialists' will feel empowered when partnered with computer scientists—they will *enjoy* their new-found ability to design applications for solving problems in their field.

What we propose is logical. Without doing something like this Wales will simply not have (or be able to afford) the pool of highly-skilled talent required to make 'the key linkages' in the globally competitive knowledge economy. The situation will become more acute when FDI (foreign direct investment) increasingly flows towards new EU states. The challenge is how to devise sustainable ways to engage this phenomenal productive potential to impact Wales's long-standing problems such as rural economic decline and economic inactivity in the working age population. The complexity and interdependence of these problems demands a range of initiatives. Significant earnings potential is open to countries that recognise the power of research-based problem solving and devise ways to package and export the solutions. There is a levelling effect in the 'geographical independence' that characterises advanced ICT solutions. The effect could be a positive and increasing 'GDP per-person' where barriers to individuals' participation in the new knowledge economy are systematically removed. This is what Wales *really* needs.

Postscript: Key translational functions of 'e-Science'

e-Science is just a convenient term originally coined for describing 'next generation' information and communication technologies (ICT) such as Grid computing underpinning science activities based on *collaboration*. The shared 'resources' implied by collaboration are typically large data collections, expensive instrument facilities or computational services. 'Grid' computing is named by analogy to electrical power distribution—except that *computing power* is delivered to users 'on demand'. Just as conventional web technology improved ways of doing some things—then ICT based on Grid technologies has great potential to improve the way science, healthcare, public services and other business processes are achieved in the 21st Century. e-Science offers profoundly new ways of working in healthcare. In the EU, this has been underpinned by large-scale academic and industrial consortia coming together under initiatives such as *HealthGrid*. Since 2001, the UK Office of Science and Technology (OST) has been developing an e-Science infrastructure that promotes a range of e-Science-based ICT technologies using Grid computing and service oriented architectures. Part of the purpose of this 'e-Science' activity is to do groundwork for developing a 'Knowledge Economy' in the UK. Initiatives like the DTI Technology Programme and translational application pipeline (described here) are early examples of how this capacity can 'cross-over' from science to society. These schemes have been (and still are) well supported with monies from the Engineering and Physical Sciences Research Council (EPSRC), the Research Councils, Department of Trade and Industry (DTI), Welsh Development Agency (WDA). Welsh universities use these funds to create many high-skill research-related jobs within a comprehensive programmes of projects.

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